CHAPTER ONE
INTRODUCTION

1.1 Background to the Study

Air pollution is the introduction of chemicals, particulate matter, or biological materials that cause harm or discomfort to humans or other living organisms, or cause damage to the natural environment or built environment, into the atmosphere (USEPA, 2010). Air pollution is a major environmental problem affecting both the developing and the developed countries of the world with suspended particulate matter affecting more people globally than any other pollutant on a continuous basis (Richard, et al., 2002). The circumstances surrounding most developing countries, Nigeria inclusive, is more pathetic in view of the utter disregard of pollution limits by most industries, low knowledge of environmental laws, immigration of polluting industries and the general poor living standard which affect people's nutritional status (Oguntoke, Aboaba & Gbadebo, 2009). The effects of poor air quality on human health are far reaching, but principally affect the body's respiratory system and the cardiovascular system (Health Canada, 2010).

Wood and timber processing is a major industry worldwide. The wood processing industry, more specifically the sawmill industry is one of the commonest major primary industries providing direct and indirect employment for thousands of Nigerians (Ugheoke et al, 2009). The process of cutting or shaping the wood (sawmill) leads to the creation of wood dusts of inspirable sizes which pollute the environment, hence sawmill workers have been severally reported to be vulnerable to developing pulmonary diseases (Jinadu and Malomo, 1986; Alakija et al, 1990; Ige and Onadeko, 2000; Okojie et al, 2003; Kuschener and Stark, 2003; Ijadunola et al, 2004; Okwari et al, 2005). Exposure to wood dust originating from a wide range of different tree species is associated with sino-nasal cancer and respiratory health effects (Demers, Teschke and Kennedy, 1997). Several studies have shown associations between dust exposure and both respiratory symptoms and decreased lung function (Shamssein, 1992; Noertjojo et al., 1996; Mandryk, Alwis and Hocking, 2000; Schlunssen et al., 2002; Schlunssen et al., 2004).

Air pollution had been described as a man-made problem from four main sources, namely: industrialisation, tobacco smoking, domestic cooking and vehicular or machinery fuel combustion (Tanimowo, 1995, 1998 & 2000), but a man-made problem needs another man to put it under control. Graveling et al (2011) opined that while the paramount priority of the reduction of risks at source must be acknowledged, respiratory protective equipment (RPE) is, and is likely to remain, a key element of many respiratory risk management programmes. Incidents can be prevented by using appropriate PPE but to be effective, the equipment should be properly selected, worn and kept (Wilson, 2005). According to the USA Centre for Disease Control (2002), in order to prevent and reduce these incidents the focus should be on workers' behaviours because in association with numerous health hazards which are life threatening, behaviours, habits and life styles are of great importance. The major determinants for the use of personal protective equipment (PPE) reported in the literature include risk of exposure and the employees' knowledge of the consequence of such exposure. The major barriers to employees using PPE include: physical discomfort, lack of time, perception of low risk, and disbelief in its efficacy (Carrico et al., 2007; DeJoy et al., 2000; Hwang et al., 2000; Hughson, Mulholland and Cowie, 2002; Macfarlane et al., 2008; Mandel et al., 2000) especially with health staff working in high-risk environments (Linn et al., 1990; Akduman et al., 1999; Ganczak and Szych, 2007). Perception of risk can become a barrier when workers perceive the risk as low because, in such circumstances, they are less convinced of the value of wearing PPE (DeJoy et al., 2000). A study had suggested that enhanced training to emphasize risk could improve subsequent uptake of RPE (Carrico et al., 2007). These studies suggest that an effective intervention should focus on several determinants and be specific to each workplace. They also agreed that propaganda itself is not enough to promote wearing of PPE.

To succeed in healthy behaviour change, health trainers should be aware of the factors affecting the formation of behaviour and theories will help this process. One of the models used for recognizing the behaviour of the individuals is the BASNEF (Belief, Attitude, Subjective Norm, and Enabling Factors) model which is a comprehensive model for studying behaviours. The BASNEF model was proposed by Hubley in 1988, the components of which deal with beliefs, attitudes, subjective norms and enabling factors (Kakaei et al., 2014). This model is used to study behaviour, plan its change and determine the factors affecting the individuals' decision for a behaviour (Charkazi et al., 2013).

According to this model, an individual turns to a new behaviour when s/he believes that the behaviour has some health, economic or other benefits (individual's belief and evaluation of the outcomes of that behaviour). Then, this evaluation leads to the formation of an attitude toward the behaviour in that individual (attitude to the behaviour). Furthermore, there are important people in the individual's life that can affect his/her decision with regard to adopting that new behaviour and act as a barrier or a facilitator (subjective norms). The subjective norms of an individual are also determined by normative beliefs; i.e. the extent to which the new behaviour is approved or rejected by those who are important for him/her. The combination of attitude toward the behaviour and abstract norms leads to the formation of a decision for adopting a new behaviour (behavioural intention); however, factors like skill, money and cost can be influential in changing behavioural intention to a behaviour; these factors must already be present for a behaviour to be formed (enabling factors). In addition to the individual, this model emphasizes the impact of family, society and national levels in the formation of a behaviour; also, it is essential to consider educational, economic, social and political changes for adopting a behaviour (Salehi et al., 2004; Charkazi et al., 2013).

1.2 Statement of the Problem

While there are some reports on Nigerians concerning the effects of wood dust on the respiratory health and lung function of exposed workers especially those working in the sawmill industry (Femi-Pearse, Adeniyi-Jones & Oke, 1973; Fatusi & Erhabor, 1996; Ige & Onadeko, 2000; Ugheoke, Ebomoyi & Iyawe, 2006) there is a dearth of literature on knowledge attitude and practice of sawmill workers in the use of personal protective equipment.

Tanimowo (2000) in his review on air pollution and respiratory health in Africa concluded that vigorous health education campaigns have to be commenced to alert the African peoples on the attendant respiratory consequences of air pollution from all sources as that will ensure that the people co-operate with any control measures taken by the government or health authorities to make cleaner the air they breathe. There is however, a dearth of such attempts towards sawmill workers in Nigeria (Ezenwa, 1997; Awoyemi, 2001).

Health education will only be appropriate and effective when it is structured to fill a gap in knowledge and fitted to modify an error in attitude and motivate practice where there is non-compliance. The BASNEF model has been acknowledged to be an effective model in health education especially in workers safety training (Solhi et al., 2013) but the applicability of this model is yet to be investigated among sawmill workers in Nigeria. Hence, the aim of this study was to survey respiratory health (selected lung function indices and symptoms of respiratory diseases) and determine the efficacy of BASNEF model-based respiratory protection education in promoting the use of personal protective equipment among sawmill workers who are exposed to high ambient air wood dust content.

1.3 Research Questions

The study sought to answer the following questions:

1. What is the respiratory health profile (selected lung function indices and symptoms of respiratory diseases) of sawmill workers in Ibadan?
2. How does the respiratory health profile (selected lung function indices and symptoms of respiratory diseases) of sawmill workers in Ibadan compared with that of individuals that are not exposed to wood dust?
3. What is the level of knowledge, attitude and practice of Nigerian sawmill workers concerning the health hazards of wood dust exposure and the necessary personal protective equipment use?
4. Will a structured BASNEF model-based respiratory protection education programme significantly influence the knowledge; attitude and practice of sawmill workers in Ibadan concerning personal protective equipment use?

1.4 Aims of Study

This study was therefore aimed at:

1. Surveying the respiratory health profile (lung function indices and the prevalence of respiratory symptoms) of sawmill workers
2. Comparing the respiratory health profile (lung function indices and the prevalence of respiratory symptoms) of sawmill workers with age and sex-matched apparently healthy subjects not exposed to wood dust
3. Assessing the knowledge, attitude and practice of sawmill workers concerning the hazard of wood dust exposure, the need for personal protection and personal protective equipment (PPE)
4. Assessing the impact of a PPE education programme in line with the BASNEF model on the workers' knowledge, attitude and practice concerning the hazard of wood dust exposure, the need for personal protection and personal protective equipment (PPE)

1.5 Hypotheses

1.5.1 Major Hypotheses

To be able to draw appropriate inferences from the findings of this study in order to achieve the set aims, the following hypotheses were proposed:

1. There will be no significant differences in the flow/volume spirometry variables between the sawmill workers and age and sex-matched individuals not exposed to wood dust.
2. There will be no significant difference in the sawmill workers' knowledge, attitude and practice on the use of personal protective equipment before and after the BASNEF model-based education.
3. There will be no significant inter-relationship between knowledge, attitude and the use of personal protective equipment among the sawmill workers.

1.5.2 Sub-Hypotheses

For in-depth analysis of the findings from this study, the following 27 sub-hypotheses were generated from the three major hypotheses:

1. There will be no significant difference in the forced vital capacity (FVC) between the sawmill workers and age and gender-matched individuals not exposed to wood dust.
2. There will be no significant difference in the forced expiratory volume in the first second (FEV_1) between the sawmill workers and age and gender-matched individuals not exposed to wood dust.
3. There will be no significant difference in the Peak expiratory flow rate (PEFR) between the sawmill workers and age and gender-matched individuals not exposed to wood dust.
4. There will be no significant difference in the forced expiratory ratio (FEV_1/FVC %) between the sawmill workers and age and gender-matched individuals not exposed to wood dust.
5. There will be no significant relationship between the forced vital capacity (FVC) and the length of engagement in the sawmill work among the sawmill workers.
6. There will be no significant relationship between the forced expiratory volume in the first second (FEV_1) and the length of engagement in the sawmill work among the sawmill workers.
7. There will be no significant relationship between the Peak expiratory flow rate (PEFR) and the length of engagement in the sawmill work among the sawmill workers.
8. There will be no significant relationship between the forced expiratory ratio (FEV_1/FVC %) and the length of engagement in the sawmill work among the sawmill workers.
9. There will be no significant difference in the forced vital capacity (FVC) of sawmill workers at high level of wood dust exposure (based on job description) and those at moderate level of wood dust exposure.
10. There will be no significant difference in the forced expiratory volume in the first second (FEV_1) of sawmill workers at high level of wood dust exposure (based on job description) and those at moderate level of wood dust exposure.
11. There will be no significant difference in the Peak expiratory flow rate (PEFR) of sawmill workers at high level of wood dust exposure (based on job description) and those at moderate level of wood dust exposure.

12. There will be no significant difference in the forced expiratory ratio (FEV_1/FVC %) of sawmill workers at high level of wood dust exposure (based on job description) and those at moderate level of wood dust exposure.
13. There will be no significant difference in the knowledge score between the Training and Non-Training groups before the BASNEF model-based respiratory protection education programme.
14. There will be no significant difference in the attitude score between the Training and Non-Training groups before the BASNEF model-based respiratory protection education programme.
15. There will be no significant difference in the practice score between the Training and Non-Training groups before the BASNEF model-based respiratory protection education programme.
16. There will be no significant difference in the knowledge score concerning wood dust hazard and the use of personal protective equipment before and after the BASNEF model-based health education programme among the untrained sawmill workers group (NTG).
17. There will be no significant difference in the attitude score concerning wood dust hazard and the use of personal protective equipment before and after the BASNEF model-based health education programme among the untrained sawmill workers group (NTG).
18. There will be no significant difference in the practice score concerning wood dust hazard and the use of personal protective equipment before and after the BASNEF model-based health education programme among the untrained sawmill workers group (NTG).
19. There will be no significant difference in the knowledge score concerning wood dust hazard and the use of personal protective equipment before and after the BASNEF model-based health education programme among the trained sawmill workers group (TG).
20. There will be no significant difference in the attitude score concerning wood dust hazard and the use of personal protective equipment before and after the BASNEF model-based health education programme among the trained sawmill workers group (TG).

21. There will be no significant difference in the practice score concerning wood dust hazard and the use of personal protective equipment before and after the BASNEF model-based health education programme among the trained sawmill workers group (TG).
22. There will be no significant difference in the knowledge score between the Training and Non-Training groups after the BASNEF model-based respiratory protection education programme.
23. There will be no significant difference in the attitude score between the Training and Non-Training groups after the BASNEF model-based respiratory protection education programme.
24. There will be no significant difference in the practice score between the Training and Non-Training groups after the BASNEF model-based respiratory protection education programme.
25. There will be no significant difference in the change in knowledge score between the Training and Non-Training groups after the BASNEF model-based respiratory protection education programme.
26. There will be no significant difference in the change in attitude score between the Training and Non-Training groups after the BASNEF model-based respiratory protection education programme.
27. There will be no significant difference in the change in practice score between the Training and Non-Training groups after the BASNEF model-based respiratory protection education programme.

1.6 Delimitations

This study was delimited to:

1. Four hundred sawmill workers.
2. Four hundred apparently healthy age and sex-matched individuals.
3. The spirometric measures of forced vital capacity (FVC), forced expiratory volume in the first second (FEV_1), and peak expiratory flow rate (PEFR). The FEV_1/FVC% was also calculated.
4. A Micro Medical Spirometer (Microplus, England) for the flow/volume spirometry.
5. Respiratory Health Questionnaire (RHQ) for the survey of respiratory symptoms

6. Personal Protective Equipment Knowledge, Attitude and Practice Questionnaire (PPE-KAP) for the assessment of the Knowledge, Attitude and Practice of sawmill workers before and after the BASNEF model-based health education intervention.

1.7 Limitations

1. The data collection required the participants to recall their experiences of symptoms and events and therefore might not have been free of recall bias.
2. Individuals who have had any respiratory disorder that could compromise the lung function were excluded from the study. Prospective participants were asked if they had been diagnosed to have any respiratory condition or had been treated recently for any chest condition. For such screening one had to depend on the responses of the prospective participants and believe their reports. Participation by any individual with such condition due to non-disclosure could be a source of overestimation of the prevalence of respiratory symptoms.

1.8 Significance of Study

1. This study has provided information on factors related to personal protective equipment use among sawmill workers and these will guide the efforts to enhance compliance to protective guidelines among this group of workers thereby stemming the burden of respiratory diseases among them.
2. It has also shown the suitability and effectiveness of the BASNEF model-based health education for promoting personal protective equipment use among this group of workers.
3. The study also provided the opportunity for participants to overcome the problem of unavailability of necessary personal protective equipment as they were given as a token of appreciation for their participation in the study.
4. For continuous availability of the equipment, the Sawmill Workers Associations were linked with the suppliers so that their members could access the equipment through the Association.

1.9 Definition of Terms

For the purpose of this study, the following terms are defined as presented below:

Sawmill:

An industrial establishment where timber is sawn into planks (Collins, 2014)

Sawmill Workers:

Individuals who carry out a range of manual tasks in the sawmill and operate the various machinery used to process the timber. They include machine operators (circular and planning), machine off-loaders, dust packers, wood loaders, plank sellers and carpenters.

Personal Protective Equipment:

Personal Protective Equipment is defined in the Personal Protective Equipment at Work Regulations (HSE, 1992) as: 'All equipment (including clothing affording protection against the weather) which is intended to be worn or held by a person at work which protects them against one or more risks to their health and safety'.

Respiratory Protection

Respiratory protection is defined as any device that is worn by the user to reduce or eliminate exposure to harmful contaminants through the inhalation of those contaminants. These devices include, but are not limited to: dust masks, dual and single cartridge half-mask and full-face respirators, gas masks, powered air-purifying respirators, supplied-air respirators, and self-contained breathing apparatuses (College of St. Benedict and St. John University).

CHAPTER TWO

LITERATURE REVIEW

Chapter 1 provided a background and justification for this study. It also identified the research questions for the study and generated the hypotheses through which appropriate inferences would be drawn from the data gathered. This chapter (chapter 2) aims to review previous relevant studies in order to be guided and to clearly reveal the gaps in existing knowledge which this study intended to fill. The chapter is organised into eight major sections:

2.1 Air pollution

2.2 Environmental pollution and respiratory health

2.3 Burden of respiratory diseases

2.4 Respiratory protection

2.5 Knowledge, Attitude and Practice (KAP) Studies

2.6 Health education

2.7 KAP studies on personal protective equipment use

2.8 Previous studies that used the BASNEF model-based health education

2.1 Air pollution

Air pollution is the introduction of chemicals, particulate matter, or biological materials that cause harm or discomfort to humans or other living organisms, or cause damage to the natural environment or built environment, into the atmosphere (USEPA, 2010). Air pollution is a major environmental problem affecting both the developing and the developed countries of the world with suspended particulate matter affecting more people globally than any other pollutant on a continuous basis (Pope III et al., 2002). The circumstances surrounding most developing countries, Nigeria inclusive, is more pathetic in view of the utter disregard of pollution limits by most industries, low knowledge of environmental laws, immigration of polluting industries and the general poor living standard which affect people's nutrition status (Oguntoke et al, 2009).

The World Health Organisation has always been interested in the subject of air pollution, and one of its expert committees on "Atmospheric Pollution" approved the basic conclusions of a WHO Inter-Regional Symposium on criteria for "Air Quality" and methods of measurement and suggested as guides to air quality, four categories of concentrations and exposure times, and corresponding effects (WHO, 1964).

Level I:

This involves concentrations and exposure times at or below which, according to present knowledge, neither direct nor indirect effects (including alteration of reflexes or of adaptive or protective reactions) have been observed.

Level II:

This involves concentrations and exposure times at and above which there is likely to be irritation of the sensory organs, harmful effects on vegetation, visibility reduction, or other adverse effects on the environment.

Level III:

This involves concentrations and exposure times at and above which there is likely to be impairment of vital physiological functions or changes that may lead to chronic diseases or shortening of life.

Level IV:

This involves concentrations and exposure times at and above which there is likely to be acute illness or death in susceptible groups of the population.

Level I is of primary practical interest for the control of atmospheric pollution, since no concentrations above that level should be permitted. There is strong evidence for an adverse effect of air pollution on lung function growth from the Southern California Children's Health Study. In adults, several cross-sectional studies observed lower levels of lung function in more polluted communities (Gotschi et al., 2008).

2.1.1 Domestic air pollution

In most homes in Africa, cooking with firewood, charcoal or kerosene is the rule rather than the exception. An association had been found between the use of firewood for cooking and early morning expectoration and persistent phlegm as far back as four decades ago (Femi-Pearse et al., 1976). They reported that 72% of their respondents used wood for cooking and they regarded this as the greatest source of atmospheric pollution in Nigeria. Sofoluwe (1968), working in Lagos, Nigeria visited the homes of 98 children suffering from bronchiolitis and pneumonia and found that these patients had been exposed to high concentrations of carbon monoxide, nitrogen dioxide, sulphur dioxide and bezene. Domestic air pollution has also been found to contribute to the development of asthma in Kenyan school children long ago (Mohamed et al., 1995), and acute respiratory infections in Ugandan children (Tumwesigire and Barton, 1995). Mozambican women who cook with firewood have been shown by Ellegard (1996) to have a high prevalence of respiratory symptoms, especially cough. In South Africa, more than 20 million people are said to rely on traditional (wood) and transitional (coal and kerosene) fuels to fulfil their basic energy needs, that is, cooking and space heating, and studies have confirmed their exposure to high concentrations of air pollutants (Terblanche et al., 1993) with the attendant respiratory impairment.

There are studies in Africa to prove that the people are exposed to air pollution from vehicular and machinery fuel combustion (Tanimowo, 1998). A study by Ogunsola et al. from Nigeria (1994) has also shown that traffic wardens have a higher blood lead levels than controls and they also have reduced spirometric measurements than controls. In South Africa, Nriagu et al. (1996) have also demonstrated higher average atmospheric concentrations of lead in industrial and commercial areas of Durban than in the residential areas.

2.1.2 Occupational exposure

Occupational toxicant exposures have an important role in many cases of lung diseases seen in workers (Kuschener and Stark, 2003). In Nigeria, various studies have shown the role of occupational exposure to environmental pollutants in the incidence of respiratory diseases (Jinadu and Malomo, 1986; Alakija et al, 1990; Ige and Onadeko, 2000; Okojie et al, 2003; Ijadunola et al, 2004; Okwari et al, 2005). Cough, sputum production and breathlessness are some of the reported respiratory symptoms in these workers, while occupational asthma (Rastogi et al, 1989) and hypersensitivity pneumonitis (Brooks et al, 1981) are recognized clinical syndromes common in such workers. The overall effect of these is a lower level of lung function in these workers.

2.1.3 Wood dust exposure

Exposure to wood dust originating from a wide range of different tree species is associated with sino-nasal cancer and respiratory health effects (Demers, Teschke and Kennedy, 1997). Several studies have shown associations between dust exposure and both symptoms and decreased lung function (Shamssein, 1992; Noertjojo et al., 1996; Mandryk, Alwis and Hocking, 2000; Schlunssen et al., 2002; Schlunssen et al., 2004) while others did not find such association (Talini et al., 1998; Bohadana et al., 2000; Borm et al., 2002).

Timber processing factories (sawmills) abound in Nigeria especially in the rain forest zone, because of the availability of timber in the zone. Wood dust (sawdust), a by-product of timber processing, is found in abundance in the sawmill industry, where it constitutes an occupational hazard. The Factories Act of Nigeria (1987) was designed to protect workers, as the legislations make provisions for the health safety and welfare of workers. Unfortunately, government is not enforcing the laws for various reasons such as insufficient manpower for enforcement. Factory inspectors are very few and the absence of health service in the sawmill industry and ignorance on the part of the workers according to Asogwa (2000) have resulted in their being exposed to hazards that have grievous consequences on their health.

Most of the tree species processed in this environment is highly allergenic (International Labour Organization, 1972), such as Mansonia, Iroko and Walnut species. Such tree species may contain high levels of irritant chemicals such as monoterpenes which have been shown to increase work related symptoms (Rosenberg et al, 2002). Another reason may be exposure to spores of moulds, which are known to cause several respiratory symptoms and mucous membrane irritation among wood workers. (Edward et al, 1993; Dutkiewicz et al, 2001).

Wood dust is emitted at high velocity by moving or spinning machine components. The primary method of controlling wood dust is with local exhaust ventilation (LEV), which removes dust at or near its source. LEV systems can often be integrated with machine guards. Exhaust hoods should be located as close as possible to the emission source, either on the woodworking machinery itself or near to the machine. The local exhaust systems should have an efficient air cleaning device (OSHA, 1999). Employers can protect workers from wood dust through a combination of engineering and work practice controls. Where necessary, employers are expected to provide PPE as a supplement to these controls (OSHA, 1999).

2.2 Environmental pollution and respiratory health

The human health effects of poor air quality are far reaching, but principally affect the body's respiratory system and the cardiovascular system (HealthCanada, 2010). Inhaling particulate matter has been widely studied in humans and animals, and is known to have certain effects that include asthma, lung cancer, cardiovascular issues, and premature death. Exposure to dust is also known to cause various types of dermatoses (WHO 1999)

Exposure to pollutants such as airborne participate matter and ozone has been associated with increases in mortality and hospital admissions due to respiratory and cardiovascular disease. These effects have been found in short-term studies, which relate day-to-day variations in air pollution and health, and long-term studies, which have followed cohorts of exposed individuals over time. Effects have been seen at very low levels of exposure, and it is unclear whether a threshold concentration exists for particulate matter and ozone below which no effects on health are likely. (Brunekreef and Holgate, 2002). In healthy and asthmatic volunteers, airborne particles increase bronchial responsiveness, airway resistance, and bronchial tissue mast cell, neutrophil, and lymphocyte counts (Holgate et al., 2003).

An extensive body of evidence links exposure to outdoor air pollution and health effects. Evidence is derived from epidemiologic studies (mostly time series studies and cohort studies), toxicologic studies of animals, and controlled human exposure studies (chamber studies); therefore, most studies provide level two (2) evidence. The health effects considered are measured by short-term exposure to pollutants of hours, days, or weeks and long-term exposure of months or years (Abelsohn and Stieb, 2011). The effects of short-term exposure include exacerbation of pre-existing respiratory disease (especially asthma and COPD) with increased hospitalization and emergency department visits. Long-term exposure to air pollution is associated with increased mortality, increased incidence of lung cancer and pneumonia. Although it was previously understood that air pollution led only to exacerbation of asthma, there is now evidence from cohort studies that long-term exposure to air pollution might lead to development of new asthma and might delay development of the lungs (Abelsohn and Stieb, 2011). A summary of recent studies on the effects of environmental pollution on respiratory health is presented in table 2.1.

2.2.1 Mechanisms of action of air pollution

Air pollution causes pathological damage in three different parts of the lung, namely, the major bronchi, the terminal bronchioles, and the alveoli (Bates, 1972).

Major bronchi:

With acute exposure, there may be reversible bronchospasm with considerable individual variation. The longer term effects are more important and they result from particles with size 2.0-50.0μ and/or gas exposure, such as, sulphur dioxide, nitrogen dioxide and ozone. These effects consist of: (i) paralysis of cilia; (ii) hyper secretion of bronchial mucous glands; (iii) mucous gland hypertrophy and extension into smaller air ways, a phenomenon documented by Reid to occur as a result of exposure of rats to high concentrations of sulphur dioxide; (iv) increased susceptibility to infections as a consequence of the above factors and; (v) these factors lead to a chronic productive cough in the long term.

Terminal bronchioles:

Smaller particles(0.01-2.0μ) will penetrate and be deposited in this region, and there could be potentiation of effects if gases and particles are inhaled concurrently as in cigarette smoke. Most of the sulphur dioxide that is breathed in is stopped in the nose, and soluble gases such as oxides of nitrogen are similarly diminished if breathed in the gas form. Combined with particles, these gases get further down the lung and have greater effect in lower concentration. There are also some experimental data and some human data indicating that acute exposure to high concentrations of oxides of nitrogen characteristically produces pulmonary oedema and fibrosing bronchiolitis rather than

Table 2.1 Summary of recent studies on respiratory health effects of environmental pollution

EXPOSURE	HEALTH EFFECTS	STUDY
Short term	Increased wheeze	Clark et al, 2010
	Exacerbation of asthma	McCreanor et al, 2007
		Holguin, 2008
		O'Connor et al, 2008
		Delfino et al, 2009
	Exacerbation of chronic obstructive pulmonary disease	Halonen et al, 2008
		Sint et al, 2008
		Zanobetti et al, 2008
	Bronchiolitis and other respiratory infections	Ségala et al, 2008
		Karr et al, 2009
	Increased emergency department visits	Stieb et al, 2009
Long term	Increased incidence of pneumonia	Neupane et al, 2010
	Increased incidence of lung cancer	Laden et al, 2006
	Impaired lung development in children	Gauderman et al, 2004
	Development of new asthma	Dell et al, 2008
		Jerrett et al, 2008
		Künzli et al, 2009
		Lindgren et al, 2009
		Clark et al, 2010

chronic bronchitis or bronchiectasis. These gas exposures produce the following effects in the terminal bronchioles: (i) loss of normal defences; (ii) adverse effect on surfactant, which has something to do with keeping these small airways patent; (ii) goblet cell metaplasia; (iv) inflammation and obliteration and; (v) premature closure of airways, which is what has been demonstrated with increased closing volume in cigarette smokers.

Alveoli:

Particles of range order 0.01-0.05μ are particularly likely to get to this region and in modern city air, there are plenty of particles in this size range. It is difficult to calculate how much of a gas such as ozone actually reaches the alveolar level because it is so reactive to surfaces, and it is possible that much of it has disappeared before reaching the alveolar wall. Some gases, such as, sulphur dioxide may be absorbed in the nose and later removed through the alveoli and then exert their effect not by having them delivered to the alveoli through the bronchial tree but by rediffusion out from the blood into alveolar gas. If both particulate and gaseous pollution are present there is potentiation of effects, and the major consequences of each of these is an increase in cells and macrophages in the lung. There is ample evidence that this is the primary response to most of these challenges, and an increased aggregation of macrophages and leucocytes occurs quite quickly in response to most of them. The presence of these cells will enhance the release of proteolytic enzymes, causing alveolar destruction in individuals with inherited deficiency of serum antitrypsin, with the subsequent possibility of developing emphysema.

2.3 Burden of illness from air pollution

Outdoor (ambient) air pollution has a substantial influence on the health of Canadians. Both short-term and long-term exposures to air pollution affect the respiratory and cardiovascular systems. Recent research has highlighted the extent of the effects of air pollution on the cardiovascular system, the complex mechanisms of these effects, and the fact that adverse health effects occur at low pollution levels, similar to those of the air that Canadians in many parts of the country breathe (Abelsohn and Stieb, 2011).

There is a meaningful burden of illness from air pollution, but because air pollution cannot be measured in the individual patient, much like hypertension, it is usually not apparent as a causative agent in clinical practice. In 2004, Health Canada estimated that air pollution caused nearly 6000 premature deaths in 8 cities in Canada each year, which accounted for approximately 8% of deaths from all causes in the study population. Long-term exposure accounted for more than 70% of these deaths (Judek et al., 2004). The Canadian Medical Association extended this analysis to the entire country and estimated that approximately 21000 deaths from all causes (excluding accidents and violence) could be attributed to air pollution in 2008 (approximately 10% owing to short-term exposure), together with 11000 cardiac- and respiratory-related hospital admissions and 92000 emergency department visits. National economic damages (including lost productivity, health care costs, pain and suffering, and loss of life) have been estimated to be $8 billion (Canadian Medical Association, 2008)

A new systematic analysis of all major global health risks has found that outdoor air pollution in the form of fine particles is a much more significant public health risk than previously known − contributing annually to over 3.2 million premature deaths worldwide and over 74 million years of healthy life lost. It now ranks among the top global health risk burdens (Lim et al., 2012). The analysis applied consistent methods to the largest global database ever assembled to estimate risks of premature mortality and contributions to global health burden from a wide variety of risks: smoking, diet, alcohol, HIV AIDS, household and outdoor air pollution, and many more. For the first time it places outdoor air pollution among the top 10 risks worldwide and among the top five or six risks in the developing countries of Asia. It documents as well that household air pollution from the burning of solid fuels is responsible for a substantial burden of disease in low- and middle income countries. This new analysis identifies especially high risk levels in the developing countries of Asia where air pollution levels are the highest in the world. Overall GBD 2010 estimates over 2.1 million premature deaths and 52 million years of healthy life lost in 2010 due to ambient fine particle air pollution, fully two-thirds of the burden worldwide. Among other risk factors studied in the GBD, outdoor air pollution ranked fourth (4th) in mortality and health burden in East Asia (China and North Korea) where it contributed to 1.2 million deaths in 2010, and sixth (6th) in South Asia (including India, Pakistan, Bangladesh and Sri Lanka) where it contributed to 712,000 deaths in 2010. The analysis found that reducing the burden of disease due to air pollution in Asia will require substantial decreases in the high levels of air pollution in those regions. The findings suggest that a large burden of disease in many parts of the world is attributable to particulate matter pollution, which is substantially higher than estimated in previous analyses.

In middle-income countries, such as in Middle East and North African (MENA) countries, COPD is emerging as public health problem. However, the disease is certainly under diagnosed. In fact, the diagnosis is made when it becomes clinically apparent and in late stage (Aït-Khaled et al., 2001). In 2001, the prevalence of COPD in Africa was estimated to be 179/100,000 and 301/100,000 in eastern Mediterranean countries. This prevalence was low compared with America and Europe (Lopez et al., 2006). In Algeria prevalence of COPD more than 40 years was 125/100,000 people in 1990 (Aït-Khaled et al., 2001).

COPD affects men more frequently than women, because of less frequent smoking in women. It usually appears after 40 years of age, and increases in frequency with age. Main risk factors for chronic respiratory diseases (CRD) in MENA are represented by tobacco smoke, second hand tobacco smoke, and other indoor and outdoor air pollutants. In This region, COPD affects people with low socioeconomic status. In fact, it has been demonstrated that smoking is more prevalent in illiterate people (Aït-Khaled et al., 2001; Fakhfakh et al., 2002). In MENA, CRD are also a result of environmental factors such as indoor air pollution from biomass fuel, used for cooking and heating, which appears to contribute to COPD in women in MENA countries, but less frequent comparing to African countries (Chan-Yeung et al., 2004; Salvi and Barnes, 2009) An estimated 25–45% of patients with COPD are not smokers but exposed to smoke from biomass, suggesting that exposure to biomass smoke contributes largely in social and economic impact of CRD (Salvi and Barnes, 2009)

COPD is a major cause of chronic morbidity and mortality and represents a substantial economic and social burden throughout the world. It is the 5th leading cause of death worldwide and further increases in its prevalence and mortality are expected in the coming decades, being projected to be the third cause of death in the world by 2020 (Halbert et al., 2003). In low- and middle income countries, COPD is also one of the 10 leading causes of death (Ko et al., 2008). In Africa, mortality resulting from COPD is globally estimated to be 18.1/100,000 in 2001 (Lopez et al., 2006). General Cost of CRD in MENA countries remains poorly recognized and difficult to estimate because of lack of data from these countries. However, it is expected that direct costs in COPD are heavy.

In most developing countries including Nigeria, the burden of respiratory disease is largely unknown (Akanbi et al., 2009). A nationwide survey of non-communicable diseases was

carried out in Nigeria (Akinkugbe, 1997) but it unfortunately excluded respiratory diseases. There are no national data on the prevalence of COPD. Risk factors for COPD, however, abound (Akanbi et al., 2009). National surveys on smoking patterns show an increase in the

number of smokers, with the age of onset of smoking progressively falling (Akinkugbe, 1997; Eder et al., 2006) A more important risk factor for COPD, especially among women, is the exposure to biomass smoke. Wood remains an important cooking fuel in many homes in

Nigeria. COPD resulting from such exposures has been reported in some parts of the continent (Gordon and Graham, 2006; Erhabor and Kolawole, 2002)

2.4 Respiratory protection

2.4.1 Personal protective equipment

Management of hazards requires the application of the traditional industrial hygiene responsibilities of anticipation, recognition, evaluation, and control to characterize the work environment, evaluate tasks and equipment, identify hazards, define exposure groups, and recommend controls. Hazards can then be further defined and the risks quantified through industrial hygiene samples and subsequent analyses of the derived data and comparisons with acceptable standards. The product of recognition and evaluation is an understanding of exposure potentials, resulting in effective engineering controls that, at a minimum, reduce exposures to within acceptable levels and, optimally, eliminate the exposure (Sargent and Gallo, 2003). According to these authors, the proper selection of control measures is based on a hierarchy of elimination and minimization by engineering controls, followed last by personal protective equipment when exposures cannot be eliminated.

Personal Protective Equipment (PPE) is safety clothing and equipment for specified circumstances or areas, where the nature of the work involved or the conditions under which people are working requires its wearing or use for their personal protection to immunize risk (UniSA, 2008). Personal Protective Equipment has also been defined as "all equipment (including clothing affording protection against the weather) that are intended to be worn or held by a person at work and which protects him against one or more risks to his health or safety, e.g. safety helmets, gloves, eye protectors, high-visibility clothing, safety footwear and safety harnesses" (HSE, 2005).

Prior to any procedure being undertaken, a risk assessment should be conducted to determine which PPE should be used for a procedure or task. The nature of the task, the duration of the task, the potential for exposure to blood and body fluids, the potential for contamination of non-intact skin or mucous membranes should all be taken into account. Gloves were first used by obstetricians as a form of barrier protection in 1758 (Fay and Dooher, 1992). The use of gloves has increased considerably since that time. With the introduction of universal precautions during the 1980s, which are now referred to as standard infection control precautions, gloves are used to protect against any microorganisms from both the patient and the health care worker. Wearing gloves, however, does not replace the need for hand washing following a procedure or period of care (Pratt et al., 2007).

According to OSHA (2003), the cooperative efforts of both employers and employees will help in establishing and maintaining a safe and healthful work environment in order to ensure the greatest possible protection for employees in the workplace.
In general, employers are responsible for:

1. Performing a "hazard assessment" of the workplace to identify and control physical and health hazards.
2. Identifying and providing appropriate PPE for employees.
3. Training employees in the use and care of the PPE.
4. Maintaining PPE, including replacing worn or damaged PPE.
5. Periodically reviewing, updating and evaluating the effectiveness of the PPE program.

In general, employees should:

1. Properly wear PPE,
2. Attend training sessions on PPE,
3. Care for, clean and maintain PPE, and
4. Inform a supervisor of the need to repair or replace PPE. (OSHA, 2003)

2.4.2 Respiratory protection programme and training

Once it is decided that personal protective equipment is needed, specific regulations and guidelines define safety standards including the elements of a sound respiratory protection program (Sargent and Gallo, 2003). The elements of such program (Table 2.2) include respirator selection (including appropriate protection factors), medical evaluation, fit testing, training, inspection, maintenance and care, quality, quantity and flow of breathing air, and routine and emergency use procedures (Sargent and Gallo, 2003). According to OSHA (2011) employers are required to include procedures for the listed elements (as applicable) in their respiratory protection program.

In the 2011 publication of OSHA on Small Entity Compliance Guide for the Respiratory Protection Standard, employers are required to develop a written respiratory protection program with procedures that are specific to your worksite; implement the program and update it as necessary; and assign a qualified program administrator to run and evaluate the program. Additionally, they are required to ensure that certain requirements of the respiratory protection program are followed by employees who wear a respirator voluntarily (that is, they wear respirators even though respirator use is not required by either the employer or the local regulatory body). OSHA (2011) provides a checklist on establishing a written respiratory protection program that is useful for guidance on the required content of the respiratory protection program (Table 2.3).

According to the OSHA (2011) guideline, employers are expected to make sure that each employee demonstrates an understanding of the PPE training as well as the ability to properly wear and use PPE before they are allowed to perform work requiring the use of the PPE. If an employer believes that a previously trained employee is not demonstrating the proper understanding and skill level in the use of PPE, that employee should receive retraining. Other situations that require additional

Table 2.2 Elements of a respirator programme

1. Procedures for selecting respirators
2. Periodic evaluation of employees required to use respirators
3. Fit testing procedures for tight-fitting respirators
4. Procedures for proper use of respirators in routine and reasonably foreseeable emergencies
5. Inspection of respirators (both emergency and nonemergency devices)
6. Provisions for the maintenance and care of respirators
7. Provisions for adequate breathing air quality, quantity, and flow for atmosphere-supplying respirators
8. Training of employees in the respiratory hazards to which they are exposed during routine and emergency situations
9. Program evaluation and auditing

(Sargent and Gallo, 2003)

Table 2.3 Checklist for Respiratory Protection Programmes

	√ **Does your program contain written procedures for (check all that apply):**
☐	Your specific workplace
☐	Selecting respirators
☐	Medical evaluations of employees required to wear respirators
☐	Fit testing
☐	Routine and emergency respirator use
☐	Schedules for cleaning, disinfecting, storing, inspecting, repairing, discarding, and maintaining respirators
☐	Ensuring adequate air quality for supplied-air respirators
☐	Training in respiratory hazards
☐	Training in proper use and maintenance of respirators
☐	Program evaluation
☐	Ensuring that employees who voluntarily wear respirators (excluding filtering face-pieces) comply with the medical evaluation and cleaning, storing and maintenance requirements of the standard
☐	A designated program administrator who is qualified to administer the program
☐	Updating the written program as necessary to account for changes in the workplace affecting respirator use
☐	Providing equipment, training and medical evaluations at no cost to employees
	If you did not check all of the boxes above, your respiratory protection program **does not** meet OSHA standards.

(OSHA, 2011)

or retraining of employees include changes in the workplace or in the type of required PPE that make prior training obsolete. The employer is expected to document the training of each employee required to wear or use PPE by preparing a certification containing the name of each employee trained, the date of training and a clear identification of the subject of the certification.

2.5 Knowledge, attitude and practice (KAP)

Knowledge, attitude and practice act as three pillars, which make up the dynamic system of life itself. Knowledge is some information that is acquired or gained. It results in congeniality and advertence about an eclectic thing or a situation. There could be many ways of procuring knowledge namely reading, sagacity etc. Knowledge, being the basic criterion that allows one to earmark between the right and the wrong, is a mixture of comprehension, experience, discernment and skill. Attitude accredits to thinking towards a proper situation. There could be a number of furtherance to empathize a situation but it depends on how an individual reacts towards the situation. Practice means contemplation of rules and knowledge that lead to action. Thus, a right knowledge, a positive attitude and a good practice are imperative to guide and serve the patients (Jain et al., 2010).

2.5.1 Description of KAP studies

A KAP survey is a representative study of a specific population to collect information on what is known, believed and done in relation to a particular topic (WHO 2008). In most KAP surveys, data are collected orally by an interviewer using a structured, standardized questionnaire. These then can be analyzed quantitatively or qualitatively depending on the objectives and design of the study. Besides, KAP survey data are essential to help plan, implement and evaluate the particular topic. It gathers information about what respondents know, what they think, and what they actually do with the particular topic. Moreover, KAP surveys can identify knowledge gaps, cultural beliefs, or behavioural patterns that may facilitate understanding and action, as well as poise problems. They can identify information that is commonly known and attitudes that are commonly held. To some extent, they can identify factors influencing behaviour that are not known to most people, reasons for their attitudes, and how and why people practice certain health behaviour. KAP surveys may be used to identify needs, problems and barriers in program delivery, as well as solutions for improving quality and accessibility of services. A KAP survey can be used to orient resource allocation and project design, and to establish a baseline for comparison with subsequent, post-intervention KAP surveys (WHO 2008).

2.5.2 Steps in KAP studies

There are 6 steps to have a KAP survey (WHO, 2008). They are as follows:

Step 1: Define the survey objectives - contains information about how to access existing information, determine the purpose of the survey and main areas of enquiry, and identify the survey population and sampling plan.

Step 2: Develop the survey protocol - outlines elements to include in the survey protocol and suggestions to help identify the key research questions. Determining whether the survey needs ethical review is critical to this step, as well as creating a work-plan and budget.

Step 3: Design the survey questionnaire - proposes important steps for developing, pre-testing and finalizing the questionnaire, and for making a data analysis plan.

Step 4: Implement the KAP study - includes considerations for choosing survey dates, recruiting and training survey supervisors and interviewers, and managing survey implementation.

Step 5: Analyze the data- consists of entering and checking the quality of the survey data, and implenmenting the data analysis plan created in step 3.

Step 6: Use the data - highlights ideas on how to translate the survey findings into action, elements to include in the study report, and how to disseminate the survey findings.

2.6 Health education

2.6.1 Introduction

The successful application of PPE hinges on proper use by individual employees. They must first understand the risks of handling chemical and biological agents and the processes that might result in exposures. Properly and effectively communicating these risks and the potential result of exposure to the respirator user is believed to increase the probability of the respirator being used at the correct times and in the correct manner. During these communications, it is also possible to obtain additional information and to suggest potential solutions for reducing exposure potentials via open dialogue with the researchers performing the respective tasks (Sargent and Gallo, 2003).

Health education has been defined in many ways by different authors and experts. Downie, Fyfe and Tannahill (1990) defined it as "communication activity aimed at enhancing positive health and preventing or diminishing ill-health in individuals and groups through influencing the beliefs, attitudes and behaviour of those with power and of the community at large". The WHO (1998) defined health education as "comprising consciously constructed opportunities for learning involving some form of communication designed to improve health literacy, including improving knowledge, and developing life skills which are conducive to individual and community health". The 2000 Joint Committee on Health Education and Promotion Terminology defined health education as "any combination of planned learning experiences based on sound theories that provide individuals, groups and communities the opportunity to acquire information and the skills needed to make quality health decisions", by increasing their knowledge or influencing their attitudes Lawrence Green defined it as “a combination of learning experiences designed to facilitate voluntary actions conducive to health” (Yazachew, 2004). Green and Kreuter (2005) defined health education as "any planned combination of learning experiences designed to predispose, enable, and reinforce voluntary behaviour conducive to health in individuals, groups or communities". While the history of health education as an emerging profession is only a little over one hundred years old, the concept of educating about health has been around since the dawn of humans. At the time of Alma Ata declaration of Primary Health Care in 1978, health education was put as one of the components of Primary Health Care and it was recognized as a fundamental tool to the attainment of health for all.

The aims of health education according to Yazachew (2004) include:

1. Motivating people to adopt health-promoting behaviours by providing appropriate knowledge and helping to develop positive attitude.
2. Helping people to make decisions about their health and acquire the necessary confidence and skills to put their decisions into practice.

Yazachew (2004) in discussing the basic principles on which health education is based highlighted the following:

1. All health education should be need based. Therefore before involving any individual, group or the community in health education with a particular purpose or for a program the need should be ascertained. It has to be also specific and relevant to the problems and available solutions.
2. Health education aims at change of behaviour. Therefore multidisciplinary approach is necessary for understanding of human behaviour as well as for effective teaching process.
3. Health Education should start from the existing indigenous knowledge and efforts should aim at small changes in a graded fashion and not be too ambitious. People will learn step by step and not everything together.
4. For every change of behaviour, a personal trail is required and therefore the health education should provide opportunities for trying out changed practices.

Approaches to health education include the persuasion approach and the informed decision making approach:

a) The persuasion approach

This involves a deliberate attempt to influence the other persons to do what we want them to do (directive approach)

b) The informed decision making approach

This involves giving people information, problem solving and decision making skills to make decisions but leaving the actual choice to the people (e.g. family planning methods).

Many health educators feel that instead of using persuasion it is better to work with communities to develop their problem solving skills and provide the information to help them make informed choices. However in situations where there is serious threat such as an epidemic, and the actions needed are clear cut, it might be considered justified to persuade people to adopt specific behaviour changes.

2.6.2 Health behaviour

Human behaviour is among the major determinants of the health of individuals, families or communities. Healthy behaviours contribute to the overall health of individuals and communities and unhealthy behaviours adversely affect the quality of life people at different levels. Most health issues cannot be dealt with by treatment alone. The promotion of health and prevention of diseases will usually involve some changes in life styles or human behaviour.

Some health behaviours have positive attributes while some focus on extinguishing negative attributes. These behaviours can be categorized as risk behaviours and protective behaviours. The WHO (1998) defines risk behaviours as "specific forms of behaviour which are proven to be associated with increased susceptibility to a specific disease or ill health". Protective behaviours aim to protect a person from developing ill health or a specific disease. Green and Kreuter (2005) divided Protective behaviours into health-directed and health-related behaviours. Health-directed behaviours are actions a person consciously pursues for health improvement or health protection, such as seeking an immunization, or eating a low-fat food. Health-related behaviours are actions performed for reasons other than health but that have health effects. An example is an individual who is trying to lose weight in order to improve his or her appearance.

Factors that affect human behaviour are:

1. Predisposing factors:

These factors provide the rationale or motivation for the behaviour to occur. Such factors include knowledge, belief, attitudes and values.

2. Enabling factors:

These are characteristics of the environment that facilitates healthy behaviour and any skill or resource required to attain the behaviour. Enabling factors are required for a motivation to be realized.

3. Reinforcing factors:

These factors come subsequent to the behaviour. They are important for persistence or repetition of the behaviour. The most important reinforcing factors for a behaviour to occur or avoid include family, peers, teachers, employers, health providers, community leaders and decision makers.

2.6.3 Health Behaviour Theories and Models

Theories may assist in the design of behaviour change interventions in various ways (Redding et al., 2000; Michie and Abraham, 2004; Eccles et al., 2005), by promoting an understanding of health behaviour, directing research and facilitating the transferability of an intervention from one health issue, geographical area or healthcare setting to another. The health belief model, social learning theory (later relabelled social cognitive theory), self-efficacy, and locus of control have all been applied with varying success to problems of explaining, predicting, and influencing behaviour.

1. Health Belief Model

The Health Belief Model (HBM) is a psychological model that attempts to explain and predict health behaviors by focusing on the attitudes and beliefs of individuals. The HBM was first developed in the 1950s in response to the failure of a free tuberculosis (TB) health screening program. Since then, the HBM has been adapted to explore a variety of long- and short-term health behaviors, including sexual risk behaviors and the transmission of HIV/AIDS.

The key variables of the HBM are as follows (Rosenstocket al., 1994):

Perceived threat:

This consists of two parts: perceived susceptibility and perceived severity of a health condition.

Perceived susceptibility:

One's subjective perception of the risk of contracting a health condition,

Perceived severity:

Feelings concerning the seriousness of contracting an illness or of leaving it untreated (including evaluations of both medical and clinical consequences and possible social consequences).

Perceived benefits:

The believed effectiveness of strategies designed to reduce the threat of illness.

Perceived barriers:

The potential negative consequences that may result from taking particular health actions, including physical, psychological, and financial demands.

Cues to action:

Events, either bodily (e.g., physical symptoms of a health condition) or environmental (e.g., media publicity) that motivate people to take action. Cues to actions is an aspect of the HBM that has not been systematically studied.

Other variables:

Diverse demographic, socio-psychological, and structural variables that affect an individual's perceptions and thus indirectly influence health-related behavior.

Self-efficacy:

The belief in being able to successfully execute the behavior required to produce the desired outcomes. (This concept was introduced by Bandura in 1977)

The Health Belief Model (Figure 2.1) views health behaviour change as based on a rational appraisal of the balance between the barriers to and benefits of action (Blackwell, 1992). According to this model, the perceived seriousness of, and susceptibility to, a disease influence individual's perceived threat of disease. Similarly, perceived benefits and perceived barriers influence perceptions of the effectiveness of health behaviour. In turn, demographic and socio-psychological variables influence both perceived susceptibility and perceived seriousness, and the perceived benefits and perceived barriers to action (Redding et al., 2000; WHO, 2003). Perceived threat is influenced by cues to action, which can be internal (e.g. symptom perception) or external (e.g. health communication) (Rosenstock, 1974 in WHO, 2003).

High-perceived threat, low barriers and high perceived benefits to action increase the likelihood of engaging in the recommended behaviour (Becker et al., 1979). Generally, all of the model's components are seen as independent predictors of health behaviour (Armitage and Conner, 2000). Bandura (1997) notes, however, that perceived threats – especially perceived severity – have a weak correlation with health

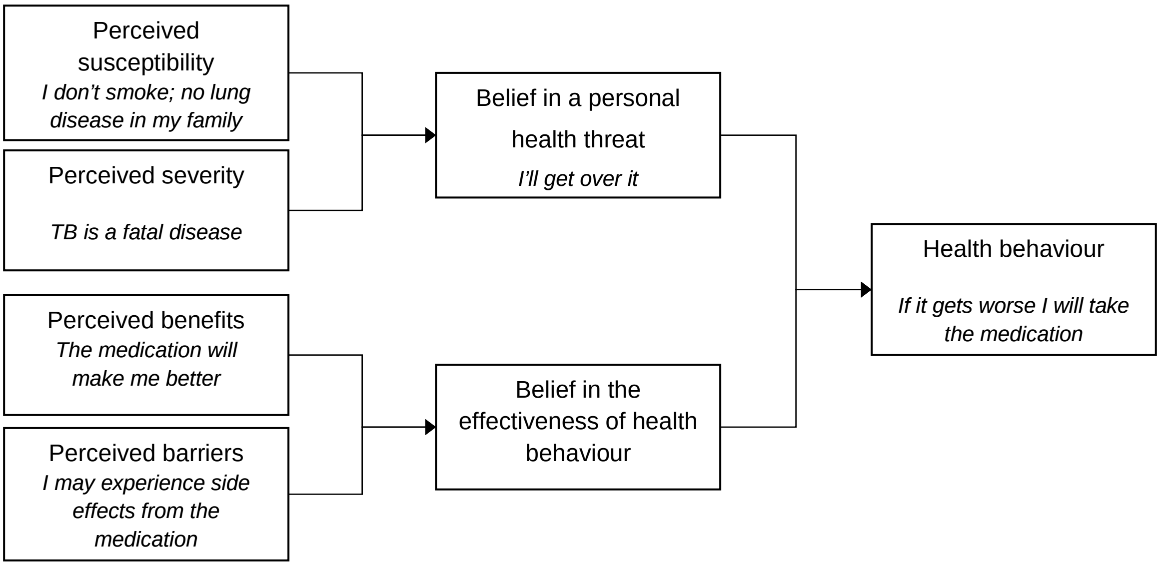


Figure 2.1 Health belief model (Adapted from Stroebe, 2000)

action and might even result in avoidance of protective action. Perceived severity may also not be as important as perceived susceptibility. Later, self-efficacy was added into the theory (Rosenstock, Strecher & Becker, 1988), thereby incorporating the need to feel competent before effecting long-term change (Strecher and Rosenstock, 1997).

The health belief model has been used to develop effective interventions to change health-related behaviors by targeting various aspects of the model's key constructs (Carpenter, 2010; Rosenstock, Strecher & Becker, 1988). According to Glanz et al. (2008), interventions based on the health belief model may aim to increase perceived susceptibility to and perceived seriousness of a health condition by providing education about prevalence and incidence of disease, individualized estimates of risk, and information about the consequences of disease (e.g., medical, financial, and social consequences). Interventions may also aim to alter the cost-benefit analysis of engaging in a health-promoting behavior (i.e., increasing perceived benefits and decreasing perceived barriers) by providing information about the efficacy of various behaviors to reduce risk of disease, identifying common perceived barriers, providing incentives to engage in health-promoting behaviors, and engaging social support or other resources to encourage health-promoting behaviors (Glanz et al., 2008). They further opined that interventions based on the health belief model may provide cues to action to remind and encourage individuals to engage in health-promoting behaviors. Interventions may also aim to boost self-efficacy by providing training in specific health-promoting behaviors (Rosenstock, Strecher & Becker, 1988; Glanz et al., 2008), particularly for complex lifestyle changes (e.g., changing diet or physical activity, adhering to a complicated medication regimen) (Rosenstock, Strecher & Becker, 1988). Strecher and Rosenstock (1997) posited that interventions can be aimed at the individual level (i.e., working one-on-one with individuals to increase engagement in health-related behaviors) or the societal level (e.g., through legislation, changes to the physical environment).

Some limitations of the HBM have been reported. The health belief model attempts to predict health-related behaviors by accounting for individual differences in beliefs and attitudes (Janz & Becker, 1984).These authors also observed that the HBM does not account for other factors that influence health behaviors. For instance, habitual health-related behaviors (e.g., smoking, seatbelt buckling) may become relatively independent of conscious health-related decision making processes. Additionally, individuals engage in some health-related behaviors for reasons unrelated to health (e.g., exercising for aesthetic reasons). Environmental factors outside an individual's control may prevent engagement in desired behaviors (Janz & Becker, 1984). For example, an individual living in a dangerous neighborhood may be unable to go for a jog outdoors due to safety concerns. Furthermore, the health belief model does not consider the impact of emotions on health-related behavior (Glanz et al., 2008). Evidence suggests that fear may be a key factor in predicting health-related behavior (Glanz et al., 2008).

Armitage and Conner (2000) in their review reported that the relationships between the variables of the HBM have not been explicitly spelt out and no definitions have been constructed for the individual components or clear rules of combination formulated. It is assumed that the variables are not moderated by each other and have an additive effect. If, for example, perceived seriousness is high and susceptibility is low, it is still assumed that the likelihood of action will be high - intuitively one might assume that the likelihood in this case would be lower than when both of the variables are high. The HBM also assumes that variables affect health behaviour directly and remain unmoderated by behavioural intentions. While the theory may predict adherence in some situations, it has not been found to do so for "risk reduction behaviours that are more linked to socially determined or unconscious motivations" (Blackwell, 1992)

2. Social-cognitive theory

This theory, illustrated in figure 2.2 evolved from social learning theory and may be the most comprehensive theory of behaviour change developed thus far (Redding et al., 2000). It posits a multifaceted causal structure in the regulation of human motivation, action and well-being

(Bandura, 2000) and offers both predictors of adherence and guidelines for its promotion (Bandura, 1997). The basic organising principle of behaviour change proposed by this theory is reciprocal determinism in which there is a continuous, dynamic interaction between the individual, the environment and behaviour (Redding et al., 2000).

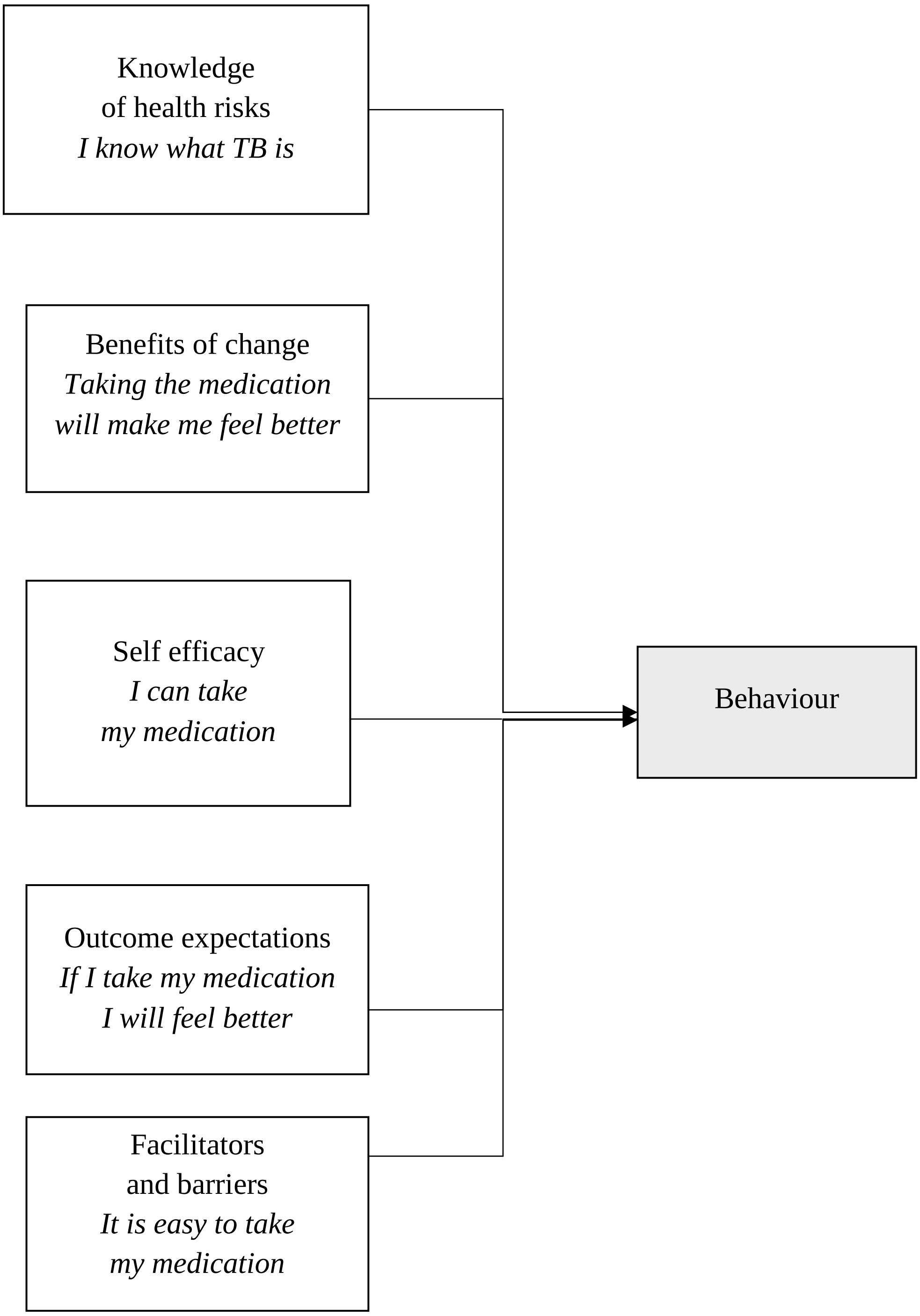


Figure 2.2 Social cognitive theory (From Munro et al., 2007)

Social-cognitive theory suggests that while knowledge of health risks and benefits are a prerequisite to change, additional self-influences are necessary for change to occur (Bandura, 2004). Beliefs regarding personal efficacy are among some of these influences, and these play a central role in change. Health behaviour is also affected by the expected outcomes – which may be the positive and negative effects of the behaviour or the material losses and benefits. Outcomes may also be social, including social approval or disapproval of an action.

A person's positive and negative self-evaluations of their health behaviour and health status may also influence the outcome. Other determinants of behaviour are perceived facilitators and barriers. Behaviour change may be due to the reduction or elimination of barriers (Bandura, 2004). In sum, this theory proposes that behaviours are enacted if people perceive that they have control over the outcome, that there are few external barriers and when individuals have confidence in their ability to execute the behaviour (Armitage and Conner, 2000). Due to its wide-ranging focus, this theory is difficult to operationalise and is often used only in part (Stone, 1999), thus raising questions regarding its applicability to intervention development.

3. Theory of planned behaviour (TPB) and the theory of reasoned action (TRA)

The first work in this area was on the TRA. Research using the TRA has explained and predicted a variety of human behaviours since 1967. Based on the premise that humans are rational and that the behaviours being explored are under volitional control, the theory provides a construct that links individual beliefs, attitudes, intentions, and behaviour (Fishbein et al., 1994). The theory variables and their definitions, as described by Fishbein et al. (1994), are:

Behaviour:

A specific behaviour defined by a combination of four components: action, target, context, and time (e.g., implementing a sexual HIV risk reduction strategy (action) by using condoms with commercial sex workers (target) in brothels (context) every time (time).

Intention:

The intent to perform a behaviour is the best predictor that a desired behaviour will actually occur. In order to measure it accurately and effectively, intent should be defined using the same components used to define behaviour: action, target, context, and time. Both attitude and norms, described below, influence one's intention to perform a behaviour.

Attitude:

A person's positive or negative feelings toward performing the defined behaviour.

Behavioural beliefs:

Behavioural beliefs are a combination of a person's beliefs regarding the outcomes of a defined behaviour and the person's evaluation of potential outcomes. These beliefs will differ from population to population. For instance, married heterosexuals may consider introducing condoms into their relationship an admission of infidelity, while for homosexual males in high prevalence areas it may be viewed as a sign of trust and caring.

Norms:

A person's perception of other people's opinions regarding the defined behaviour.

Normative beliefs:

Normative beliefs are a combination of a person's beliefs regarding other people's views of a behaviour and the person's willingness to conform to those views. As with behavioural beliefs, normative beliefs regarding other people's opinions and the evaluation of those opinions will vary from population to population. The TRA provides a framework for linking each of the above variables together (Figure 2.3). Essentially, the behavioural and normative beliefs - referred to as cognitive structures - influence individual attitudes and subjective norms, respectively. In turn, attitudes and norms shape a person's intention to perform a behaviour. Finally, as the authors of the TRA argue, a person's intention remains the best indicator that the desired behaviour will occur. Overall, the TRA model supports a linear process in which changes in an individual's behavioural and normative beliefs will ultimately affect the individual's actual behaviour.

The TRA assumes that most socially relevant behaviours are under volitional control, and that a person's intention to perform a particular behaviour is both the immediate determinant and the single best predictor of that behaviour (Sutton, 1997). An

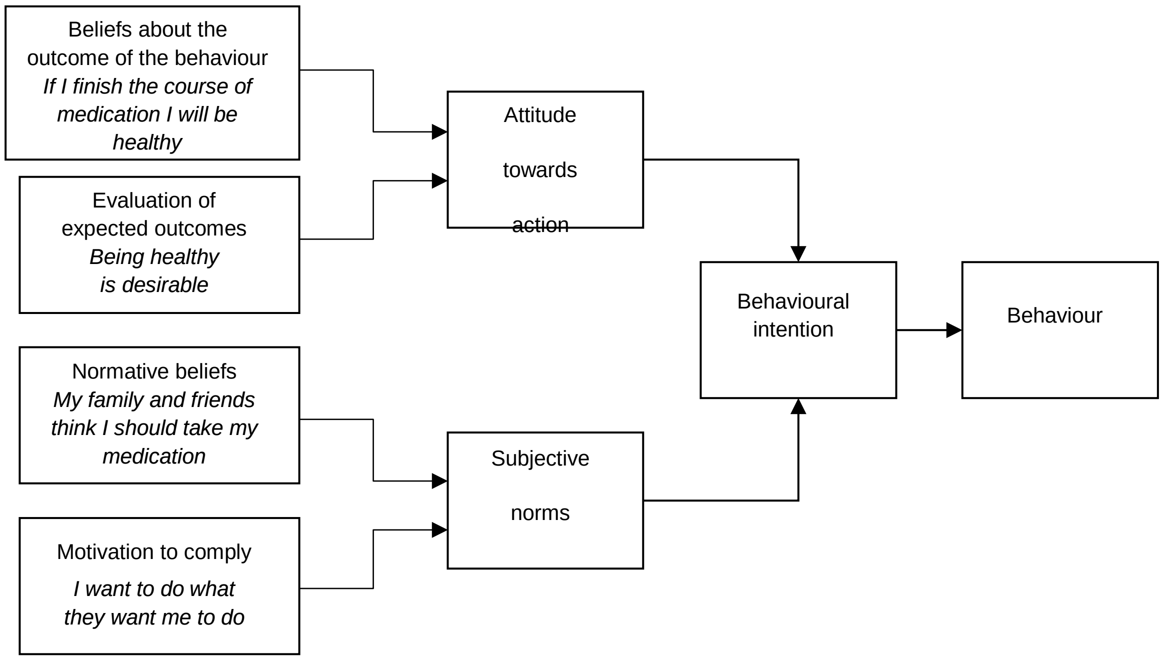


Figure 2.3 Theory of Reasoned Action (TRA). (Adapted from Stroebe, 2000)

intention to perform a behaviour is influenced by attitudes towards the action, including the individual's positive or negative beliefs and evaluations of the outcome of the behaviour. It is also influenced by subjective norms, including the perceived expectations of important others (e.g. family or work colleagues) with regard to a person's behaviour; and the motivation for a person to comply with others' wishes. Behavioural intention, it is contended, then results in action. The authors argue that other variables besides those described above can only influence the behaviour if such variables influence attitudes or subjective norms.

A meta-analysis examining this theory found that it could explain approximately 25% of variance in behaviour in intention alone, and slightly less than 50% of variance in intentions (Sutton, 1997). This suggests that support for this theory is limited. Additionally, The TRA omits the fact that behaviour may not always be under volitional control and the impacts of past behaviour on current behaviours (Stroebe, 2000). Recognising this, the authors extended the theory to include behavioural control and termed this the TPB (Figure 2.4). 'Behavioural control' represents the perceived ease or difficulty of performing the behaviour and is a function of control beliefs (Sutton, 1997). Conceptually it is very similar to self-efficacy (Stroebe, 2000) and includes knowledge of relevant skills, experience, emotions, past track record and external circumstances (Ajzen, in St Claire, 2003). Behavioural control is assumed to have a direct influence on intention (Sutton, 1997). Meta-analyses examining the TPB have found varied results regarding the effectiveness of the theory's components (Godin and Kok, 1996; Armitage and Conner,2001; Hardeman et al., 2002). Although not conclusive, the results of the analyses were promising.

Sutton (1997) suggests that the TRA and TPB require more conceptualisation, definition and additional explanatory factors. Attitudes and intentions can also be influenced by a variety of factors that are not outlined in the above theories (Stroebe, 2000). Specifically, these theories are largely dependent on rational processes (Mullen et al., 1987) and do not allow explicitly for the impacts of emotions or religious beliefs on behaviour, which may be relevant to stigmatised diseases.

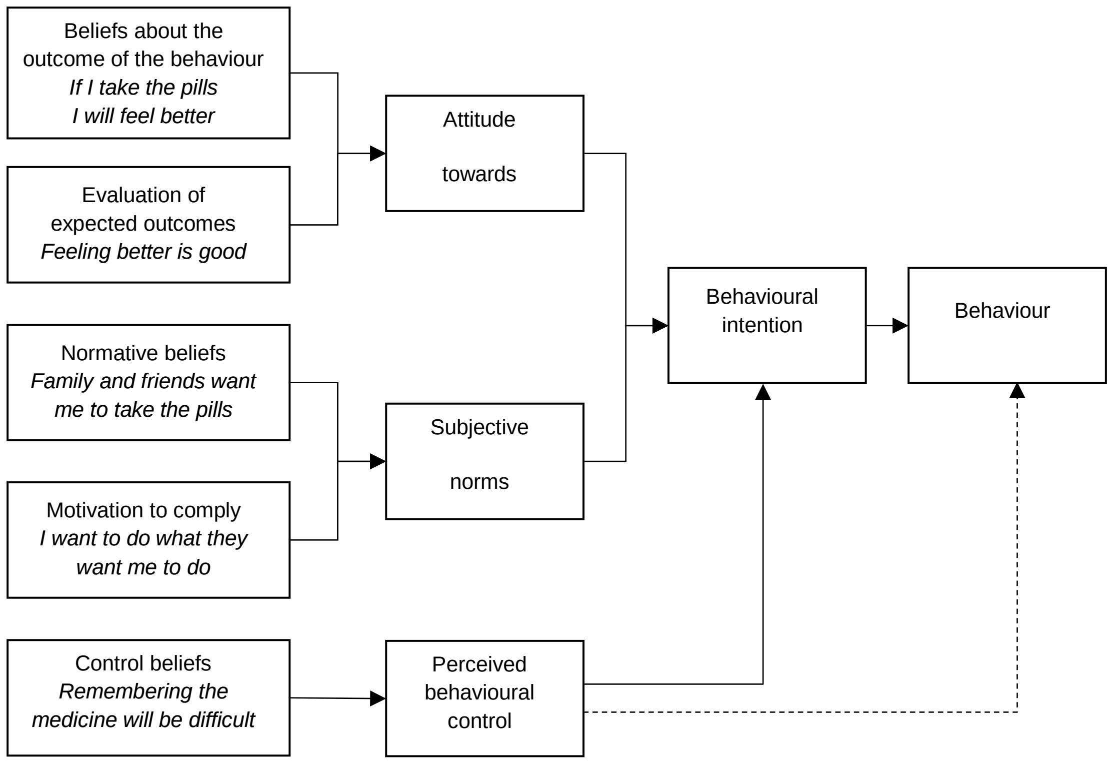


Figure 2.4 Theory of planned behaviour (TPB, from Munro et al., 2007)

2.6.4 The BASNEF model

To succeed in healthy behaviour change, health trainers should be aware of the factors affecting the formation of a behaviour and theories will help this process. Theories may assist in the design of behaviour change interventions in various ways (Redding et al., 2000; Michie, 2004; Eccles et al., 2005), by promoting an understanding of health behaviour, directing research and facilitating the transferability of an intervention from one health issue, geographical area or healthcare setting to another. The value of health education programmes depends on designing appropriate educational programme based on theories and models (Allahverdipoor, 2005).

One of the models used for recognizing the behaviour of the individuals is the BASNEF (Belief, Attitude, Subjective Norm, and Enabling Factors) model which is a comprehensive model for studying behaviours. The BASNEF model was proposed by Hubley in 1988 (Figure 2.5) and the components deal with beliefs, attitudes, subjective norms and enabling factors (Kakaei et al., 2014). This model is used to study behaviour, plan its change and determine the factors affecting the individuals' decision for behaviour (Charkazi et al., 2013).

According to this model, an individual turns to a new behaviour when s/he believes that the behaviour has some health, economic or other benefits (individual's belief and evaluation of the outcomes of that behaviour). Then, this evaluation leads to the formation of an attitude toward the behaviour in that individual (attitude to the behaviour). Furthermore, there are important people in the individual's life that can affect his/her decision with regard to adopting that new behaviour and act as a barrier or a facilitator (subjective norms). The subjective norms of an individual are also determined by normative beliefs; i.e. the extent to which the new behaviour is approved or rejected by those who are important for him/her. The combination of attitude toward the behaviour and abstract norms leads to the formation of a decision for adopting a new behaviour (behavioural intention); however, factors like skill, money, cost, etc., can be influential in changing behavioural intention to a behaviour; these factors must already be present for a behaviour to be formed (enabling factors). In addition to the individual, this model emphasizes the impact of family, society and national levels in the formation of a behaviour; also, it is essential to consider

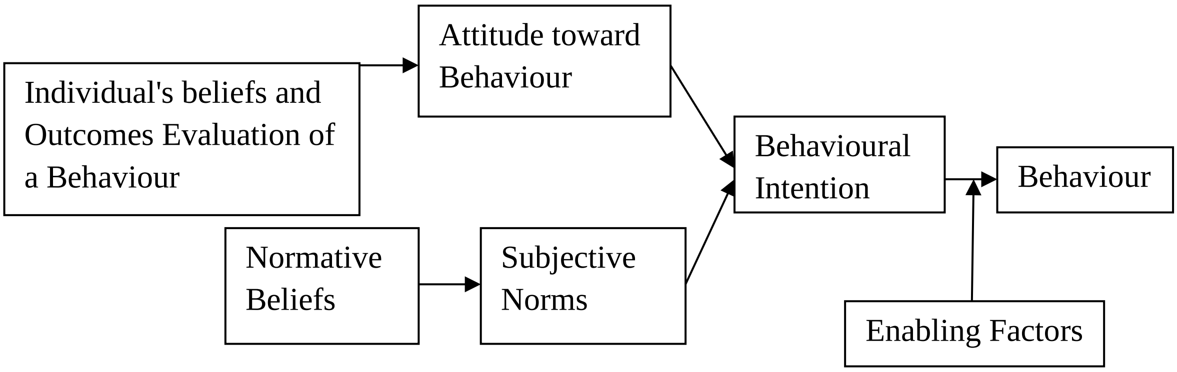


Figure 2.5 A schematic view of BASNEF model

educational, economic, social and political changes for adopting a behaviour (Salehi et al., 2004; Charkazi et al., 2013).

The BASNEF model has been widely reported to be an effective model in health education especially in workers' safety training (Solhi et al., 2013). It has been used widely to study behaviour, plan its change and determine the factors affecting the individuals' decision for a behaviour (Mohamaei et al., 2004; Hazavehei et al., 2008; Baghianimoghadam et al., 2010; Hazavehei et al., 2011; Sharifirad et al., 2011; Hazavehei et al., 2011).

Munro et al. (2007) reported on the meta-analyses synthesizing the evidence of various health behaviour theories. The evidence supporting the Theory of Reasoned Action and Theory of Planned Behaviour reveal some superiority over the others (Table 2.4). The BASNEF model is based on these two theories and this may explain the wide acceptance and utilisation.

2.7 KAP studies on personal protective equipment use

Jain et al. (2010) carried out a cross sectional survey among 311 dental faculty and the undergraduate students under clinical training in Udaipur, Rajasthan with a view to obtain comprehensive information about the knowledge, attitude and practices in regard to droplet and airborne infection related precautions among faculty member and the undergraduate students in Udaipur, Rajasthan, India. Their results highlighted that though the professionals had good knowledge and attitude; the practice levels for the same were low. The study corroborates several earlier studies that observed a gap between knowledge and practice among various categories of workers.

Askarian et al. (2005) had earlier on carried out a similar study among the Dental Health Practitioners (DHPs) in Shiraz, Iran. Their study revealed a poor compliance with airborne and droplet isolation precautions among Iranian professionals. Their study revealed that while the DHPs were quite knowledgeable with respect to the contents of the guidelines, this was not reflected in their practice. Another similar study (McCarthy and MacDonald, 1997) had found that some predictors of the use of the recommended infection control were age less than 40 years, lack of concern regarding the increased personal risk or cost of infection control procedures.

Table 2.4 Summary of selected health behaviour theories

Model	Author	Meta-analyses examining the model	Evidence supporting theory
HBM	Rosenstock et al. 1966	1. Rosenstock et al., 1988 2. Strecher and Rosenstock, 1997	1. 46 studies- substantial empirical support. 2. 16 studies; at best 10% of variance accounted for by any one dimension of the theory.
SCT	Bandura 1950's	Maddux and Rogers, 1983	27 studies; self-efficacy explained between 4% and 26% of variance
TRA	Fishbein & Ajzen, 1975	Bandura, 2004	Theory explains about 25% of variance in behaviour from intention alone, and explains slightly less than 50% of variance in intentions.
TPB	Fishbein & Ajzen, 1975	1. Stone, 1999 2. Fishbein and Ajzen, 1975 3. Sutton, 1997	1. 13 studies; 75% of interventions effected a change in behaviour in desired direction. 2. 56 studies; About a third of the variations in behaviour can be explained by the combined effect of intention and perceived behavioural control in the domain of health. 3. 185 independent empirical tests: combined effect of intention and perceived behavioural control explained about a third of variation in behaviour. Theory can explain 20% of prospective measures of actual behaviour.

From Munro *et al.*, 2007

Other studies that reported a gap between knowledge and practice among different categories of workers include – Haldiya et al. (2005), Yu, Lee and Wong (2005) and Parimalam, Kamalamma and Ganguli (2007). Haldiya et al. (2005) reported that the salt workers in their study had good knowledge about the health problems and the protective measures, but a huge gap could be observed between the knowledge and usage of PPE, mainly due to the non-availability of safety devices, high cost and safety devices not provided by the salt manufacturers. Yu and colleagues indicated in their own report that safe practice did not depend on knowledge and attitude but was positively associated with being informed of safety precautions and being supplied with chemical information by supervisors.

2.8 Studies that Used the BASNEF Model-Based Health Education

Table 2.5 presents some studies that had utilised the BASNEF model-based health education model among various populations. Mohamaei et al., (2004) reported improvements in knowledge, attitude and practice of patients with coronary artery disease in preventing the occurrence of risk factors leading to myocardial infarction. Several of the studies reported positive behavioural changes following health education using the BASNEF model (Baghianimo-ghadam et al., 2010; Hazavehei et al., 2011; Charkazi et al., 2013; Jeihooni et al., 2012; Jeihooni, Kashfi & Hazavehei, 2013; Hazavehei et al., 2010; Hazavehei et al., 2014). Hazavehei et al. (2008) and Sharifirad et al. (2010) stressed on the advantage of the model-based health education in accordance with its main parts over the performance of classic health education while Sharifirad et al. (2011) and Hazavehei et al. (2014) reported a 3-month and a 2-month carry-over of the positive behavioural change respectively.

2.9 Summary of the Literature Review

Air pollution is a major environmental problem affecting both the developing and the developed countries of the world with suspended particulate matter affecting more people globally than any other pollutant on a continuous basis (Richard, et al., 2002; USEPA, 2010). An extensive body of evidence links exposure to outdoor air pollution and health effects (Abelsohn and Stieb, 2011). Exposure to pollutants such as airborne participate matter and ozone has been associated with increases in mortality and hospital admissions due to respiratory and cardiovascular disease. (Brunekreef and Holgate, 2002 and Health Canada, 2010). There is a meaningful burden of illness

from air pollution, but because air pollution cannot be measured in the individual patient, much like hypertension, it is usually not apparent as a causative agent in clinical practice. A systematic analysis of all major global health risks has found that outdoor air pollution in the form of fine particles is a much more significant public health risk than previously known − contributing annually to over 3.2 million premature deaths worldwide and over 74 million years of healthy life lost. It now ranks among the top global health risk burdens (Lim et al., 2012).

In adults, several cross-sectional studies observed lower levels of lung function in more polluted communities (Gotschi et al., 2008). In Nigeria, various studies have shown the role of occupational exposure to environmental pollutants in the incidence of respiratory diseases (Jinadu and Malomo, 1986; Alakija et al, 1990; Ige and Onadeko, 2000; Okojie et al, 2003; Ijadunola et al, 2004; Okwari et al, 2005). Cough, sputum production and breathlessness are some of the reported respiratory symptoms in these workers, while occupational asthma (Rastogi et al, 1989), and hypersensitivity pneumonitis (Brooks et al, 1981) are recognized clinical syndromes common in such workers. The overall effect of these is a lower level of lung function in these workers.

According to WHO, poor occupational health and reduced working capacity of workers may cause economic loss up to 10-20% of the Gross National Product of many countries (Amponsah-Tawiah and Dartey-Baah, 2011). The Factories Act of Nigeria (1987) was designed to protect workers, as the legislations make provisions for the health safety and welfare of workers. Unfortunately, government is not enforcing the laws for various reasons such as insufficient manpower for enforcement. Factory inspectors are very few and the absence of health service in the sawmill industry and ignorance on the part of the workers according to Asogwa (2000) have resulted in their being exposed to hazards that have grievous consequences on their health.

Wood and timber processing is a major industry worldwide. Exposure to wood dust originating from a wide range of different tree species is associated with sino-nasal cancer and respiratory health effects (Demers, Teschke and Kennedy, 1997). Sawmill workers have been severally reported to be vulnerable to developing pulmonary diseases because of their occupational exposure to wood dust generated in the process of cutting or shaping wood (Kuschener and Stark, 2003; Ijadunola et al, 2004; Okwari et al, 2005). Many microorganisms (including fungi), toxins and chemical substances contained in wood may also significantly affect human health (Mandryk et al, 1999; Douwes et al, 2001; Edman et al, 2003). Several studies have shown associations between dust exposure and both symptoms and decreased lung function (Shamssein, 1992; Noertjojo et al., 1996; Mandryk, Alwis and Hocking, 2000; Schlunssen et al., 2002; Schlunssen et al., 2004) while others did not find such association (Talini et al., 1998; Bohadana et al., 2000; Borm et al., 2002).

Management of hazards requires the application of the traditional industrial hygiene responsibilities of anticipation, recognition, evaluation, and control to characterize the work environment, evaluate tasks and equipment, identify hazards, define exposure groups, and recommend controls. According to Sargent and Gallo (2003), the proper selection of control measures is based on a hierarchy of elimination and minimization by engineering controls, followed last by personal protective equipment when exposures cannot be eliminated. While the paramount priority of the reduction of risks at source must be acknowledged, respiratory protective equipment (RPE) remains, a key element of many respiratory risk management programmes (Graveling et al, 2011).

Knowledge, attitude and practice act as three pillars, which make up the dynamic system of life itself. Knowledge is some information that is acquired or gained. It results in congeniality and advertence about an eclectic thing or a situation. There could be many ways of procuring knowledge namely reading, sagacity etc. Knowledge, being the basic criterion that allows one to earmark between the right and the wrong, is a mixture of comprehension, experience, discernment and skill. Attitude accredits to thinking towards a proper situation. There could be a number of furtherance to empathize a situation but it depends on how an individual reacts towards the situation. Practice means contemplation of rules and knowledge that lead to action. Thus, a right knowledge, a positive attitude and a good practice are imperative to guide and serve the patients (Jain et al., 2010).

The successful application of personal protective equipment (PPE) hinges on proper use by individual employees. They must first understand the risks and the processes that might result in exposures. Properly and effectively communicating these risks and the potential result of exposure is believed to increase the probability of the PPE being used at the correct times and in the correct manner. (Sargent and Gallo, 2003).

In line with the HBM of health education it is more likely for woodworkers to be willing to use personal protective equipment when they are aware of the safety and health implications on their occupation. It is however generally acknowledged that knowledge does not necessarily translate to practice suggesting that some other factors are important for the development of a behavior/practice. A huge gap had beeen observed between the knowledge and usage of PPE. Several studies that reported a gap between knowledge and practice among various categories of workers include (Askarian et al., 2005; Haldiya et al., 2005; Yu, Lee and Wong, 2005; Parimalam, Kamalamma and Ganguli, 2007 and Jain et al., 2010).

The value of health education programmes depends on designing appropriate educational programme based on theories and models (Allahverdipoor, 2005). Health behaviour theories that had been employed include the health belief model, social cognitive theory, theory of reasoned action (TRA), theory of planned behaviour (TPB) and the belief, attitude, subjective norms and enabling factor (BASNEF) model. The Health Belief Model views health behaviour change as based on a rational appraisal of the balance between the barriers to and benefits of action (Blackwell, 1992). The model had been used to develop effective interventions to change health-related behaviors by targeting various aspects of the model's key constructs (Carpenter, 2010; Rosenstock et al., 1988). Some limitations of the HBM have been reported. The health belief model attempts to predict health-related behaviors by accounting for individual differences in beliefs and attitudes (Janz et al., 1984). It had been observed that the HBM does not account for other factors that influence health behaviors. The HBM also assumes that variables affect health behaviour directly and remain unmoderated by behavioural intentions. While the theory may predict adherence in some situations, it has not been found to do so for "risk reduction behaviours that are more linked to socially determined or unconscious motivations" (Blackwell, 1992). The Social-cognitive theory evolved from social learning theory

(Redding et al., 2000). It posits a multifaceted causal structure in the regulation of human motivation, action and well-being (Bandura, 2000) and offers both predictors of adherence and guidelines for its promotion (Bandura, 1997). Due to its wide-ranging focus, the social-cognitive theory is difficult to operationalise and is often used only in part (Stone, 1999), thus raising questions regarding its applicability to intervention development. A meta-analysis examining the theory of reasoned action (TRA) found that it could explain approximately 25% of variance in behaviour in intention alone, and slightly less than 50% of variance in intentions (Sutton, 1997). This suggests that support for this theory is limited. Additionally, The TRA omits the fact that behaviour may not always be under volitional control and the impacts of past behaviour on current behaviours (Stroebe, 2000). Recognising this, the authors extended the theory to include behavioural control and termed this the theory of planned behaviour (TPB). Meta-analyses examining the TPB have found varied results regarding the effectiveness of the theory's components (Godin and Kok, 1996; Armitage and Conner,2001; Hardeman et al., 2002). The BASNEF model had been reported to be a comprehensive model for studying behaviours. The components deal with beliefs, attitudes, subjective norms and enabling factors (Kakaei et al., 2014). This model is used to study behaviour, plan its change and determine the factors affecting the individuals' decision for behaviour (Charkazi et al., 2013). Munro et al. (2007) reported on the meta-analyses synthesizing the evidence of various health behaviour theories. The evidence supporting the Theory of Reasoned Action and Theory of Planned Behaviour reveal some superiority over the others. The BASNEF model is based on these two theories and this may explain the wide acceptance and utilisation. The BASNEF model has been widely reported to be an effective model in health education especially in workers' safety training (Solhi et al., 2013). It has been used widely to study behaviour, plan its change and determine the factors affecting the individuals' decision for a behaviour (Mohamaei et al., 2004; Hazavehei et al., 2008; Baghianimoghadam et al., 2010; Hazavehei et al., 2011; Sharifirad et al., 2011; Hazavehei et al., 2011).

Several studies have reported positive behavioural changes following health education using the BASNEF model (Baghianimo-ghadam et al., 2010; Hazavehei et al., 2011; Charkazi et al., 2013; Jeihooni et al., 2013a; Jeihooni et al., 2013b; Hazavehei et al., 2014a; Hazavehei et al., 2014b). Hazavehei et al. (2008) and Sharifirad et al. (2011a) stressed on the advantage of the model-based health education in accordance with its main parts over the performance of classic health education while Sharifirad et al. (2011b) and Hazavehei et al. (2014b) reported a 3-month and a 2-month carry-over of the positive behavioural change respectively.

Previous studies in Nigeria have reported a poor knowledge of the danger of sawmill dust and health effects of the dust (Osagbemi et al, 2010; Faremi et al, 2014) as well as a lack of safety education, protective measures or accident prevention training for workers (Ezenwa, 1997; Awoyemi, 2001). There is therefore a critical need for educational training based on health education models that have measurable and reliable effects rather than traditional instructions (Sharifirad et al, 2010) in order to prevent lung function deterioration and respiratory diseases among this group of workers. The Belief, Attitude, Subjective Norms and Enabling Factors (BASNEF) model of Health education had been used to improve workers knowledge, attitude and safety practices in other countries. However, its effects on sawmill workers in Nigeria have not been adequately reported.

CHAPTER THREE

MATERIALS AND METHODS

Chapter 1 identified the research questions for this study while chapter 2 identified previous studies that reveal the gaps in knowledge which the study intended to fill. This chapter (chapter 3) describes the methodology used to provide data to investigate the research questions. The chapter also aims to provide assurance that appropriate and standard procedures were followed and is organised around five areas – participants, sampling techniques, instrumentation (hardware and software), procedures and data analysis.

3.1 Participants

The study population consisted of individuals working in selected sawmills and age-matched apparently healthy non-sawmill workers. The sawmill workers were recruited for the study from 4 sawmills randomly selected from among the 12 active sawmills in Ibadan metropolis. They are located at Bodija, Egbeda, Sango and SDP area, off New Ife Road. The non-sawmill workers were recruited from among the staff of the Ibadan North Local Government, Oyo State Secretariat, University of Ibadan and the University College Hospital. They had the same criteria that obtained for the sawmill workers but had never worked in a sawmill industry or had a past history of exposure to wood dust.

3.1.1 Inclusion Criteria

Only sawmill workers who had been in continuous employment for a minimum of one year were included in the study. Participants were able to communicate either in English or Yoruba.

3.1.2 Exclusion Criteria

Sawmill workers who have been diagnosed with any restrictive or obstructive pulmonary disease were excluded from the study. Prospective participants were asked if they had been diagnosed to have any respiratory condition or had been treated recently for any chest condition. Individuals with such history were excluded from the study.

3.2 Materials

3.2.1 Instruments

The following instruments were used for data collection:

1. **Spiromete**r: A Micro Medical spirometer (Microplus, England) was used to record flow/volume spirometry.

2. **Height meter** (SECA 220, Germany): This (calibrated in centimetres from 20-210cm) was used to measure height of participants in centimetres but was converted to metres and recorded to the nearest 0.01 metres.

3. **Weight measuring scale:** An electronic weighing scale **(**Hanson, Ireland**)** calibrated in kilogrammes from 0-220kg was used to measure the participant’s body weight to the nearest 0.1kg.

4. **Respiratory Health Questionnaire (RHQ):**

   This is a 4-part, 61-item instrument adapted from the ATS-DLD-78A questionnaire (Appendix IIIa).

   <u>Section A</u>

   This 7-item section sought to obtain participants’ demographic data**.**

   <u>Section B</u>

   This 2-item section sought to obtain data on job history.

   <u>Section C</u>

   This 38-item section sought to obtain information concerning the presence or otherwise of chronic respiratory symptoms in the participants.

   <u>Section D</u>

   This 14-item section probed into the smoking history or otherwise of the participants.

A Yoruba version of this instrument (Appendix IIIb) was developed through the process of translation and back-translation to serve participants that cannot comprehend the English Language. The translation and back-translation was done by separate individuals from the Department of Linguistics, University of Ibadan, Nigeria.

5. **Personal Protective Equipment Knowledge, Attitude and Practice Questionnaire (PPE-KAP):**

This instrument was adapted from the study of Truong, Siriwong and Robson (2009). It was originally designed based on the Health Believe Model Theory (Stretcher and Rosenstock, 1997) and the WHO guidelines on how to conduct KAP survey (WHO, 2008). The questionnaire (Appendix IVa) was employed in this study to access the knowledge, attitude and practices concerning the use of personal protective equipment among sawmill workers. The questionnaire consisted of four sections.

Section A (Socio-demographic):

There are 8 questions in this section that sought to obtain the demographic data of the participants.

Section B (Knowledge regarding using personal protective equipment):

This section consisted of 16 questions that sought to know about the knowledge of the participants concerning wood dust, its health hazards and the use of personal protective equipment. A correct answer was given 1 score and 0 score for wrong answer. The score varied from 0-16 points and was classified into 3 levels as follows:

High level (80-100%)	13-16 scores	
Moderate level (60-80%)	10-12 scores	
Low levels (Less than 59%)	00-09 scores	(Truong et al, 2009)

Section C (Attitude regarding using personal protective equipment)

This section was designed to assess the attitude of the participants towards using personal protective equipment and it was assessed by using the 5-point Likert's scale. There are 8 statements which are both positively and negatively framed. The rating scale was measured as follows:

Positive Statement		Negative Statement	
Choice	**Scores**	**Choice**	**Scores**
Strongly agree	4	Strongly agree	0
Agree	3	Agree	1
Neutral	2	Neutral	2
Disagree	1	Disagree	3
Strongly disagree	0	Strongly disagree	4

The scores varied from 0 to 32 and all individual answers were summed up for total scores and calculated for means. The scores were classified into 3 levels (Positive Attitude, Neural Attitude, and Negative Attitude).

Positive Attitude	26-32 scores
Neural Attitude	19-25 scores
Negative Attitude	00-18 scores

Section D (Practice of workers about using personal protective equipment to protect themselves from wood dust)

These are questions in general about the practice of the sawmill workers in using PPE on their job. The sawmill workers were asked about how often they use each PPE, if they answered usually use, they were graded with good practice (2 scores), if they answered sometimes use they were graded with fair practice (1 score), and if they answered never use they were graded with poor practice (0 score). All individual answers were summed up for total scores which varied from 0 to 10. The mean scores were classified into 3 levels (Good Practice, Fair Practice, and Poor Practice).

Good Practice	8-10 scores
Fair Practice	3-7 scores
Poor Practice	0-2 scores

A Yoruba version of this instrument (Appendix IVb) was also developed through the process of translation and back-translation to serve participants that cannot comprehend the English Language. The translation and back-translation were done by separate individuals from the Department of Linguistics, University of Ibadan, Nigeria.

3.3 Methods

3.3.1 Research Design

This study was in two phases:

1. The first phase which was aimed at investigating the respiratory health profile (lung function indices and respiratory symptoms) among sawmill workers and comparing them to apparently healthy subjects not exposed to workplace wood dust followed the cross-sectional, analytical design.
2. The second phase which was aimed at investigating the effect of the BASNEF model-based health education on knowledge, attitude and practice of sawmill workers concerning respiratory protection equipment use followed the 2-group quasi-experimental pre- and post-test design.

3.3.2 Sampling Technique

The consecutive purposive sampling technique was used to recruit sawmill workers from four randomly selected sawmills in the Ibadan metropolis. For the interventional phase of the study, the four sawmills were randomly divided to two intervention centres and two control centres using the fish-bowl method. Thereafter, 45 of the participants from the intervention centres were randomly selected for the educational intervention (experimental group, Group I). The other participants did not receive the educational intervention.

3.3.3 Sample Size Determination

Daniel's equation (1999) was used to calculate the sample size for the respiratory health survey:

$$n = (Z^2pq)/d^2$$

Where:

n = desired sample size

Z = confidence interval at 95% (1.96)

p = proportion of sawmill workers with symptoms (0.5)

q = proportion of sawmill workers without symptoms (1-0.5 = 0.5)

d = precision or absolute sample error (0.05)

$n = (1.96^2 \times 0.5 \times 0.5) / 0.05^2$

n = 384.16 = 385

For the experimental phase, the following equation was used to calculate the sample size:

$$N = 4\sigma^2(Z_{crit} + Z_{pwr})^2 / D^2 \qquad \text{(Eng, 2003)}$$

where:

N is the total sample size (the sum of the sizes of both comparison groups)

σ is the assumed SD of each group (assumed to be equal for both groups)

Z_{crit} = 1.96 (at 0.05 (95) significance criterion)

Z_{pwr} = 1.036 (at 0.85 statistical power) [Watson et al., 1999; Hazavehei et al, 2014]

D is the minimum expected difference between the two means.

N = 80

Allowing for a 10% attrition rate (eight), 88 participants were selected and divided to two equal groups of 44 as intervention and control groups.

3.3.4 Ethical Approval

Ethical approval of the University of Ibadan/University College Hospital Health Research Ethics Committee was sought and obtained before the commencement of the study (Appendix I).

3.4 Procedure

Four sawmills were randomly selected within the Ibadan metropolis from among those registered with their association. The researcher met the leaders of the selected sawmills by prior appointment and sought permission to gather the required data. Repeated visits was made to all sawmills for the purpose of the study to be explained clearly and to ensure the co-operation from the decision makers in providing essential information about the sawmill culture and work practices. A letter indicating the purpose of the study and requesting their co-operation was given to all the workers that gathered at the meeting in the selected sawmills. Answers were provided for those who had questions bothering on their decision to participate or not. The letter also assured them about the confidentiality of the information provided as well as their right to withdraw their participation from the study at any point they so wish. Freely consenting workers were recruited (after completing the informed consent form, Appendix II) consecutively into the study, stratified according to the nature of their activities and hence degrees of exposure to wood dust (Moderate and High). Those who work at the machines (circular machine or planning machine) where the dust is generated were considered to be highly exposed (High exposure group) while carpenters, machine off-loaders, wood loaders and plank sellers were considered to be moderately exposed (Moderate exposure group). Number of participants recruited from each sawmill was proportional to the population of workers in each. Forty five participants were randomly selected from the two intervention centres (sawmill) to go through the BASNEF model-based education programme. Another 45 participants were randomly selected from the other two centres (sawmill) to serve as control.

Lung Function Survey:

Participants were instructed on the test procedure. For easy understanding of the test procedure, demonstrations of the test were performed and all doubts cleared. The RHQ (Appendix II) and the PPE-KAP (Appendix III) were administered to all subjects before the lung function test was performed.

a) Parameters Recorded

The gender of each participant and age at the last birthday were recorded.

b) Parameters Measured

Measurement of Body Weight

The body weight of each participant was measured with an electronic weighing scale. The participant was instructed to stand erect and bare-foot on the weighing scale while looking ahead with hands held on either side of the body. The body weight was then read off to the nearest 0.1kilogramme (Fahey, Insel and Roth, 2010).

Measurement of Standing Height

Participants stood barefoot, with their heads straight and their back against the upright height meter. The perpendicular bar (lever arm of the height meter) was brought in contact with the vertex of the participants' heads with a light pressure applied on the participants' heads. The height was then read off in centimetres and converted to the nearest 0.01 metres (Fahey, Insel and Roth, 2010).

Spirometric Measurement (FVC, FEV_1, PEF)

Spirometric measurements were obtained as previously described (Hankinson, Odencrantz and Fedan, 1999). The same spirometer was used for all measurements but each participant was given a disposable mouthpiece. The participant was seated and wearing a nose clip. Extension or flexion of the neck was avoided. Two relaxed measurements of slow vital capacity (SVC) were performed first, followed by three forced vital capacity (FVC) measurements. A large breath to full inspiration was taken through the mouth. The mouthpiece was placed into the participant's mouth and the participant placed his or her lips and teeth around the disposable mouthpiece to form a tight seal. For the SVC, the participant breathed out at a comfortable speed, but for the FVC the participant breathed out hard and quickly. At least 30 seconds was left between consecutive blows (exhalations using the spirometer) to enable the participant to recover. A minimum of three and a maximum of eight blows were attempted at any one time (Langhammer et al., 2001). Only lung functions meeting the reproducibility criteria of less than 200ml difference between the largest and the second largest value were accepted.

The spirometer was calibrated regularly with a syringe (standard accessory to the equipment). The researcher and 2 assistants (hired) also performed a daily biological control by assessing their own lung function. They initially went through formal training and the researcher continuously monitored the assistants during the entire study. In accordance with the joint 2005 American Thoracic Society (ATS) and European Respiratory Society (ERS) recommendations (Miller et al., 2005), they were taught to instruct the subjects to perform three acceptable and reproducible manoeuvres, ensuring that the subjects produce the highest possible peak flows and that the expiration continues for 6 s. If the subjects were unable to do this, up to five manoeuvres were performed.

KAP Survey:

The PPE-KAP Questionnaire was administered to each worker twice (initial and final). After the initial administration of the Questionnaire the randomly selected workers (48) in the two experimental sawmills were taken through a structured personal protection education programme based on the BASNEF model. The final administration of the Questionnaire was done one month after.

3.5 Health Education Content

The health education programme was conducted in the meeting hall of the respective sawmills. The educational intervention (6 sessions) involved various forms of training including lecture (with audio-visuals), question and answer, group discussion and practical presentation. Each session lasted about 20-40 minutes (average 30 minutes). The schedule of training is presented in table 3.1. During these sessions, participants were given all necessary information and instructions in line with the Occupational Safety and Health Administration of the USA guidelines (OSHA 1994). The Basic Training Course in Personal Breathing Protection material (Volumes 1 and 2) produced by the International Society for Respiratory Protection (ISRP) was used (International Society for Respiratory Protection, 2007) following the BASNEF concept. Plates 3.1, 3.2, 3.3 and 3.4 show the different types of respiratory protection equipment used for the training. Plate 3.1 shows the full face mask, Plate 3.2 the half face mask, Plate 3.3 the low-cost half face mask that was given as gift to the participants and Plate 3.4 the disposable masks.

3.6 Data Analysis

The data collected were analyzed as follows:

1. Descriptive statistics of frequency distribution was used to summarize the respiratory health data for the participants.
2. Descriptive statistics of mean, standard deviation and range were used to summarize the age, weight, height and lung function data of the participants (sawmill workers and apparently healthy age and sex-matched subjects separately).
3. The independent t-test was used for the following:
    a. Comparison of lung function indices between the sawmill workers and the apparently healthy age and sex-matched group of workers not similarly exposed
    b. Comparison of lung function indices between the sawmill workers at high wood dust exposure and moderate wood dust exposure
    c. Comparison of knowledge score, attitude score and practice score before the BASNEF model-based respiratory protection education between the training and non-training groups
    d. Comparison of knowledge score, attitude score and practice score after the BASNEF model-based respiratory protection education between the training and non-training groups

Table 3.1 The schedule of health education training sessions

Training Session	Training Content
None	Pre-Training Data Collection
1	Need for respiratory protection (air quality, respiratory hazards and harmful pollutants in the workplace, health effects of hazards), Purpose, limitations and how it works. Medical signs and symptoms that may limit or prevent effective use of equipment.
2	Which type of equipment to use (Different types and components, degrees of protection offered by the different equipment [limitations], equipment selection)
3	How to use the equipment (Donning/doffing and adjustments, Fit-testing [seal check])
4	When to use the equipment and for how long
5	Care, cleaning, maintenance and storage of equipment (Equipment frailty and life span). Inspection for damage or wear and recognition of when to replace.
6	Identification of medical signs and symptoms, dealing with dangerous situations at workplace and a recap of the training content
One month post-training	Post-Training Data Collection

Plate 3.1 A Full Face Mask

Plate 3.2 A Half Face Mask

Plate 3.3 A Low-cost Half Face Mask

Plate 3.4 Disposable Masks with and without

4. The paired t-test was used for the following:
    a. Comparison of knowledge score, attitude score and practice score before and after the BASNEF model-based respiratory protection education in the training group.
    b. Comparison of knowledge score, attitude score and practice score before and after the BASNEF model-based respiratory protection education in the non-training group.
5. The Pearson product-moment correlation method was used to investigate the relationship between the following:
    a. Lung function indices and work experience among the sawmill workers
    b. Knowledge score and each of age and work experience among the sawmill workers
6. The Spearman correlation method was used to investigate the relationship between the following:
    a. Attitude score and each of age and work experience among the sawmill workers
    b. Practice score and each of age and work experience among the sawmill workers

Level of significance was set at 0.05

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Results

A total of 400 sawmill workers (350 males and 50 females) from four sawmills in the Ibadan metropolis and 400 non-sawmill workers (350 males and 50 females) participated in this 2-phase study. The results are here presented.

4.1.1 Sociodemographic characteristics of participants

The mean age, weight and height of the sawmill workers (SW) and the non-sawmill workers (NSW) were 38.77±11.11years, 65.82±12.10kg, 1.63±0.08m and 37.35±10.94years, 65.78±9.55, 1.69±0.11m respectively (Table 4.1a). The non-sawmill workers were significantly taller than the sawmill workers ($p<0.01$) but the two groups were matched in age and weight ($p>0.05$). When the male and female participants were compared (Table 4.1b), the male and female non-sawmill workers were matched in age, weight and height ($p>0.05$). The male and female sawmill workers were also matched in age ($p>0.05$) but the males were significantly taller while the females were significantly heavier ($p<0.01$).

About four-fifths (79.50%) of the sawmill workers and three-quarters (72.30%) of the non-sawmill workers were married while 17.80% of the sawmill workers and 26.50% of the non-sawmill workers were single (Figure 4.1). Majority (65.8%) of the sawmill workers had only secondary school education and below while majority (93.8%) of the non-sawmill workers had secondary school education and above (Figure 4.2).

The sawmill workers had been on the job for between one and 63years and the average period they work in months per year, days per month and hours per day are presented in table 4.2. The job description of the sawmill workers in this study varied

Table 4.1a Physical characteristics of participants

	Sawmill Workers (n=400) Mean±S.D.	Non-Sawmill Workers (n=400) Mean±S.D.	P-value
Age (yrs)	38.77±11.11	37.35±10.94	0.07
Weight (kg)	65.82±12.10	65.78±9.55	0.96
Height (m)	1.63±0.08	1.69±0.11	<0.01*

S.D – Standard Deviation

* Indicates significant between group difference (p<0.01)

Table 4.1b Physical characteristics of participants (Comparison between males and females)

	Male (n=350) Mean±S.D.	Female (n=50) Mean±S.D.	P-value
Sawmill Workers			
Age (yrs)	37.41±11.23	36.90±8.80	0.76
Weight (kg)	66.07±9.31	63.78±10.95	0.11
Height (m)	1.69±0.12	1.66±0.08	0.08
Non-Sawmill Workers			
Age (yrs)	38.47±11.13	40.84±10.85	0.16
Weight (kg)	65.03±11.73	71.32±13.25	<0.01*
Height (m)	1.65±0.08	1.59±0.10	<0.01*

S.D. – Standard Deviation

* Indicates significant between group difference ($p<0.01$)

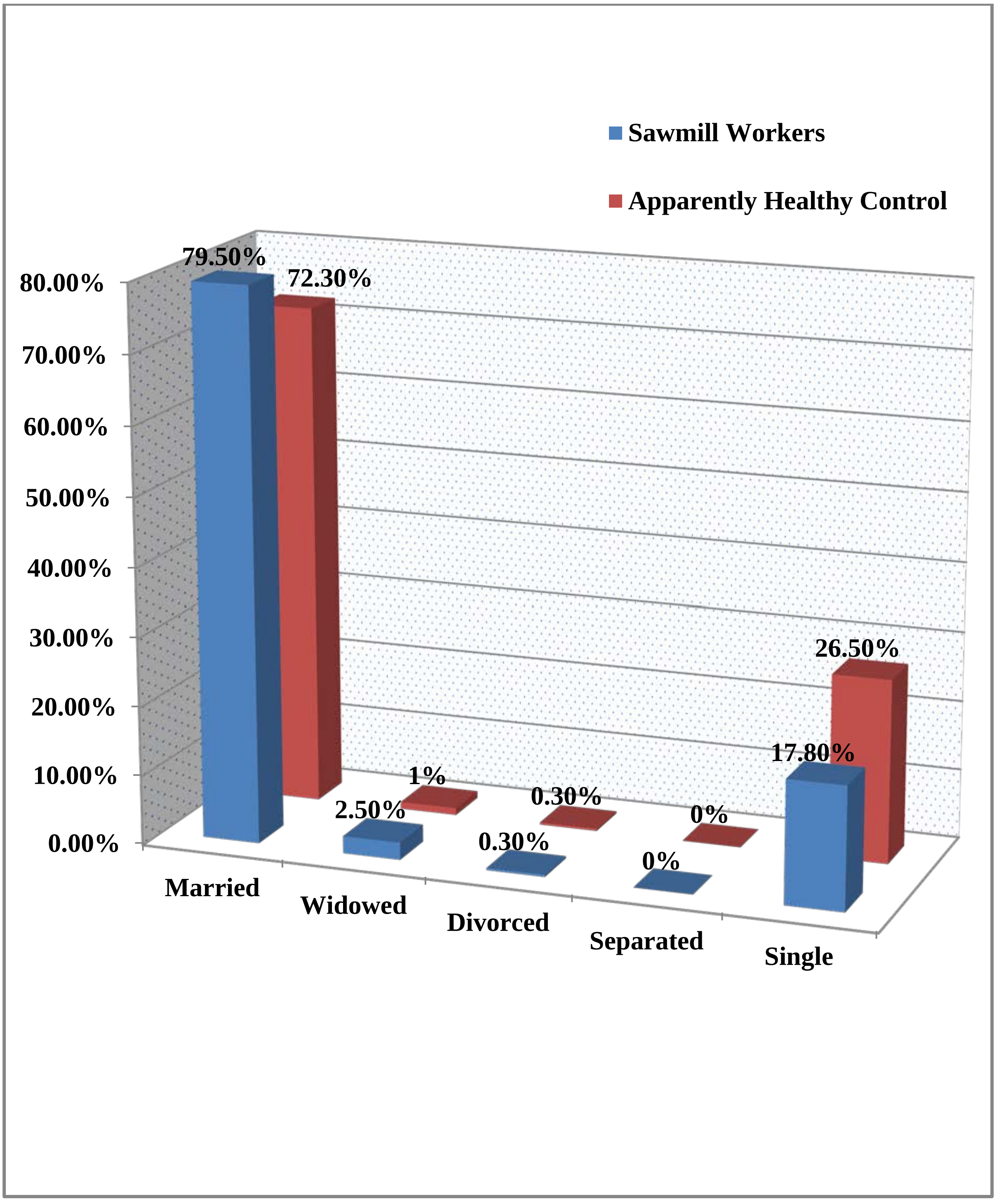
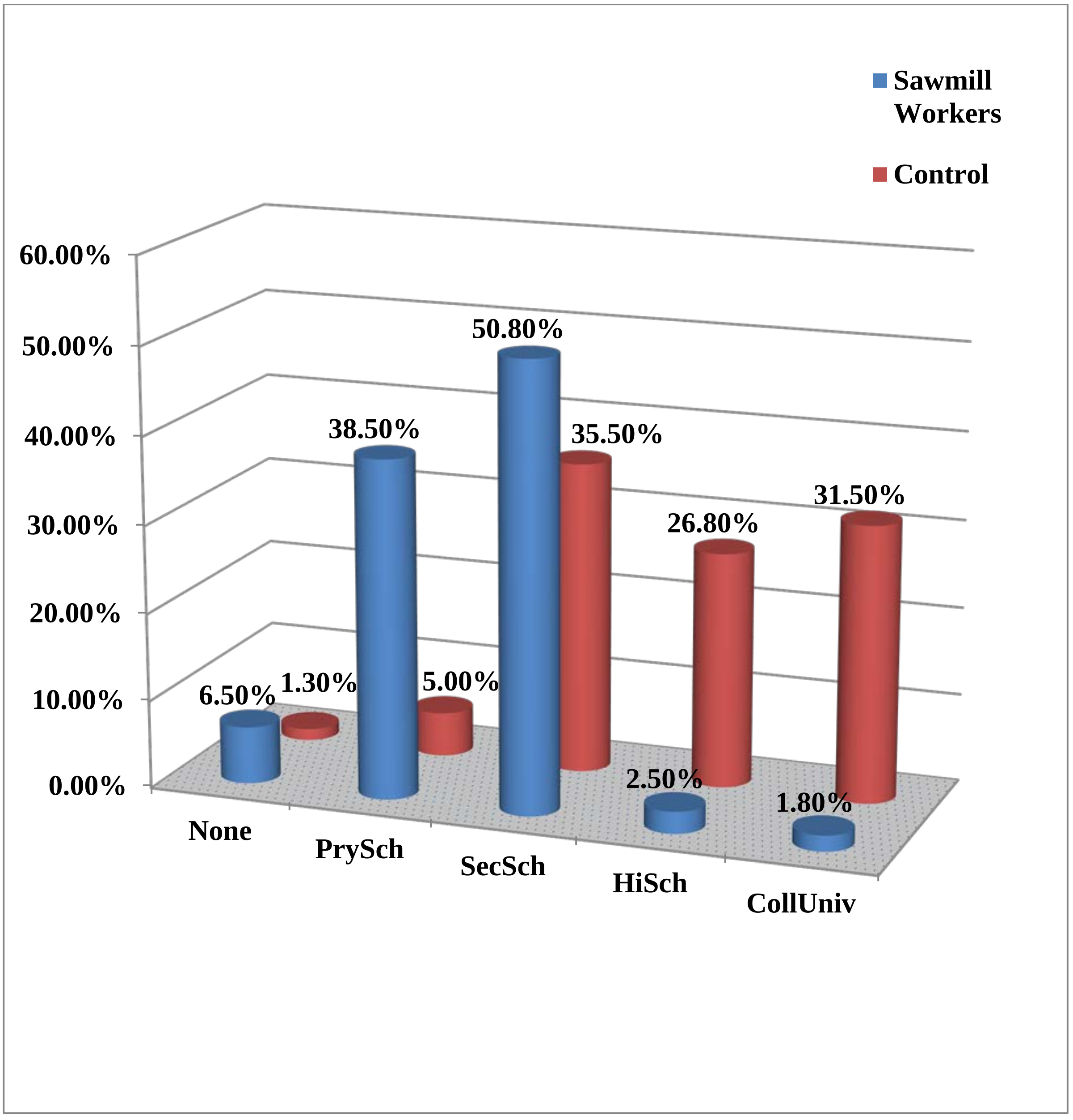


Figure 4.1 Participants' marital status



Key – PrySch – Primary School; SecSch – Secondary School;
HiSch – High School; CollUniv – College/University

Figure 4.2 Participants' highest educational attainment

Table 4.2 Sawmill workers' work history

	Minimum	Maximum	Mean	S.D.
Work Experience (years)	1	63	14.94	10.28
Yearly Workload (months/year)	1	12	11.88	0.87
Monthly Workload (days/month)	4	30	26.39	3.59
Daily Workload (hours/day)	3	12	10.44	1.75

Key: - S.D. – Standard Deviation

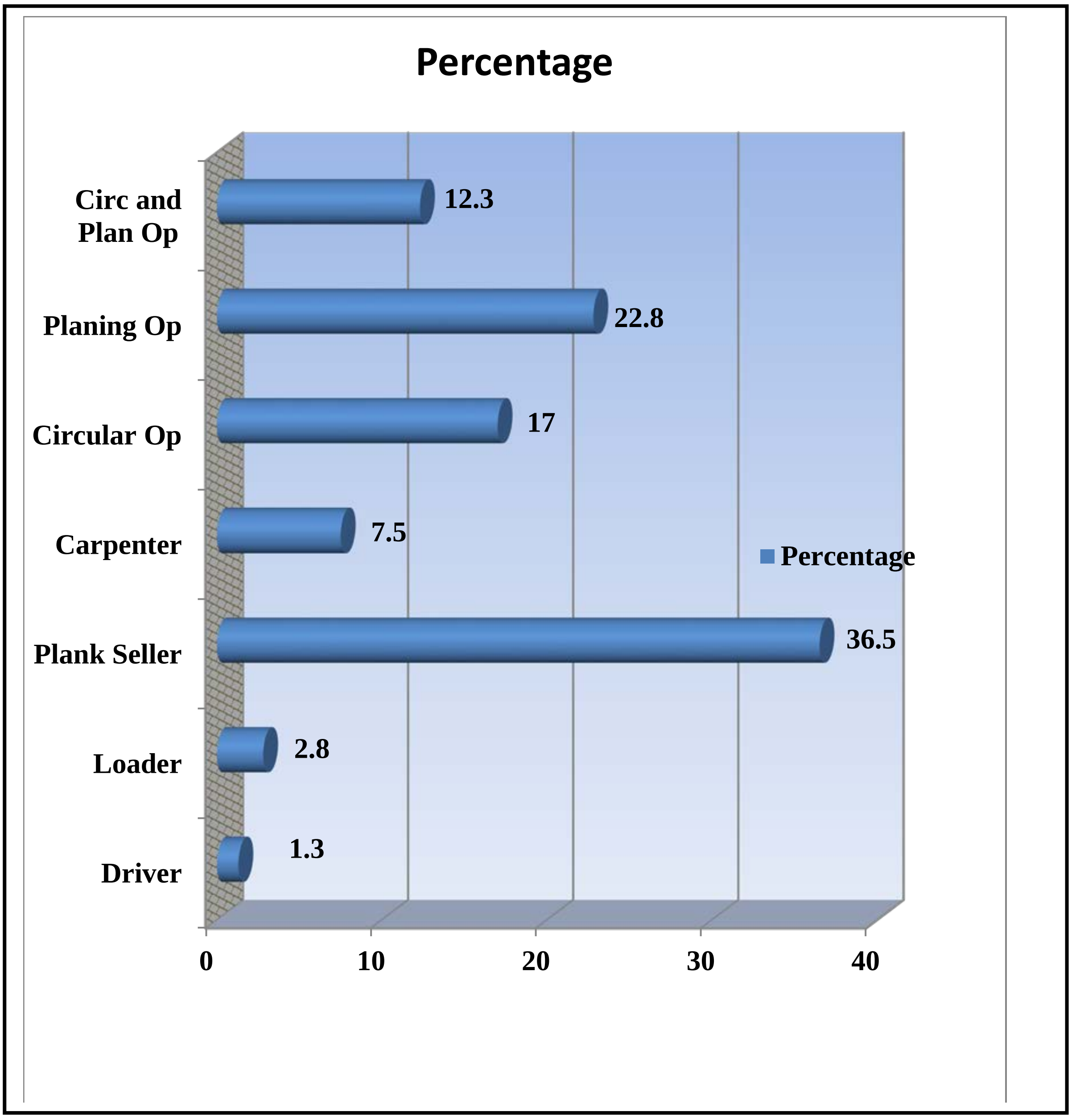
widely (Figure 4.3) but more than half operated one type of wood processing machine or the other constituting those at high wood dust exposure. The others were mostly plank sellers and carpenters constituting those at moderate level of wood dust exposure (Figure 4.4).

A few of the sawmill workers had previous occupational dust exposure while majority had no previous occupational dust exposure (Table 4.3). Table 4.4 summarises the smoking history among the participants. There were more current cigarette smokers among the sawmill workers (5.50%) than the non-sawmill workers (1.30%). There were those who once stopped smoking but resumed after one year among both sawmill workers and non-sawmill workers. A lower proportion of the sawmill workers were current cigar smokers (0.50%) while none was currently smoking pipe.

4.1.2 Participants' lung function indices (LFI)

The lung function indices (LFIs) are presented in Table 4.5. The mean values were 2.52±0.60L, 1.73±0.49L, 0.69±0.10 and 270.77±91.02L/min for FVC, FEV_1, FEV_1/FVC and PEFR respectively for the sawmill workers while those of the control subjects were 3.35±0.70L, 2.64±0.60L, 0.79±0.06 and 402.43±94.18L/min for FVC, FEV_1, FEV_1/FVC and PEFR respectively. The two groups were compared for the lung function indices using the independent t-test. Table 4.5 shows that the sawmill workers have significantly lower LFIs ($p<0.001$) than the non-sawmill workers.

Because of the significant difference in height between the sawmill workers and the control subjects and the established influence of height on LFIs, the individual LFI values were normalised by dividing with each participant's height. The normalised LFI (LFI_n) values are also presented on table 4.5. Independent t-test again showed significant differences in all the LFI_ns between the two groups ($p<0.01$). A comparison of the LFIs and LFI_ns between male and female sawmill workers (Table 4.6) showed that the males had significantly higher values ($p<0.05$) than the females except for expiratory ratio (FEV1/FVC). Such differences were however not found ($p>0.05$) among the non-sawmill workers (Table 4.7). The LFIs and LFI_ns were also compared between smokers and non-smokers. No significant difference was found ($p>0.05$) for both the sawmill workers and the non-sawmill workers (Tables 4.8 and 4.9).



Key – Circ and Plan Op – Circular and Planing Machine Operator

Planing Op – Planing Machine Operator

Circular Op – Circular Machine Operator

Figure 4.3 Sawmill workers' job description

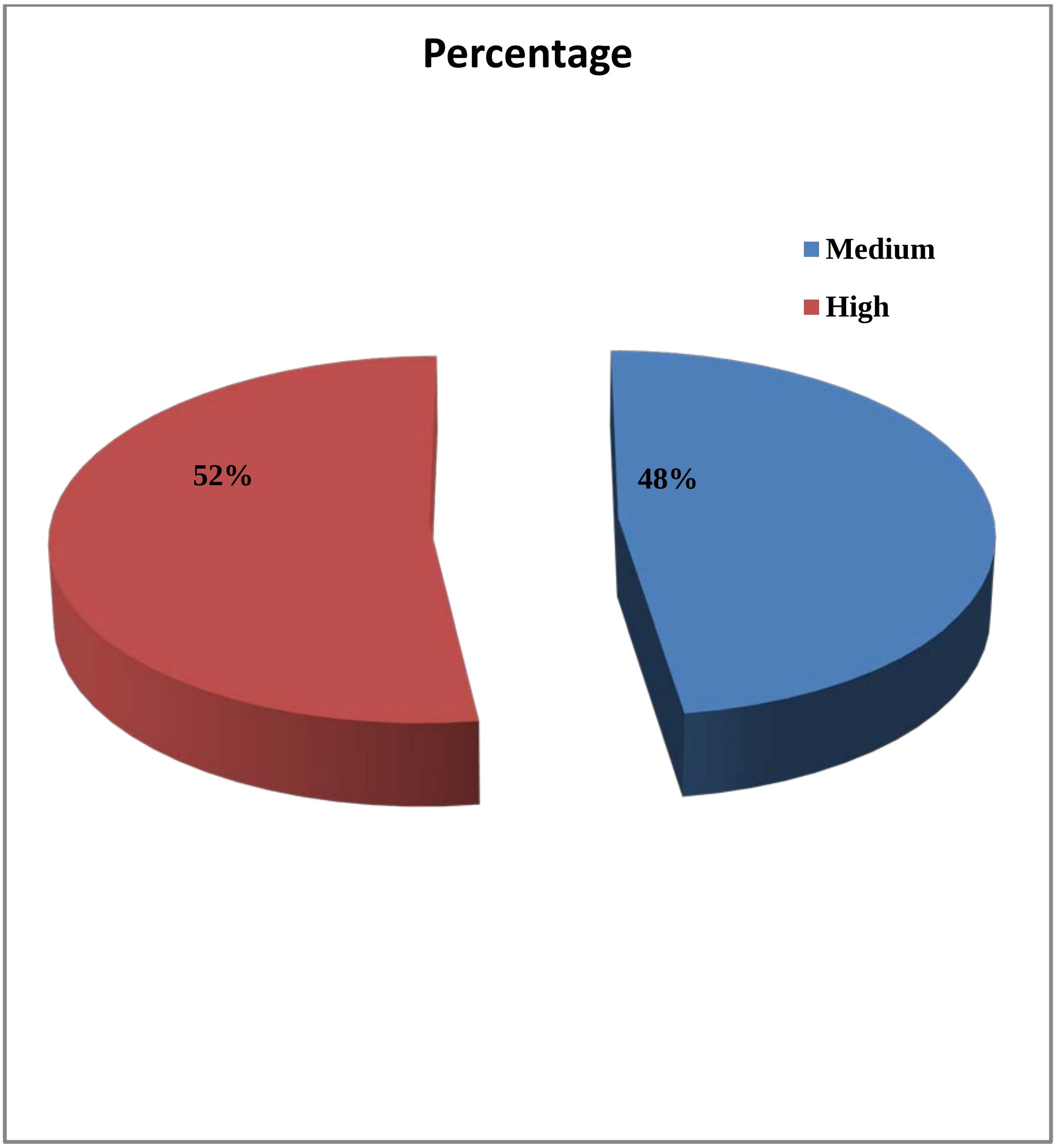


Figure 4.4 Sawmill workers' level of wood dust exposure

Table 4.3 Sawmill workers' previous dust exposure

Previous Exposure to Dust	**Frequency (n)**	**Percentage (%)**
Quarry	16	4.00
Foundary	1	0.25
Pottery	0	0.00
Cotton	4	1.00
Asbestos	0	0.00
Other Mines	1	0.25
Other Dusty Jobs	31	7.75
None	354	88.50

Table 4.4 Participants' smoking history

	Sawmill Workers		Non-Sawmill Workers	
	(n)	**(%)**	**(n)**	**(%)**
Cigarette Ever	50	12.50	23	5.80
Cigarette Now	22	5.50	5	1.30
5 Packs of Cigarette	23	5.8	11	2.80
Inhalation of Cigarette Smoke	24	6.00	10	2.50
At least 1 year Interruption	17	4.30	10	2.50
Cigar Ever	5	1.30	0	0.00
Cigar Now	2	0.50	0	0.00
Pipe Ever	1	0.30	0	0.00
Pipe Now	0	0.00	0	0.00

Table 4.5 Participants' lung function indices

	Sawmill Workers		Non-Sawmill Workers		P-value
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**	
LFI					
FVC (L)	2.52	0.60	3.35	0.70	<0.001*
FEV_1 (L)	1.73	0.49	2.64	0.60	<0.001*
FEV_1/FVC	0.69	0.10	0.79	0.06	<0.001*
PEFR ($L.min^{-1}$)	270.77	91.02	402.43	94.18	<0.001*
Normalized LFI					
FVC ($L.m^{-1}$)	1.54	0.34	1.98	0.40	<0.001*
FEV_1($L.\ m^{-1}$)	1.05	0.28	1.56	0.35	<0.001*
FEV_1/FVC.	0.42	0.06	0.47	0.04	<0.001*
PEFR ($L.\ m^{-1}.min^{-1}$)	165.08	54.03	237.68	54.01	<0.001*

Key: – FVC – Forced Vital Capacity,
FEV_1 – Forced Expiratory Volume in the First Second,
PEFR – Peak Expiratory Flow Rate
***** Indicates significant between group difference p<0.001

Table 4.6 Lung function indices of male and female sawmill workers

	Male (n=350)		Female (n=50)		P-Value
	Mean	**S.D.**	**Mean**	**S.D.**	
Lung Function Indices					
FVC (L)	2.56*	0.61	2.26	0.52	<0.01*
FEV_1 (L)	1.76*	0.50	1.55	0.39	<0.01*
FEV_1/FVC	0.69	0.10	0.69	0.09	0.83
PEFR ($L.min^{-1}$)	279.83*	87.91	207.38	88.02	<0.01*
Normalized LFI					
FVC ($L.m^{-1}$)	1.55*	0.34	1.42	0.31	<0.01*
FEV_1($L. m^{-1}$)	1.07*	0.29	0.97	0.23	0.01*
FEV_1/FVC. m^{-1}	0.42	0.06	0.43	0.06	0.09
PEFR ($L. m^{-1}.min^{-1}$)	170.06*	52.10	130.25	54.98	<0.01*

Key: – FVC – Forced Vital Capacity,
FEV_1 – Forced Expiratory Volume in the First Second,
PEFR – Peak Expiratory Flow Rate
S.D. – Standard Deviation
* Indicates significant between group difference $p<0.05$

Table 4.7 Lung function indices of male and female non-sawmill workers

	Male (n=350)		Female (n=50)		P-Value
	Mean	S.D.	Mean	S.D.	
Lung Function Indices					
FVC (L)	3.35	0.68	3.30	0.79	0.64
FEV_1 (L)	2.63	0.59	2.66	0.69	0.75
FEV_1/FVC	0.78	0.06	0.80	0.06	0.04*
PEFR ($L.min^{-1}$)	404.26	96.94	389.64	71.46	0.31
Normalized LFI					
FVC ($L.m^{-1}$)	2.55	1.08	1.98	0.45	0.71
FEV_1($L.\ m^{-1}$)	2.02	0.88	1.60	0.39	0.73
FEV_1/FVC. m^{-1}	0.60	0.25	0.48	0.04	0.75
PEFR ($L.\ m^{-1}.min^{-1}$)	303.03	121.34	234.01	39.63	0.69

Key: – FVC – Forced Vital Capacity,
FEV_1 – Forced Expiratory Volume in the First Second,
PEFR – Peak Expiratory Flow Rate
* Indicates significant between group difference $p<0.05$

4.1.3 Lung function indices and dust exposure among the sawmill workers

The Pearson product-moment correlation method was used to evaluate the relationship between each of the lung function indices (absolute [LFI] and normalised [LFI_n]) and years of participants' engagement in sawmill work. Table 4.10 presents the correlation coefficients obtained. The results showed that though the relationship was not significant ($p>0.05$), there was an inverse relationship between the FVC and PEFR and the years of engagement in sawmill work. The independent t-test was used to compare the lung function indices (absolute [LFI] and normalised [LFI_n]) between the sawmill workers who were highly exposed and moderately exposed to wood dust. Results in table 4.11 show that the FVC, FEV1 and FEV1/FVC were similar for the two categories ($p>0.05$) but the highly exposed workers had significantly higher PEFR than the moderately exposed workers ($p<0.05$).

4.1.4 Prevalence of respiratory symptoms among participants

Tables 4.12a, 4.12b and 4.12c show the prevalence of respiratory symptoms among the sawmill workers and the non-sawmill workers. Symptoms that were more prevalent among the sawmill workers included cough, phlegm production breathlessness (dyspnoea) and other chest illnesses. The non-sawmill workers showed higher prevalence of wheezing and were more affected by weather. Nasal drainage during the cold season was more common among the non-sawmill workers (34.80% compared to 31.50%) while nasal drainage during the dry/hot season was more common among the sawmill workers (19.30% compared to 5.30%)

4.1.5 Knowledge about wood dust hazard, personal protection and equipment among the sawmill workers

The knowledge of the sawmill workers concerning the hazard posed by wood dust, the need for personal protection and the various personal protective equipment was assessed and their responses to the various knowledge items are recorded in tables 4.13a, 4.13b and 4.13c. From the responses, it is worthy of note that almost a third (31.3%) of the sawmill workers did not know that their occupation poses a challenge to their health and about two-thirds did not know that wood dust is hazardous to the lungs (Table 4.13a). More than half of the workers (53.5%) did not know that wood dust can be carcinogenic and about three quarters of them (74.8%) erroneously believed that wearing face masks or clothing was enough at work (Table 4.13b).

Table 4.8 Lung function indices of smoking and non-smoking sawmill Workers

	Smokers (n=52)		Non-Smokers (n=348)		P-Value
	Mean	Std. Dev.	Mean	Std. Dev.	
Lung Function Indices					
FVC (L)	2.68	0.50	2.50	0.62	0.06
FEV_1 (L)	1.86	0.44	1.72	0.50	0.05
FEV_1/FVC	0.69	0.11	0.68	0.09	0.48
PEFR ($L.min^{-1}$)	279.46	96.06	269.81	90.47	0.49
Normalized LFI					
FVC ($L.m^{-1}$)	1.61	0.30	1.53	0.34	0.09
FEV_1($L. m^{-1}$)	1.12	0.26	1.05	0.28	0.08
FEV_1/FVC. m^{-1}	0.42	0.07	0.42	0.06	0.97
PEFR ($L. m^{-1}.min^{-1}$)	168.30	56.83	164.80	53.74	0.67

Key: – FVC – Forced Vital Capacity,
FEV_1 – Forced Expiratory Volume in the First Second,
PEFR – Peak Expiratory Flow Rate

Table 4.9 Lung function indices of smoking and non-smoking non-sawmill workers

	Smokers (n=23)		Non-Smokers (n=377)		P-Value
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**	
Lung Function Indices					
FVC (L)	3.15	0.68	3.36	0.70	0.16
FEV_1 (L)	2.48	0.55	2.64	0.61	0.21
FEV_1/FVC	0.79	0.06	0.79	0.06	0.78
PEFR ($L.min^{-1}$)	414.61	66.21	401.69	95.64	0.52
Normalized LFI					
FVC ($L.m^{-1}$)	1.87	0.40	2.52	1.03	0.76
FEV_1($L. m^{-1}$)	1.48	0.33	1.99	0.85	0.77
FEV_1/FVC. m^{-1}	0.47	0.05	0.59	0.25	0.81
PEFR ($L. m^{-1}.min^{-1}$)	246.72	38.61	297.31	116.93	0.84

Key: – FVC – Forced Vital Capacity,
FEV_1 – Forced Expiratory Volume in the First Second,
PEFR – Peak Expiratory Flow Rate

Table 4.10 Relationship between lung function measures and work experience among sawmill workers

	Unnormalized		Normalized	
	Correlation Coefficient (r)	P-value	Correlation Coefficient (r)	P-value
FVC (L)	-0.042	0.40	-0.046	0.36
FEV_1(L)	0.002	0.97	0.001	0.99
FEV_1/FVC	0.076	0.13	0.072	0.15
PEFR($L.min^{-1}$)	-0.049	0.33	-0.052	0.30

Key: – FVC – Forced Vital Capacity,
FEV_1 – Forced Expiratory Volume in the First Second,
PEFR – Peak Expiratory Flow Rate

Table 4.11 Comparison of lung function measures between sawmill workers at different levels of dust exposure

	Medium Exposure (n=191)		High Exposure (n=209)		P-Value
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**	
Lung Function Indices					
FVC (L)	2.48	0.57	2.56	0.63	0.22
FEV_1 (L)	1.72	0.47	1.74	0.51	0.60
FEV_1/FVC	0.69	0.10	0.68	0.10	0.28
PEFR ($L.min^{-1}$)	249.20	90.72	290.48	86.95	<0.01*
Normalized LFI					
FVC ($L.m^{-1}$)	1.52	0.32	1.55	0.35	0.27
FEV_1($L. m^{-1}$)	1.05	0.27	1.06	0.29	0.72
FEV_1/FVC	0.42	0.06	0.42	0.06	0.16
PEFR ($L.min^{-1}$)	152.26	54.18	176.80	51.27	<0.01*

Key: – FVC – Forced Vital Capacity,
FEV_1 – Forced Expiratory Volume in the First Second,
PEFR – Peak Expiratory Flow Rate
* Indicates significant between group difference p<0.01

Table 4.12a Prevalence of respiratory symptoms among participants

	Respiratory Symptoms	Frequency (%) Sawmill Workers	Non-Sawmill Workers	X^2	p-value
COUGH					
1	Cough first thing in the morning (on getting up) in the harmattan season	11.30	3.70	17.30	0.00
2	Cough during the day (or at night) in the harmattan season	15.00	12.80	2.58	0.28
3	Cough like this on most days (or nights) for as much as three months each year	9.30	2.80	15.46	0.00
PHLEGM					
4	Phlegm from chest first thing in the morning(on getting up) in the rainy season	18.50	7.00	23.78	0.00
5	Phlegm from chest during the day (or at night) in the rainy season	21.80	11.80	15.47	0.00
6	Phlegm like this on most days (or nights) for as much as three months each year	10.50	6.00	105.65	0.00
7	A period of (increased) cough and phlegm lasting for 3 weeks or more in the past three years	9.80	8.30	2.59	0.27
8	More than one such period	4.80	2.50	221.23	0.00
9	Ever coughed up blood	2.50	1.5	11.22	0.00
10	Coughed up blood in the past year	2.00	2.0	0.51	0.78

Key: - X^2 – Chi square

Table 4.12b Prevalence of respiratory symptoms among participants

	Respiratory Symptoms		Frequency (%) Sawmill Workers	Non-Sawmill Workers	X^2	p-value
BREATHLESSNESS:						
11	Troubled by shortness of breath when hurrying on level ground or walking up a slight hill		29.5	8.80	59.51	0.00
12	Short of breath walking with other people of own age on level ground		9.80	3.30	14.98	0.00
13	Stop for breath when walking at own pace on level ground		8.30	1.50	54.00	0.00
WHEEZING:						
14	Chest sound wheezing or whistling		7.00	12.00	8.66	0.00
15	Such sound most days or nights		4.00	2.00	16.92	0.01
16	Attacks of shortness of breath with wheezing		7.80	9.30	0.58	0.26
17	Absolutely normal breathing between attacks		4.80	5.00	0.06	0.97
WEATHER:						
18	Weather affects the chest		11.30	24.80	24.70	0.00
19	Weather causes shortness of breath		4.80	7.00	27.93	0.00
20	Kind of Weather:	Cold	5.80	10.80	27.71	0.00
		Hot	0.50	0.50		
		Harmattan	5.00	13.50		

Key: - X^2 – Chi square

Table 4.12c Prevalence of respiratory symptoms among participants

	Respiratory Symptoms	Frequency (%)			
		Sawmill Workers	**Non-Sawmill Workers**	**X^2**	**p-value**
NASAL DRAINAGE:					
21	Stuffy nose or drainage at the back of the nose in the winter	31.50	34.80	0.95	0.33
22	Stuffy nose or drainage in the dry/hot	19.30	5.30	37.64	0.00
23	Stuffy nose or drainage on most days for as much as three months each year	6.00	4.00	3.28	0.19
CHEST ILLNESS:					
24	Chest illness that kept from usual activities for as much as a week during the past three years	7.80	0.00	32.25	0.00
25	Brought up more phlegm than usual in any of the illnesses	4.30	0.00	32.25	0.00
EXPOSURE:					
27	Ever been exposed regularly to irritating gas or chemical fumes	0.00	0.00		
28	Ever been exposed (within 30 feet) to the smoke of an underground cable fire	0.00	0.00		

Key: - X^2 – Chi square

Table 4.13a Sawmill workers' responses to items on wood dust hazard, personal protection and equipment

Item	Statement	Frequency (%) Correct	Incorrect	Unsure
	Sawmill work can cause harmful effects to health	68.8	31.3	
1.	Wood dust is described as any wood particle arising from the processing or handling of wood, such as cutting, sanding, or milling	93.0	2.5	4.5
2.	When handling wood waste and cleaning around operations such as grinding, sanding, cutting, milling, and debarking, wood dust that has settled may become airborne	88.8	8.3	3.0
3.	Workers can breathe wood dust whenever it is generated	97.0	2.3	0.8
4.	The nose filters out larger dust particles, but smaller wood particles may be breathed into your lungs	85.3	8.0	6.8
5.	Wood dust is not hazardous to the lungs	36.5	44.0	19.5
6.	Dust from some woods can be hazardous to the skin	68.0	21.5	10.5

Table 4.13b Sawmill workers' responses to items on wood dust hazard, personal protection and equipment

		Frequency (%)		
Item	**Statement**	**Correct**	**Incorrect**	**Unsure**
7.	Wood dust can cause eye irritation	93.0	4.5	2.5
8.	Wood dust when inhaled over a time may cause an obstruction of the respiratory system	78.8	11.5	9.8
9.	Some effects associated with wood dust are thought to be due to moulds, bacteria, or pesticides present on the wood	48.3	30.0	21.8
10.	Wood dust, particularly when generated in furniture manufacturing and cabinet making, has been associated with nasal cancer	46.5	19.0	34.5
11.	Wearing face masks or clothing is enough at work	25.3	69.3	5.5
12.	I need to wear glasses to avoid effect of wood dust on the eyes	81.3	14.3	4.5

Table 4.13c Sawmill workers' responses to items on wood dust hazard, personal protection and equipment

		Frequency (%)		
Item	**Statement**	**Correct**	**Incorrect**	**Unsure**
13.	**I need wear face masks to avoid effect of wood dust on my respiratory system**	10.3	86.5	3.3
14.	**Wearing face mask, clothing, gases can prevent me from inhaling the wood dust**	7.8	90.0	2.3
15.	**Wearing only clothing can prevent effects of wood dust on skin**	30.0	67.0	3.0
16.	**A respirator may be used to reduce the amount of dust particles that would be breathed in during dusty operations**	81.0	5.0	14.0

An overwhelming majority of them (89.8% and 92.3% respectively) erroneously believed that wearing face masks will make them avoid the effect of wood dust on their respiratory system and that wearing face mask, clothing and glasses will prevent them from inhaling the wood dust. Almost three-quarters of the workers (70.0%) reported that wearing only clothing can prevent the effects of wood dust on skin which is untrue.

The sawmill workers' knowledge scores are presented in tables 4.14a, 4.14b, 4.14c and 4.14d while figure 4.5 shows their knowledge level distribution. The sawmill workers were generally moderately knowledgeable with a knowledge score of 65.44±14.37% (Table 4.14a). Less than a fifth (17.0%) of the sawmill workers had high knowledge scores and almost a quarter (24.5%) had low knowledge scores (Figure 4.5).

The tables (4.14a – 4.14d) also present the outcome of comparison of the sawmill workers' knowledge by categorical variables (sex, level of exposure, job type and educational level). The knowledge scores were similar (p>0.05) for the males and females (Table 4.14a) as well as those at high and moderate dust exposure levels (Table 4.14b). The knowledge scores were not significantly different (p>0.05) across job descriptions (Table 4.14c) as well as across educational levels (Table 4.14d). Correlational analysis showed weak and inverse relationship that was not statistically significant (p>0.05) between the workers knowledge score and each of age and work experience (Table 4.15).

4.1.6 Attitude towards wood dust hazard and the use of personal protective equipment among the sawmill workers

The attitude of the sawmill workers concerning the hazard posed by wood dust, the need for personal protection and the use of personal protective equipment was assessed and their responses to the various attitude items are summarised in table 4.16. From the responses, it is worthy of note that about a third (33.0%) of the workers did not see any danger posed by their occupation (item 1) and more than half (58.8%) felt safe continuing to work when they lack personal protective equipment (item 7). Majority of the workers (80.0%) tend to have a false sense of security in the use of personal protective equipment (item 8).

Table 4.14a Sawmill workers' knowledge score and comparison by sex

		Raw Score (Out of 16)		Percentage Score	
	N	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
All	400	10.47	2.30	65.44	14.37
Sex:					
Male	350	10.55	2.22	65.93	13.90
Female	50	9.92	2.73	62.00	17.07
Calculated t-value					1.81
P-value					0.07

Table 4.14b Comparison of sawmill workers' knowledge score by level of dust exposure

		Raw Score (Out of 16)		Percentage Score	
	N	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
Level of Exposure:					
Medium	191	10.48	2.22	65.51	13.87
High	209	10.46	2.37	65.37	14.85
Calculated t-value					0.10
P-value					0.92

Table 4.14c Comparison of sawmill workers' knowledge score by job description

		Raw Score (Out of 16)		Percentage Score	
	N	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
Job Description:					
Driver	5	11.60	1.95	72.50	12.18
Loader	11	9.63	1.50	60.23	9.38
Plank Seller	146	10.43	2.30	65.20	14.36
Carpenter	30	10.76	1.91	67.29	11.91
Circular Machine Operator	68	10.51	2.34	65.72	14.63
Planing Machine Operator	91	10.38	2.51	64.90	15.69
Circular and Planing Machine Operator	49	10.57	2.27	66.07	14.21
Calculated f-value					0.57
P-value					0.76

Table 4.14d Comparison of sawmill workers' knowledge score by educational level

		Raw Score (Out of 16)		Percentage Score	
	N	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
Level of Education					
None	34	9.56	2.92	59.74	18.28
PrySch	153	10.57	2.27	66.05	14.19
SecSch	191	10.60	2.19	66.23	13.69
HiSch	13	10.15	2.48	63.46	15.49
CollUniv	9	10.00	1.66	62.50	10.36
Calculated f-value					1.72
P-value					0.15

Key – PrySch – Primary School; SecSch – Secondary School;
HiSch – High School; CollUniv – College or University

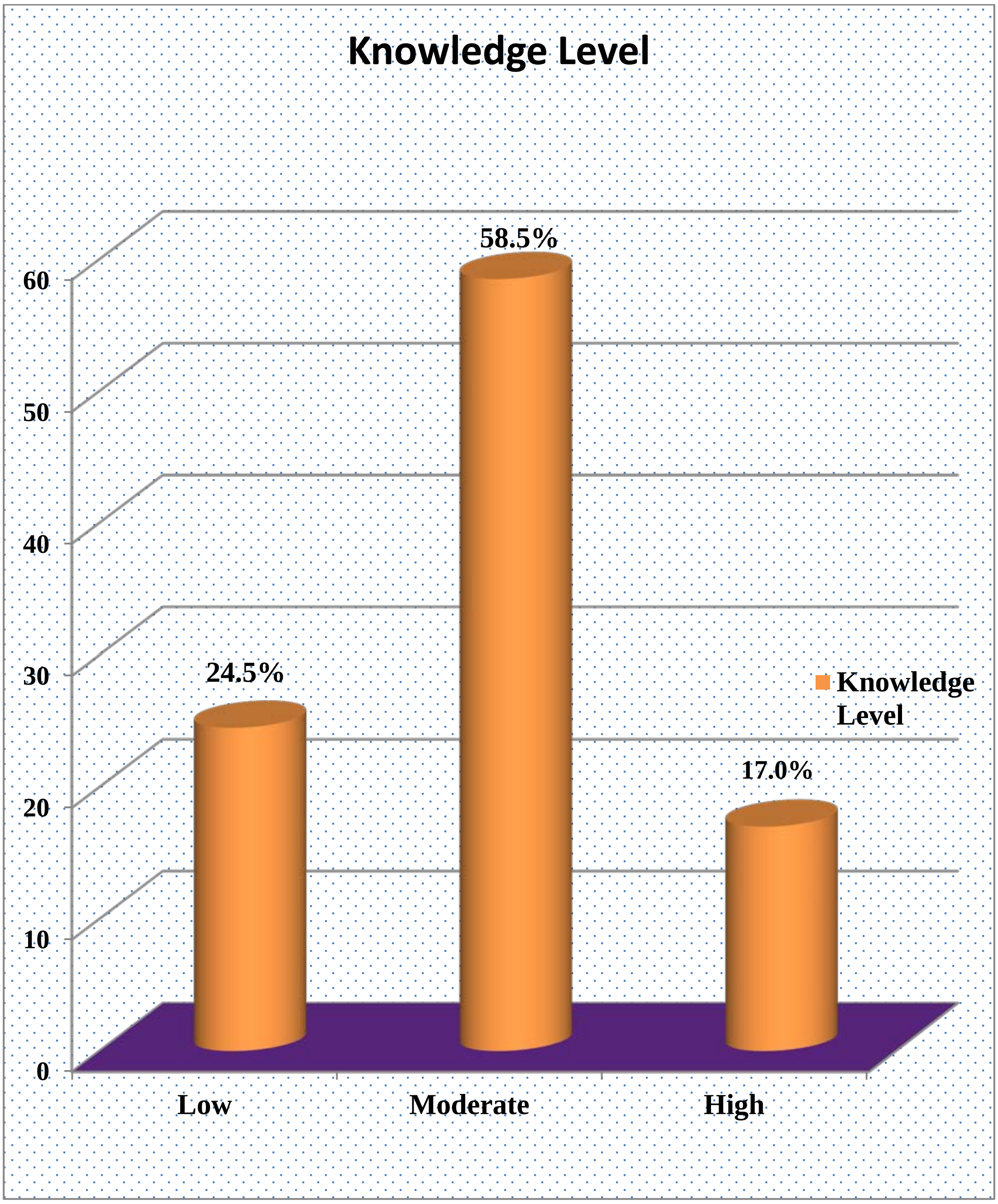


Figure 4.5 Sawmill Workers Distribution by Knowledge Level

Table 4.15 Relationship between the knowledge score of sawmill workers and each of age and work experience

	Age		Work Experience	
	Correlation Coefficient (r)	**P-value**	**Correlation Coefficient (r)**	**P-value**
Knowledge Score	**-0.003**	**0.95**	**-0.046**	**0.36**

Table 4.16 Attitude towards wood dust hazard, personal protection and equipment among sawmill workers

		Frequency (%)				
		A	**B**	**C**	**D**	**E**
	Scores for positively framed statements	**4**	**3**	**2**	**1**	**0**
	Scores for negatively framed Statements	**0**	**1**	**2**	**3**	**4**
1.	**I think it could be dangerous when working at the sawmill**	32.0	28.0	6.3	21.5	11.5
2.	**I think it is necessary to have respiratory organs checked by medical workers annually**	48.8	48.0	1.5	1.3	0.5
3.	**Sawmill workers need to be trained in the use of clothing, gloves, face mask and eye glasses**	49.5	43.8	3.5	3.3	0.0
4.	**In my opinion, health workers should monitor the use of clothing, gloves, face mask, eye glasses by sawmill workers**	45.0	46.0	4.0	3.5	1.5
5.	**In my opinion, face mask is not enough to protect myself from wood dust**	28.3	40.3	10.8	18.8	2.0
6.	**I don't think I can get skin disease from wood dust**	23.3	23.8	8.3	37.8	7.0
7.	**I think I should not continue working if I lack personal protective equipments**	16.8	17.3	7.3	38.3	20.5
8.	**In my opinion, if I wear enough personal protective equipment, I can be protected from the hazardous effects of wood dust**	43.5	36.5	7.5	10.8	1.8

Key – A- Strongly Agree; B- Agree; C- Neutral; D- Disagree; E- Strongly Disagree

* Negatively framed statements

The sawmill workers' attitude scores are recorded in tables 4.17a, 4.17b, 4.17c and 4.17d while figure 4.6 shows their distribution by attitude scores. The sawmill workers generally had a neutral attitude towards wood dust hazard, need for personal protection and use of personal protective equipment with an attitude score of 61.63±11.86% (Table 4.17a). The mean attitude scores for the various categories ranged between 56.99% and 66.25%. Less than a tenth (4.0%) of the sawmill workers had a positive attitude, more than two-fifths (41.0%) were neutral and more than half (55.0%) had a negative attitude (Figure 4.6).

The tables (4.17a – 4.17d) also present the outcome of comparison of the sawmill workers' attitude by categorical variables (sex, level of exposure, job type and educational level). Attitude scores were similar ($p>0.05$) for the males and females (Table 4.17a) as well as those at high and moderate dust exposure levels (Table 4.17b). The attitude scores were not significantly different ($p>0.05$) across job descriptions (Table 4.17c) as well as across educational levels (Table 4.17d). Correlational analysis showed weak and inverse relationship between the workers attitude score and each of age and work experience (Table 4.18). The relationship with age was significant ($p<0.05$) while that with work experience was not significant ($p>0.05$).

4.1.7 The use of personal protective equipment among the sawmill workers

Table 4.19 summarises the use of personal protective equipment among the sawmill workers. None of the personal protective equipment was reportedly used by at least a third of the workers (31.3%, 12.0%, 16.0% and 26.5% for face masks, gloves, footwear and clothing respectively). None of the personal protective equipment was also reportedly used always by at least a quarter of the workers (7.5%, 4.8%, 6.3%, 12.0%, and 18.3% for face masks, gloves, glasses, footwear and clothing respectively). More than three-fifth of the sawmill workers reported poor practice for all the protective equipment (64.3%, 85.8%, 86.0%, 84.8%, and 72.3% for face masks, gloves, glasses, footwear and clothing respectively). More than a quarter (28.3%) of the workers however, reported fair practice with the face mask.

Table 4.17a Sawmill workers' attitude score and comparison by sex

		Raw Score (Out of 32)		Percentage Score	
	N	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
All	400	19.72	3.79	61.63	11.86
Sex:					
Male	350	19.74	3.78	61.69	11.82
Female	50	19.58	3.92	61.19	12.24
Calculated t-value					0.28
P-value					0.78

Table 4.17b Comparison of sawmill workers' attitude score by level of dust exposure

		Raw Score (Out of 32)		Percentage Score	
	N	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
Level of Exposure:					
Medium	191	19.98	3.71	62.45	11.58
High	209	19.48	3.87	60.87	12.08
Calculated t-value					1.33
P-value					0.18

Table 4.17c Comparison of sawmill workers' attitude score by job description

		Raw Score (Out of 32)		Percentage Score	
	N	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
Driver	5	21.20	5.63	66.25	17.59
Loader	11	18.36	3.75	57.39	11.72
Plank Seller	146	19.83	3.51	61.97	10.98
Carpenter	30	21.23	4.15	66.36	12.97
Circular Machine Operator	68	19.88	4.10	62.13	12.81
Planing Machine Operator	91	19.66	3.70	61.44	11.57
Circular and Planing Machine Operator	49	18.51	3.70	57.85	11.54
Calculated f-value					2.06
P-value					0.06

Table 4.17d Comparison of sawmill workers' attitude score by educational level

	N	Raw Score (Out of 32)		Percentage Score	
		Mean	Standard Deviation	Mean	Standard Deviation
Level of Education					
None	34	18.23	3.68	56.99	11.52
PrySch	153	19.98	3.72	62.46	11.63
SecSch	191	19.77	3.87	61.78	12.09
HiSch	13	20.07	3.77	62.74	11.79
CollUniv	9	19.22	3.31	60.07	10.34
Calculated f-value					1.58
P-value					0.18

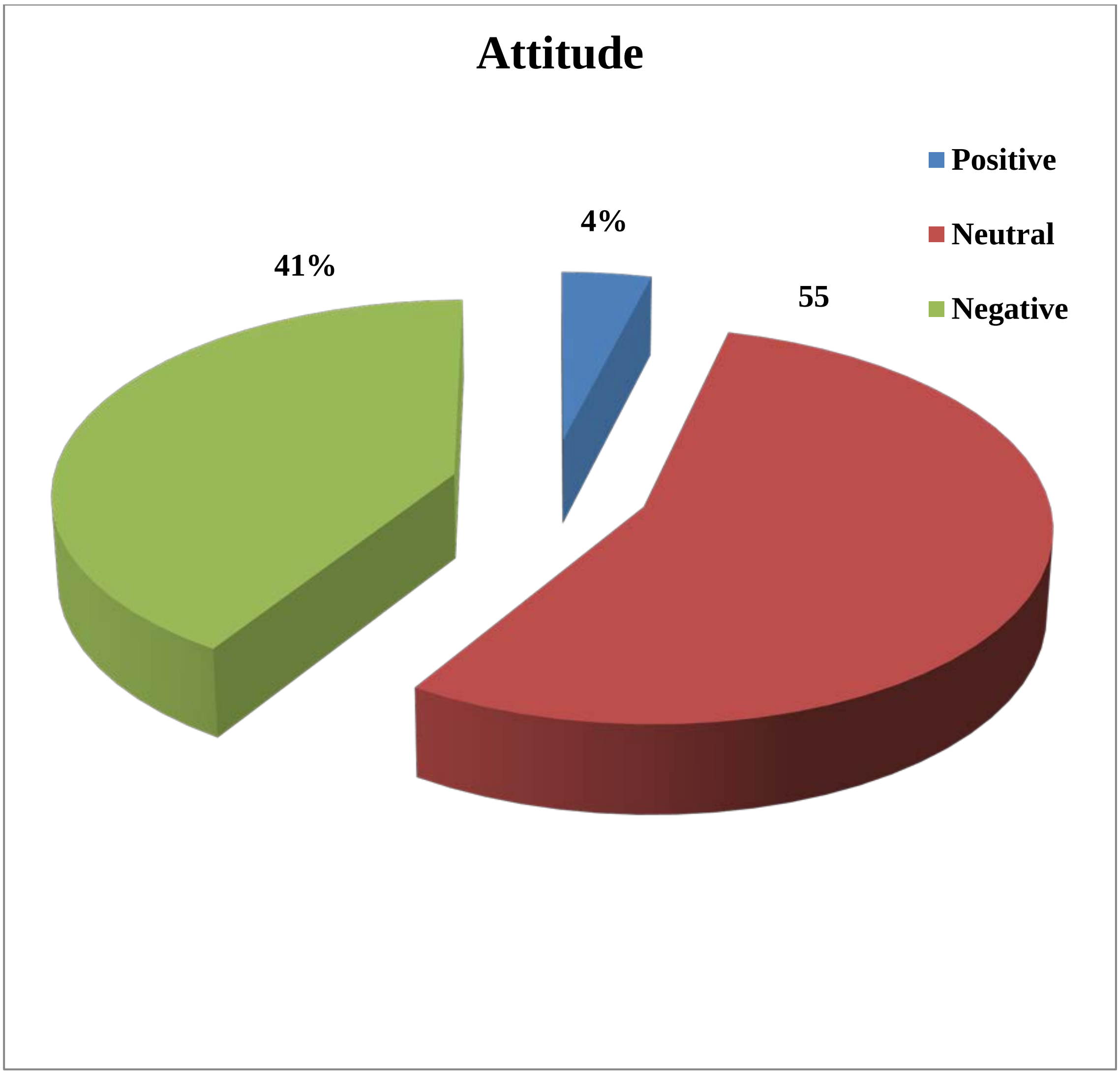


Figure 4.6 Sawmill Workers Distribution by Attitude Level

Table 4.18 Relationship between the attitude score of sawmill workers and each of age and work experience

	Attitude Score	
	Spearman's rho	**P-value**
Age	-0.103	0.04*
Work Experience	-0.051	0.31

* Indicates significant correlation (p<0.05)

Table 4.19 Use of personal protective equipment by sawmill workers

	Frequency (%)				
	Face Masks	**Gloves**	**Glasses**	**Footwear**	**Clothing**
Use of Personal Protective Equipment:					
YES	31.3	12.0	---	16.0	26.5
NO	58.5	88.0	---	84.0	73.5
Frequency of Usage:					
NEVER	64.3	85.8	86.0	84.8	72.3
SOMETIME	28.3	9.5	7.8	3.3	9.5
ALWAYS	7.5	4.8	6.3	12.0	18.3

The sawmill workers' practice (use of PPE) scores are presented in tables 4.20a, 4.20b, 4.20c and 4.20d while figure 4.7 shows their practice level distribution. The sawmill workers had a poor mean practice score (15.58±22.77%). The mean practice scores ranged between 11.43% and 23.67% for the different categories of workers. The tables (Tables 4.20a, 4.20b, 4.20c and 4.20d) present the outcome of comparison of the sawmill workers' practice scores by categorical variables (sex, level of exposure, job type and educational level). The practice scores were similar ($p>0.05$) for the males and females (Table 4.20a) as well as those at high and moderate dust exposure levels (Table 4.20b). The practice scores were also not significantly different ($p>0.05$) across different job descriptions (Table 4.20c) as well as across educational levels (Table 4.20d). Relationship between the workers practice score and each of age and work experience (Table 4.21) were weak and not significant ($p>0.05$).

The various reasons offered by the workers for not using specific protective equipment are summarised in Table 4.22. Problem of availability dominated for facemasks (61.0%) and gloves (66.5%) while about a fifth (19.5%) of the workers reported that using the facemask was uncomfortable. The sawmill workers predominantly thought it was not necessary to use glasses (67.0%), footwear (64.5%) and clothing (63.5%).

4.1.8 Effects of the BASNEF model-based respiratory protection education on knowledge, attitude and practice concerning wood dust hazard, personal protection and equipment among the sawmill workers

The knowledge, attitude and practice scores before the health education programme were compared using the independent t-test. The results obtained and recorded in table 4.23 showed that all the variables were not significantly different ($p>0.05$) between the Training group (TG) and the Non-Training group (NTG).

The pre-training and post-training scores were compared using the paired t-test for each of the two groups. Significant differences were found in all the variables ($p<0.05$) both for the NTG (Table 4.24) and the TG (Table 4.25).

Table 4.20a Sawmill workers' practice score and comparison by gender

		Raw Score (Out of 10)		Percentage Score	
	N	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
All	400	1.56	2.27	15.58	22.77
Sex:					
Male	350	1.62	2.34	16.20	23.38
Female	50	1.12	1.74	11.20	17.45
Calculated t-value					1.45
P-value					0.15

Table 4.20b Comparison of sawmill workers' practice score by level of dust exposure

		Raw Score (Out of 10)		Percentage Score	
	N	Mean	Standard Deviation	Mean	Standard Deviation
Level of Exposure					
Medium	191	1.51	2.22	15.08	22.19
High	209	1.60	2.33	16.03	23.33
Calculated t-value					-0.42
P-value					0.68

Table 4.20c Comparison of sawmill workers' practice score by job description

		Raw Score (Out of 10)		Percentage Score	
	N	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
Driver	5	1.60	3.05	16.00	30.50
Loader	11	0.64	1.20	6.36	12.06
Plank Seller	146	1.44	2.16	14.38	21.62
Carpenter	30	2.37	2.64	23.67	26.46
Circular Machine Operator	68	1.84	2.80	18.38	27.99
Planing Machine Operator	91	1.60	2.17	16.04	21.75
Circular and Planing Machine Operator	49	1.14	1.71	11.43	17.08
Calculated f-value					1.46
P-value					0.19

Table 4.20d Comparison of sawmill workers' practice score by educational level

		Raw Score (Out of 10)		Percentage Score	
	N	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
Level of Education					
None	34	1.68	2.07	16.76	20.70
PrySch	153	1.68	2.28	16.80	22.82
SecSch	191	1.47	2.34	14.76	23.39
HiSch	13	1.23	2.16	12.31	21.66
CollUniv	9	1.22	2.05	12.22	20.48
Calculated f-value					0.31
P-value					0.87

Key – PrySch – Primary School; SecSch – Secondary School; HiSch – High School; CollUniv – College or University

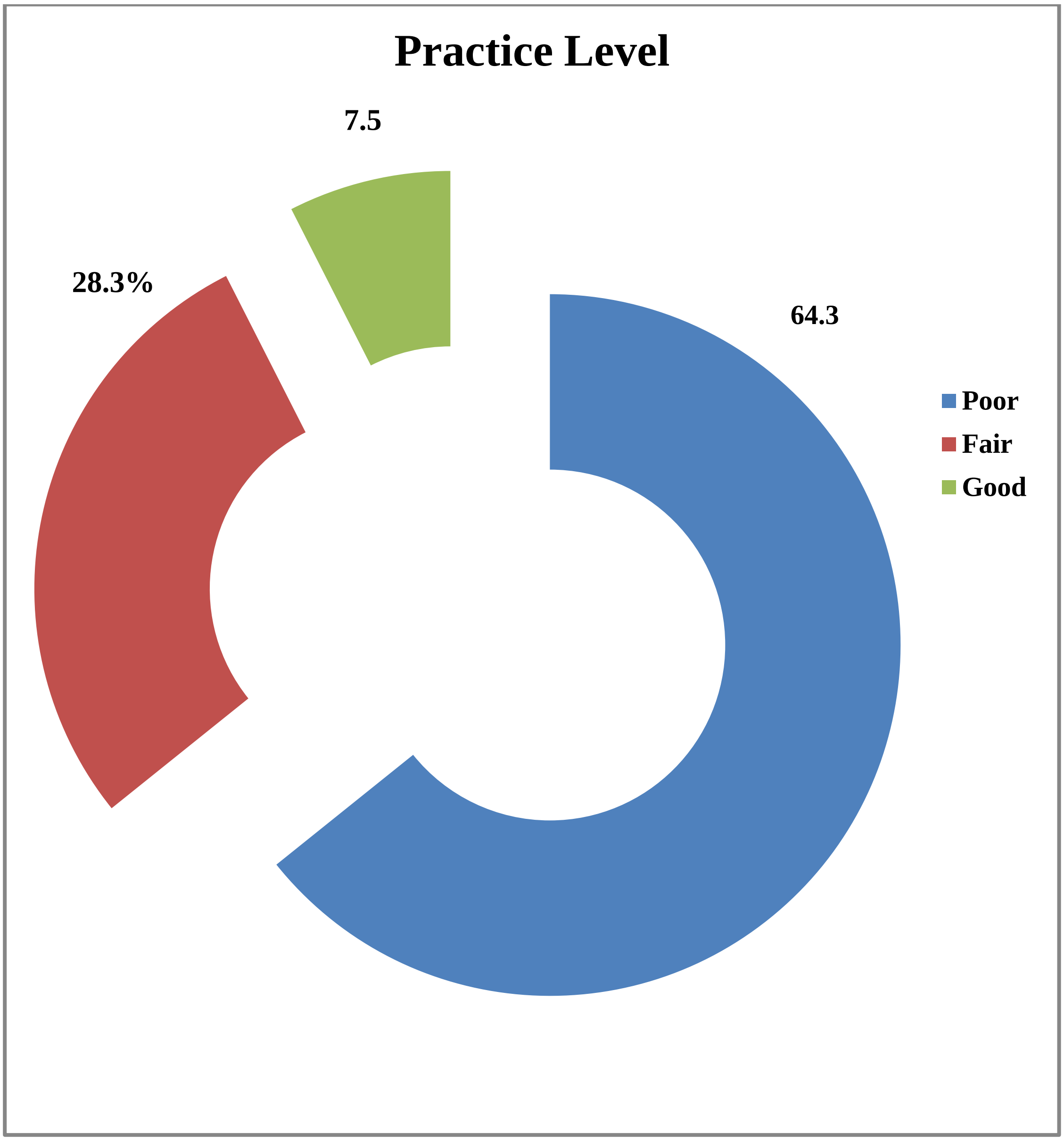


Figure 4.7 Practice Level Distribution of Sawmill Workers

Table 4.21 Relationship between the practice score of sawmill workers and each of age and work experience

	Practice Score	
	Spearman's rho	**P-value**
Age	-0.037	0.47
Work Experience	0.055	0.28

Table 4.22 Reasons offered for not using personal protective equipment (PPE)

	Frequency (%)				
PPE	**Unavailable**	**Unnecessary**	**Uncomfortable**	**Nobody Uses**	**Not Told**
Facemask	61.0	4.8	19.5	1.3	3.5
Gloves	66.5	11.5	7.5	1.8	5.5
Glasses	13.8	67.0	3.3	2.0	5.8
Footwear	13.5	64.5	2.8	1.8	5.5
Clothing	10.8	63.5	1.8	1.5	5.0

Table 4.23 Baseline comparison of knowledge, attitude and practice scores between the training and non-training groups

	Study Group		
	Training Group (n=45) **Mean±S.D.**	**Non-Training Group (n=45)** **Mean±S.D.**	**P-value**
Knowledge Score (%)	62.92±16.01	63.19±14.37	0.931
Attitude Score (%)	60.28±12.76	62.02±11.99	0.508
Practice Score (%)	15.33±17.91	14.67±16.73	0.856

Table 4.24 Pre-training and post-training comparison of knowledge, attitude and practice scores in the non-training group

	Pre-Training Mean±S.D.	Post-Training Mean±S.D.	P-Value
Knowledge Score (%)	63.19±14.37	65.42±12.04	0.01*
Attitude Score (%)	62.02±11.99	62.92±12.53	0.01*
Practice Score (%)	14.67	16.89	0.02*

* Indicates significant difference (p<0.05)

Table 4.25 Pre-training and post-training comparison of knowledge, attitude and practice scores in the training group

	Pre-Training Mean±S.D.	Post-Training Mean±S.D.	P-Value
Knowledge Score (%)	62.92±16.01	91.39±3.60	<0.01*
Attitude Score (%)	60.28±12.76	83.68±8.35	<0.01*
Practice Score (%)	15.33	91.33±9.68	<0.01*

* Indicates significant difference (p<0.01)

The post-training scores were also compared between the Non-Training group and the Training group using the independent t-test. Analysis revealed significantly higher knowledge, attitude and practice scores ($p<0.01$) for the Training group than the Non-Training group (Table 4.26). The independent t-test was also used to compare the changes in knowledge, attitude and practice scores ($p<0.01$) between the Training group and the Non-Training group (Table 4.27). The changes in knowledge, attitude and practice scores were significantly greater in the Training group than in the Non-Training group ($p<0.001$).

Table 4.26 Post-training comparison of knowledge, attitude and practice scores between the non-training and training groups

	Study Group		
	Training Group (n=45) Mean±S.D.	Non-Training Group (n=45) Mean±S.D.	P-value
Knowledge Score (%)	91.39±3.60	65.42±12.04	<0.01*
Attitude Score (%)	83.68±8.35	62.92±12.53	<0.01*
Practice Score (%)	91.33±9.68	16.89	<0.01*

* Indicates significant difference (p<0.01)

Table 4.27 Comparison of change in knowledge, attitude and practice scores between the non-training and training groups

	Study Group		
	Training Group (n=45) Mean±S.D.	Non-Training Group (n=45) Mean±S.D.	P-value
Change in Knowledge Score (%)	28.47±15.91	2.22	<0.001*
Change in Attitude Score (%)	2340±15.08	0.90	<0.001*
Change in Practice Score (%)	76.00±19.35	2.22	<0.001*

* Indicates significant difference (p<0.001)

4.2 Testing of hypotheses

Hypothesis 1

There will be no significant difference in the forced vital capacity (FVC) between the sawmill workers and age and gender-matched non-sawmill workers.

Test statistic – Independent t-test

Since the calculated p value (<0.001) was lesser than the alpha level of 0.05, the hypothesis was **REJECTED**.

Inference – The sawmill workers have a significantly lower FVC than the age and gender-matched non-sawmill workers.

Hypothesis 2

There will be no significant difference in the forced expiratory volume in the first second (FEV_1) between the sawmill workers and age and gender-matched non-sawmill workers.

Test statistic – Independent t-test

Since the calculated p value (<0.001) was lesser than the alpha level of 0.05, the hypothesis was **REJECTED**.

Inference – The sawmill workers have a significantly lower FEV_1 than the age and gender-matched non-sawmill workers.

Hypothesis 3

There will be no significant difference in the Peak expiratory flow rate (PEFR) between the sawmill workers and age and gender-matched non-sawmill workers.

Test statistic – Independent t-test

Since the calculated p value (<0.001) was lesser than the alpha level of 0.05, the hypothesis was **REJECTED**.

Inference – The sawmill workers have a significantly lower PEFR than the age and gender-matched non-sawmill workers.

Hypothesis 4

There will be no significant difference in the forced expiratory ratio (FEV_1/FVC %) between the sawmill workers and age and gender-matched non-sawmill workers.

Test statistic – Independent t-test

Since the calculated p value (<0.001) was lesser than the alpha level of 0.05, the hypothesis was **REJECTED**.

Inference – The sawmill workers have a significantly lower FEV_1/FVC % than the age and gender-matched non-sawmill workers.

Hypothesis 5

There will be no significant relationship between the forced vital capacity (FVC) and the length of engagement in the sawmill work among the sawmill workers.

Test statistic – Pearson product-moment correlation

Since the calculated p value (0.40) was greater than the alpha level of 0.05, the hypothesis **COULD NOT BE REJECTED**.

Inference – The FVC of the sawmill workers is not significantly related to their length of engagement in the sawmill work (occupational exposure to wood dust).

Hypothesis 6

There will be no significant relationship between the forced expiratory volume in the first second (FEV_1) and the length of engagement in the sawmill work among the sawmill workers.

Test statistic – Pearson product-moment correlation

Since the calculated p value (0.97) was greater than the alpha level of 0.05, the hypothesis **COULD NOT BE REJECTED**.

Inference – The FEV_1 of the sawmill workers is not significantly related to their length of engagement in the sawmill work (occupational exposure to wood dust).

Hypothesis 7

There will be no significant relationship between the Peak expiratory flow rate (PEFR) and the length of engagement in the sawmill work among the sawmill workers.

Test statistic – Pearson product-moment correlation

Since the calculated p value (0.13) was greater than the alpha level of 0.05, the hypothesis **COULD NOT BE REJECTED**.

Inference – The PEFR of the sawmill workers is not significantly related to their length of engagement in the sawmill work (occupational exposure to wood dust).

Hypothesis 8

There will be no significant relationship between the forced expiratory ratio (FEV_1/FVC %) and the length of engagement in the sawmill work among the sawmill workers.

Test statistic – Pearson product-moment correlation

Since the calculated p value (0.38) was greater than the alpha level of 0.05, the hypothesis **COULD NOT BE REJECTED**.

Inference – The FEV_1/FVC % of the sawmill workers is not significantly related to their length of engagement in the sawmill work (occupational exposure to wood dust).

Hypothesis 9

There will be no significant difference in the forced vital capacity (FVC) of sawmill workers at high level of wood dust exposure (based on job description) and those at moderate level of wood dust exposure.

Test statistic – Independent t-test

Since the calculated p value (0.27) was greater than the alpha level of 0.05, the hypothesis **COULD NOT BE REJECTED**.

Inference – There is no significant difference in the forced vital capacity (FVC) of sawmill workers at high level of wood dust exposure (based on job description) and those at moderate level of wood dust exposure.

Hypothesis 10

There will be no significant difference in the forced vital capacity (FEV_1) of sawmill workers at high level of wood dust exposure (based on job description) and those at moderate level of wood dust exposure.

Test statistic – Independent t-test

Since the calculated p value (0.72) was greater than the alpha level of 0.05, the hypothesis **COULD NOT BE REJECTED**.

Inference – There is no significant difference in the forced vital capacity (FEV_1) of sawmill workers at high level of wood dust exposure (based on job description) and those at moderate level of wood dust exposure.

Hypothesis 11

There will be no significant difference in the forced vital capacity (PEFR) of sawmill workers at high level of wood dust exposure (based on job description) and those at moderate level of wood dust exposure.

Test statistic – Independent t-test

Since the calculated p value (0.16) was greater than the alpha level of 0.05, the hypothesis **COULD NOT BE REJECTED**.

Inference – There is no significant difference in the forced vital capacity (PEFR) of sawmill workers at high level of wood dust exposure (based on job description) and those at moderate level of wood dust exposure.

Hypothesis 12

There will be no significant difference in the forced vital capacity (FEV_1/FVC %) of sawmill workers at high level of wood dust exposure (based on job description) and those at moderate level of wood dust exposure.

Test statistic – Independent t-test

Since the calculated p value (<0.01) was lesser than the alpha level of 0.05, the hypothesis was **REJECTED**.

Inference – There is a significant difference in the forced vital capacity (FEV_1/FVC %) of sawmill workers at high level of wood dust exposure (based on job description) and those at moderate level of wood dust exposure.

Hypothesis 13

There will be no significant difference in the knowledge score between the Training and Non-Training groups before the BASNEF model-based respiratory protection education programme.

Test statistic – Independent t-test

Since the calculated p value (0.93) was greater than the alpha level of 0.05, the hypothesis **COULD NOT BE REJECTED**.

Inference – There was no significant difference in the knowledge score between the Training and Non-Training groups before the BASNEF model-based respiratory protection education programme.

Hypothesis 14

There will be no significant difference in the attitude score between the Training and Non-Training groups before the BASNEF model-based respiratory protection education programme.

Test statistic – Independent t-test

Since the calculated p value (0.51) was greater than the alpha level of 0.05, the hypothesis **COULD NOT BE REJECTED**.

Inference – There was no significant difference in the attitude score between the Training and Non-Training groups before the BASNEF model-based respiratory protection education programme.

Hypothesis 15

There will be no significant difference in the practice score between the Training and Non-Training groups before the BASNEF model-based respiratory protection education programme.

Test statistic – Independent t-test

Since the calculated p value (0.86) was greater than the alpha level of 0.05, the hypothesis **COULD NOT BE REJECTED**.

Inference – There was no significant difference in the practice score between the Training and Non-Training groups before the BASNEF model-based respiratory protection education programme.

Hypothesis 16

There will be no significant difference in the knowledge score concerning wood dust hazard and the use of personal protective equipment before and after the BASNEF model-based health education programme among the untrained sawmill workers group (NTG).

Test statistic – Paired t-test

Since the calculated p value (0.01) was lesser than the alpha level of 0.05, the hypothesis was **REJECTED**.

Inference – There was a significant difference in the knowledge score concerning wood dust hazard and the use of personal protective equipment before and after the BASNEF model-based health education programme among the untrained sawmill workers group (NTG).

Hypothesis 17

There will be no significant difference in the attitude score concerning wood dust hazard and the use of personal protective equipment before and after the BASNEF model-based health education programme among the untrained sawmill workers group (NTG).

Test statistic – Paired t-test

Since the calculated p value (0.01) was lesser than the alpha level of 0.05, the hypothesis was **REJECTED**.

Inference – There was a significant difference in the attitude score concerning wood dust hazard and the use of personal protective equipment before and after the BASNEF model-based health education programme among the untrained sawmill workers group (NTG).

Hypothesis 18

There will be no significant difference in the practice score concerning wood dust hazard and the use of personal protective equipment before and after the BASNEF model-based health education programme among the untrained sawmill workers group (NTG).

Test statistic – Paired t-test

Since the calculated p value (0.01) was lesser than the alpha level of 0.05, the hypothesis was **REJECTED**.

Inference – There was a significant difference in the practice score concerning wood dust hazard and the use of personal protective equipment before and after the BASNEF model-based health education programme among the untrained sawmill workers group (NTG).

Hypothesis 19

There will be no significant difference in the knowledge score concerning wood dust hazard and the use of personal protective equipment before and after the BASNEF model-based health education programme among the trained sawmill workers group (TG).

Test statistic – Paired t-test

Since the calculated p value (<0.01) was lesser than the alpha level of 0.05, the hypothesis was **REJECTED**.

Inference – There was a significant difference in the knowledge score concerning wood dust hazard and the use of personal protective equipment before and after the BASNEF model-based health education programme among the trained sawmill workers group (TG).

Hypothesis 20

There will be no significant difference in the attitude score concerning wood dust hazard and the use of personal protective equipment before and after the BASNEF model-based health education programme among the trained sawmill workers group (TG).

Test statistic – Paired t-test

Since the calculated p value ((<0.01) was lesser than the alpha level of 0.05, the hypothesis was **REJECTED**.

Inference – There was a significant difference in the attitude score concerning wood dust hazard and the use of personal protective equipment before and after the BASNEF model-based health education programme among the trained sawmill workers group (TG).

Hypothesis 21

There will be no significant difference in the practice score concerning wood dust hazard and the use of personal protective equipment before and after the BASNEF model-based health education programme among the trained sawmill workers group (TG).

Test statistic – Paired t-test

Since the calculated p value ((<0.01) was lesser than the alpha level of 0.05, the hypothesis was **REJECTED**.

Inference – There was a significant difference in the practice score concerning wood dust hazard and the use of personal protective equipment before and after the BASNEF model-based health education programme among the trained sawmill workers group (TG).

Hypothesis 22

There will be no significant difference in the knowledge score between the Training and Non-Training groups after the BASNEF model-based respiratory protection education programme.

Test statistic – Independent t-test

Since the calculated p value (<0.01) was lesser than the alpha level of 0.05, the hypothesis was **REJECTED**.

Inference – There was a significant difference in the knowledge score between the Training and Non-Training groups after the BASNEF model-based respiratory protection education programme.

Hypothesis 23

There will be no significant difference in the attitude score between the Training and Non-Training groups after the BASNEF model-based respiratory protection education programme

Test statistic – Independent t-test

Since the calculated p value (<0.01) was lesser than the alpha level of 0.05, the hypothesis was **REJECTED**.

Inference – There was a significant difference in the attitude score between the Training and Non-Training groups after the BASNEF model-based respiratory protection education programme.

Hypothesis 24

There will be no significant difference in the practice score between the Training and Non-Training groups after the BASNEF model-based respiratory protection education programme

Test statistic – Independent t-test

Since the calculated p value (<0.01) was greater than the alpha level of 0.05, the hypothesis was **REJECTED**.

Inference – There was a significant difference in the practice score between the Training and Non-Training groups after the BASNEF model-based respiratory protection education programme.

Hypothesis 25

There will be no significant difference in the change in knowledge score between the Training and Non-Training groups after the BASNEF model-based respiratory protection education programme.

Test statistic – Independent t-test

Since the calculated p value (<0.001) was lesser than the alpha level of 0.05, the hypothesis was **REJECTED**.

Inference – There was a significant difference in the change in knowledge score between the Training and Non-Training groups after the BASNEF model-based respiratory protection education programme.

Hypothesis 26

There will be no significant difference in the change in attitude score between the Training and Non-Training groups after the BASNEF model-based respiratory protection education programme.

Test statistic – Independent t-test

Since the calculated p value (<0.001) was lesser than the alpha level of 0.05, the hypothesis was **REJECTED**.

Inference – There was a significant difference in the change in attitude score between the Training and Non-Training groups after the BASNEF model-based respiratory protection education programme.

Hypothesis 27

There will be no significant difference in the change in practice score between the Training and Non-Training groups after the BASNEF model-based respiratory protection education programme.

Test statistic – Independent t-test

Since the calculated p value (<0.001) was lesser than the alpha level of 0.05, the hypothesis was **REJECTED**.

Inference – There was a significant difference in the change in practice score between the Training and Non-Training groups after the BASNEF model-based respiratory protection education programme.

4.3 Discussion

4.3.1 Sociodemographic characteristics of participants

Participants in this study were matched for gender, age and weight but the non-sawmill workers were significantly taller than the sawmill workers. Lung function indices increases with height and decreases with weight (David et al, 2001). To control for any differences related to height differential, the normalized values of LFI are also reported in this study. Thus the differences observed in the normalized LFI could not have been due to height differences between the groups but most likely that of exposure to dust.

Majority of the sawmill workers in this study (87.5%) were males. This male predominance can be attributed to the nature of the job being physically demanding and dusty. Other studies that reported male predominance among workers in the sawmilling industry include Jacobsen et al (2008), Bello and Mijinyawa (2010), Uhumwangho et al (2010), Klaric et al (2012) and Agbana et al (2016). Tobin et al (2016) carried out a study on occupational exposure to wood dust and respiratory health status of sawmill workers in Egor Local Government area of Benin City in South-South Nigeria and in the 17 sawmills covered the workers were all males. Similar observation had also been made in other industries. Truong et al (2009) in their assessment of knowledge, attitude and practice of Personal Protective Equipment in Rattan Craftsmen observed a male predominance among the participants and ascribed the observation to the fact that rattan sulfur - bleaching process is a hard and poisonous work that requires much of time (18 hours each time on average) and strength and as such may be more fitting for men.

The mean age of the sawmill workers in this study (38.77±11.11 years) imply that those who participate in milling activities are those in the middle age category who can hustle around for the demands of the job. This is similar to the mean age of 38.9±12.8 years for the sawmill workers in the study of Uhumwangho et al (2010), the mean age of 38.28±11.67 years in the study of Faremi et al (2014), average age of 37.73±9.79 years for the workers surveyed by Soongkhang and Laohasiriwong (2015) and 37.78±14.7 years in the study of Agbana et al (2016). Adeoye et al (2015) also concluded that sawmill workers are usually in the active age group because of the demands of the job.

Very few of the sawmill workers had beyond secondary school education. This finding may not be surprising as the majority of these workers were unskilled who only required apprenticeship to carry out their job. This trend had been severally observed since the study of Awoyemi (1997) on occupational health problems of sawmill workers in Ilorin. In the study of Bello and Mijinyawa (2010), sawmill workers with tertiary education were only 9%, West Africa School Certificate (WASC) holders were 58% while first school leaving certificate (FSLC) holders were 33%. Osuchukwu et al (2013) also recorded only 10% of the woodworkers in their study having gone through tertiary education, 38% with secondary education and 52% with only primary education or no formal education at all while in the study of Adeoye et al (2014) only 14% of the sawmill workers went beyond secondary school education and the majority (86%) had secondary education or less. Faremiet al, (2014) recorded 76.6% of the sawmill workers in their study having secondary education or less. Majority of the workers (63.99%) in the study of Soongkhang and Laohasiriwong (2015) only finished primary education. More than three-quartes (80.7%) of the sawmill workers in the study of Agbana et al (2016) also had secondary education or less.

The sawmill workers work almost throughout the year, working for over ten hours per day, twenty six days per month and twelve months per year. This is contrary to reports from studies conducted in some other countries where strict labour regulations exist. Soongkhang and Laohasiriwong (2015) reported that majority of the wood furniture factory workers were working for 6 days a week with 8 average working hours a day and Thetkathuek et al (2010) also reported similarly. Soongkhang and Laohasiriwong (2015) ascribed this to the fact that every organization has to follow the Labour Protection Act concerning the normal working hour, for not more than 8 hours a day. Such law does not seem to be enforced in Nigeria considering reports of studies conducted among sawmill workers in the Country. Osuchukwu et al (2013) reported that most of the workers in their study (75.8%) worked for 8-12 hours per day. Adeoye et al (2015) also reported that Over 90% of the sawmill workers in their study worked for over eight hours per day and according to Agunbiade (2015), the average labourer at sawmills works for 10 hours per day.

Bello and Mijinyawa (2010) had reported about the frailty of enforcement mechanism of the factory laws in the small-scale sawmills with employers' claiming ignorance on certain aspects of the provisions of the ordinance, laws, code or decree. Some other researchers opined that employers or owners of sawmills are not unaware of the labour laws and factory safety acts but rather, it is the dominance of fragile monitoring framework and the desire to maximise profits (Ahiauzu, 1984, Bamidele et al., 2010). The labour laws specify the rights and privileges of the employer and employees, including the need for the employer to present in clear terms, the possible occurrence of hazards or risks and ways or measures of avoiding them in the workplace (Baram, 2009) but desperate job seekers are more interested in getting the job than worry about the effect on their health (Bello and Mijinyawa, 2010). This observation could also be ascribed to the ignorance of the sawmill workers. In a study by Akinyeye et al (2013), only half of the respondents knew that exposure to hazards could be reduced by limiting their work hours to a maximum of 8 hours per day and in another study by Agbana et al (2016), a greater proportion of the respondents (62.8%) claimed that they did not know the maximum acceptable working hours per day.

4.3.2 Participants' lung function indices

The sawmill workers in this study had significantly lower lung function indices (FVC, FEV_1, FEV_1/FVC and PEFR) than the non-sawmill workers. This is in line with previous reports (Fatusi and Erhabor 1996; Mandryk et al, 2000; Milanowski et al, 2002; Okwari et al, 2005; Meo, 2006; Ugheoke *et al*., 2006; Ugheoke *et al*., 2009; Mohan Aprajita and Panwar, 2013; Deshpande and Afshan, 2014 and Adeoye et al., 2015. Tobin et al, 2016). In a systematic review by Wiggans et al (2016), fourteen (78%) of the studies reviewed reported significantly lower single time point (STP) FEV_1 or FVC in their exposed populations compared to control populations while four studies reported no difference in STP lung function between exposed and control populations. They therefore identified conflicting evidence for impaired lung function among exposed woodworkers. This study therefore further corroborates the lung function impairing effect of wood dust exposure.

The lung function decline according to Iyawe and Ebomoyi (2005) is attributable to inflammatory changes in the respiratory tracts brought about by the sawdust exposure which ultimately results in airway remodeling and lung dysfunction. Most of the tree species processed in Nigeria are highly allergenic (Keay, 1989). This might be the cause of such inflammation. It has also been opined that chronic dust exposure impairs the phagocytic activity of alveolar macrophages and also affects the mucociliary performance. When the dust particles are inhaled, scavenger cells like macrophages dissolve the dust by surrounding it, but if there is dust overload, the macrophages fail to completely clear the dust; consequently the dust particles lodge in and irritate the lungs setting up an inflammation in the small airways of the lung. The healing of the inflammation by fibrosis leads to thickening of lining of airways leading to obstruction (Kasper et al, 2008; Itagi et al, 2011).

The reduced lung function indices (FVC, FEV_1, FEV_1/FVC and PEFR) among the sawmill workers in this study is suggestive of a mixed pattern (combined restrictive and obstructive patterns) of lung function impairment. This is contrary to the findings of Pramanik and Chaudhury (2013) who reported a significant decrease in FVC and FEV_1 and normal FEV_1/FVC ratio among carpenters indicating a restrictive type of pulmonary impairment. A low spirometric FVC together with a normal or high FEV_1/FVC ratio has earlier been classified as a restrictive abnormality (Carpo, 1994; Cheeta et al, 2004). The findings in the present study however conforms to Mahmood et al (2016) who reported that continuous wood dust exposure was associated with a significant decline in lung function, of both an obstructive (FEV_1 and PEF) and restrictive (FVC) nature. According to Dave-Mclean, elevated exposure to both “green” and “dry” dust is associated with a significant decline in lung function of both an obstructive (FEV_1, PEF) and a restrictive (FVC) nature among New Zealand sawmill workers. Douwes et al, (2001) had also earlier reported that exposure to pine wood dust increases the risk of atopy and obstructive and restrictive pulmonary effects. The BTS and NICE guidelines define airway obstruction using the fixed ratio of 0.70 and an FEV_1 below 80% predicted, while GOLD and ATS/ERS COPD guidelines only use the 0.70 fixed ratio (Swanney et al 2008). The sawmill workers in this study had FEV_1/FVC ratio of 0.69 which is below 0.70 and can therefore be said to present with an obstructive pattern.

The male sawmill workers in this study had significantly higher LFIs and LFI_ns than the females except for expiratory ratio (FEV_1/FVC and FEV_{1n}/FVC_n). This is in line with previous reports on the effect of gender on lung function indices (Behera et al, 2014; Jaga and Hegde, 2014). According to Card and Zeldin (2009) and Algadir et al, (2012) this gender differential can be attributed to the fact that men are more muscular and have bigger lungs for the same height as compared to females. Thurlbeck (1982) from the examination of 56 children reported larger total number of alveoli and a larger aveolar surface area in boys than in girls for a given age and stature. Sex hormones, sex hormone receptors or intracellular signaling pathways in addition to the anatomical and physiological differences may also be responsible for the gender-difference in lung functions.

The LFIs and LFI_ns were comparable between smokers and non-smokers among the sawmill workers and the non-sawmill workers. This implies that smoking did not significantly impact on LFIs. Ugheoke et al (2006) in their study on the influence of smoking on respiratory symptoms and lung function indices in sawmill workers in Benin City, Nigeria reported that sawmill workers are at an increased risk of developing respiratory disorders compared to control subjects, and this risk is even more pronounced in a situation where the sawmill worker is also a smoker.

There are no generally agreed-upon definitions of heavy smoking, but a cumulative dose of 73,000–146,000 cigarettes, which corresponds to 20 cigarettes per day over 10–20 years, or 10–20 pack-years, is associated with a clinically relevant increase in morbidity (Kamholz, 2004). Pack-years of smoking are calculated by multiplying the number of years smoked by the average number of packs per day. Yun et al, (2012) have also classified status of smoking exposure as light smoker (≤10 cigarettes daily), moderate smoker (≤20 cigarettes daily), and heavy smoker (>20 cigarettes daily). Jacobsen et al, (2012b) used 7 pack-yrs as the cut-off point between light and heavy smokers. From the foregoing, the smokers in the present study could be considered to be light smokers and this might account for the impact on the LFIs not being significant.

4.3.3 Lung function indices and dust exposure among the sawmill workers

In considering respiratory health effects of occupational exposure to wood dust, wood dust exposure had been assessed in different ways. Some studies estimated exposure solely on employment status or job description (Chan-Yeung et al, 1984; Douwes et al, 2001; Ugheoke et al, 2006) while some studies based exposure assessment on a substantial amount of measurements (Noertjojo et al, 1996; Mandryk et al, 2000; Borm et al, 2002; Teschke et al, 2004; Douwes et al, 2006; Friesen et al, 2007; Glindmeyer et al, 2008). This study classified exposure level based on job description and cumulative exposure based on years of exposure. This was done because of the unavailability of facilities for actual gravimetric measurement of ambient wood dust concentration.

Workers at higher dust exposure level had significantly higher PEFR than those at lower dust exposure but all the other LFIs were similar. This observation is suggestive that the inflammation of the airway caused by wood dust exposure is not dose-dependent. In the dry wood industry, cross-sectional studies using cumulative exposure indexes or years of employment have reported conflicting results (Jacobsen et al 2008). While a number of studies have shown an association between decreased lung function and wood dust exposure [Shamssain et al 1992; Noertjojo, 1996; Mandryk et al 1999], others found no such association (Talini et al 1998; Ahman et al 1996; Bohadana et al 2000; Borm et al 2002). Wiggans et al (2016) in their systematic review considered the studies of Glindmeyer et al (2008) and Jacobsen et al (2008) and concluded that evidence for a greater risk of impaired lung function with increasing exposure to wood dust is conflicting. Whitehead et al. (1981) found lower FEV_1/FVC values for the workers who were exposed to wood dust at higher values compared with those exposed at lower levels in their study. Such correlation could not be found between pulmonary function tests and cumulative dust concentrations in the study of Bohadana et al. (2000). Vedal et al. (1986) found statistically significantly lower FEV_1 and FVC values for the workers who were exposed to dust at high levels compared with those exposed to it at lower values in their study on the workers working with Western Red Cedar wood in Canada. This may imply that dose-dependent inflammatory response to wood dust exposure is dependent upon the tree type.

Schlunssen et al., (2002) in their baseline study found no association between wood dust concentration level or seniority in the wood industry and baseline lung function parameters. The present study also found no significant relationship between LFIs and work experience (seniority) which is contrary to the reports of Okwari et al., (2005), Pramanik and Chaudhury (2013) and Adeoye et al, (2015). Mahmood et al 2016 reported a weak negative correlation that was not significant between duration of exposure to work environment in sawmill workshops and FVC, FEV_1, FEV_1/FVC and a weak positive correlation that was not significant between duration of exposure to work environment and PEF in sawmill workers while Aguwa et al, (2007) reported that the PEFR significantly became low with increasing years of exposure to woodwork. Pramanik and Chaudhury (2013) in their study on the impact of occupational exposure to wood dust on pulmonary health of carpenters in small scale furniture industries in West Bengal reported that the harmful effect of wood dust exposure is associated with the duration of exposure to wood dust. This is suggestive that the inflammatory reaction of the airway to wood dust exposure is non-progressive.

4.3.4 Prevalence of respiratory symptoms among participants

Higher prevalence of respiratory symptoms (especially cough, phlegm, shortness of breath and chest illnesses was recorded among the sawmill workers in this study compared to the non-sawmill workers. This is in accordance with previously published studies (Borm et al, 2002; Fransman et al, 2003; Oppliger et al, 2005; Adeoye et al, 2015). A good number of the tree species processed in this environment such as Mansonia, Iroko and Walnut species are highly allergenic (Ugheoke et al, 2006). Such tree species may contain high levels of irritant chemicals such as monoterpenes which have been shown to increase work related symptoms (Rosenburg et al, 2002). Another reason may be exposure to spores of molds, which are known to cause several respiratory symptoms and mucous membrane irritation among wood workers (Edward et al, 1993; Dutkiewicz et al, 2001). The higher prevalence of cough and phlegm is in conformity with the theory of inflammation of the airway by the wood dust. The increased cough is an attempt to clear the airway of the wood dust trapped in the mucus lining. This finding is in conformity with results from several other studies (Borm et al, 2002; Rongo et al, 2002; Fransman et al, 2003; Rongo et al, 2005; Oppligor et al, 2005; Sripaiboonkij et al, 2009; Bhatti et al, 2011)

The implication of the combination of symptoms is that both upper respiratory tract and lower respiratory tract involvement are likely. This finding is contrary to some previous reports (Eriksson et al, 1996; Demers et al, 2000; Douwes et al, 2000) that suggested mainly upper respiratory tract involvement. They opined that wood dust, made up of cellulose and other soluble chemicals including acetic acid and resins, is largely of large diameter fibres that irritate the cough receptors in the trachea and cause mucostasis in the upper respiratory tract, leading to cough and phlegm production. The lower respiratory tract involvement suggested by the present study is however in line with several studies that have reported association between wood dust exposure and asthma symptoms (Douwes et al, 2001; Jones et al., 2004; Aguwa et al, 2007; Heikkila et al, 2008; Klaric et al., 2012; Wiggans et al., 2016). Borm et al, (2002) reported that upper and lower respiratory system symptoms increased in people exposed to wood dust. These symptoms are said to be related to the exposure levels (Fransman et al, 2003). The proportion of the sawmill workers who reported being short of breath walking with other people of own age on level ground (9.80%) and stopping for breath when walking at own pace on level ground (8.30%) are very close to those who reported chest sound wheezing or whistling (7.00%) and attacks of shortness of breath with wheezing (7.80%). The lower respiratory symptoms may also be attributable to the irritant and allergic properties of wood dust.

4.3.5 Knowledge about wood dust hazard, personal protection and equipment among the sawmill workers

Knowledge, according to concise oxford dictionary is information and skills, acquired through experience and/or education. Knowledge of potential occupational hazards and safety is germane to forming positive attitude that will inform behaviour. Less than a fifth (17.0%) of the sawmill workers in this study had high knowledge about wood dust hazard, need for personal protection and personal protective equipment. The proportion of workers having high level of knowledge in the present study is similar to previous reports (Bolaji et al., 2005; Osagbemi et al., 2015; Agbana et al., 2016). In the study of Agbana et al, (2016), only 15.8% of the sawmill workers had good knowledge of occupation-related hazards while 61.7% had poor knowledge and 22.5% had average knowledge. In a study on the awareness of occupational hazards, health problems and safety measures among sawmill workers in North Central Nigeria, Osagbemi et al (2010) also indicated that the level of awareness of various occupational hazards among sawmill workers was low. Only 28.1% of the 257 respondents in their study perceived dust to be a hazard in the workplace. That 58.5% of the workers in the present study had moderate knowledge however suggests that the respondents were not outrightly ignorant of the need for occupational health and safety practice.

Mitchual et al, (2015a) on the other hand in a study on the "Awareness and Willingness to Utilize Health and Safety Measures among Woodworkers of a Timber Processing Firm in Ghana", reported that the level of awareness of occupational health and safety by the respondents was high. They opined that various reasons like institutional training, adaptation of regulatory measures for safety precautions by management of the company might have contributed to the workers' high awareness of occupational health and safety issues related to their work. These were lacking in sawmills studied as less than a quarter of them (23.0%) claimed to have had any form of training before. Ahmed and Newson-Smith (2010) reported that receiving information about the job-associated hazards, and attending a training course about occupational health and safety had significant influence on the knowledge of workers about occupational hazards. Aluko et al, (2016) in a study on knowledge, attitudes and perceptions of occupational hazards and safety practices in Nigerian healthcare workers reported that the commonest source of knowledge of occupational hazards identified by their study was in-school professional training (87.2 %), on the job experience, and post-employment professional in-service workshops. Lack/inadequate training for sawmill workers have been reported in previous studies [Bello and Mijinyawa, 2010; Rus et al, 2008] and its implication of not properly equipping workers with the information needed for injury prevention [Bello and Mijinyawa, 2010]. Tetemke et al, (2014) in their study on knowledge and practices regarding safety information among textile workers in Adwa town, Ethiopia reported significant association between workers knowledge level and each of health and safety training, display of work regulations and workers' rights at work place. In the study of Adeoye et al (2015) only one-third (34%) of the sawmill workers had formal training for the job.

The sawmill workers do not necessarily undergo any professional training and neither do they partake in post-employment professional in-service workshops. The poor knowledge of the danger of sawmill dust and health effects of the dust among the sawmill workers is probably due to the fact that most of the respondents received their training through apprenticeship and thereby rely on their masters for information on the job especially knowledge of hazards associated with wood dust of which the master too probably have insufficient knowledge. This lack of formal training for the job might not allow the workers to learn about the hazards associated with their occupation as well as possible precautions to be taken in the practice of their vocation. This is a shortcoming of apprentice training in that the trainee is exposed to only what the trainer knows and practices.

The knowledge of the workers concerning occupational health and safety practice was not different across the job categories. Since level of exposure was classified in this study based on the job description, it is not surprising that their knowledge also did not differ between those at high dust exposure level and those at moderate exposure.
The knowledge of the sawmill workers in this study was not influenced by their educational level. This is in agreement with the report of Mitchual et al, (2015a) that educational background of the respondents in their study appeared not to have significant influence on their awareness of occupational health and safety issues. In contrast, Gyekye and Salminen (2005) according to Adebola (2014) reported that level of education influences worker health and safety in the workplace. Level of education was also shown to provide the appropriate skills needed to achieve social status and make healthy lifestyle choices; hence a high level of education increases the awareness of occupational safety. On the other hand, Parimalam, Kamalamma and Ganguli (2007) found out that workers who had tertiary education were less likely to regularly use personal protective equipment compared to those with secondary education thus debunking the claims by other studies. It therefore appears that there is more that determines awareness or knowledge about occupational hazards than level of education.

The relationship between the workers knowledge score and each of age and work experience was weak and not significant but the inverse nature of the relationship implies that the older workers who had longer working experience tend to be less aware. In contrast, Massrouje (2001) reported that the highest knowledge about occupational hazards was found among those who had worked for 10 years or more and the lowest was for newly employed subjects. Ahmed and Newson-Smith (2010) also reported that years of service had no statistically significant effect on the knowledge related to occupational hazards among cement workers in United Arab Emirates.

4.3.6 Attitude towards wood dust hazard and the use of personal protective equipment among the sawmill workers

Very few of the sawmill workers (4.0%) had a positive attitude towards wood dust hazard and the use of protective equipment. About a third (33.0%) of the workers did not see any danger posed by their occupation and more than half (58.8%) felt safe continuing to work when they lack personal protective equipment. According to the Health Belief Model, the perceived seriousness of, and susceptibility to, a disease influence an individual's perceived threat of disease. This is why Glanz et al. (2008), opined that interventions based on the health belief model may aim to increase perceived susceptibility to and perceived seriousness of a health condition by providing education about prevalence and incidence of disease, individualized estimates of risk, and information about the consequences of disease (e.g., medical, financial, and social consequences). The neutral attitude of the workers may therefore be attributed to their low perceived susceptibility.

Attitude did not differ significantly across gender, level of exposure, job categories and educational level. This implies that no matter the gender, job description and educational level, the peer (societal) influence is a major determinant of the sawmill workers' attitude. In other words, the peers constitute a group that hold normative beliefs that lead to the subjective norms in that workplace according to the BASNEF concept. According to the BASNEF model of health education, an individual turns to a new behaviour when s/he believes that the behaviour has some health, economic or other benefits (individual's belief and evaluation of the outcomes of that behaviour). Then, this evaluation leads to the formation of an attitude toward the behaviour in that individual (attitude to the behaviour). Furthermore, there are important people in the individual's life that can affect his/her decision with regard to adopting that new behaviour and act as a barrier or a facilitator (subjective norms). The subjective norms of an individual are also determined by normative beliefs; i.e. the extent to which the new behaviour is approved or rejected by those who are important for him/her, in this instance the peers/co-workers.

Attitude though not significantly related to work experience, showed a weak but significant inverse relationship with age in this study. This is contrary to the findings of Bolaji (2005) who found the variables of age, years of education, years of experience, and knowledge of the hazards correlated positively and significantly with the attitude of the carpenters towards occupational health and safety. The present findings imply that the older sawmill workers probably because they have been lucky not to be seriously affected by their work environment tend to cast aspersion in relation to the wood dust hazard.

Poor attitude towards the use of PPE does not seem peculiar to sawmill workers only. Similar trend had been reported concerning other worker groups that need similar personal protection. Truong et al (2009) in their study of Rattan craftsmen reported that only 4.2% of the respondents had positive attitude, 69.0% had neutral attitude while 26.8% had negative attitude.

4.3.7 The use of personal protective equipment among the sawmill workers

Several studies have suggested the need for people in the wood industry to adopt the use of protective respiratory device during their work and for sawmill managements to do more to enforce practice of safety including PPE use (Pramanik and Chaudhury, 2013; Mitchual et al, 2015b).

The practice of personal protection was generally poor among the sawmill workers in this study. Such poor compliance and use of protective equipment would make the workers to be highly susceptible to developing respiratory illnesses and sustaining other injuries. This finding is similar to previous reports. According to Osonwa et al (2013) studies in Nigeria on PPE use among industrial workers are sparsely reported but the few studies have highlighted that PPE availability, access and use still suffers a setback especially in third world countries. Adeoye et al (2014) conducted a walk-through survey in ten sawmill sites to assess the usage of personal protective equipment by the workers. It was observed that very little attention was paid to the use of PPE in all the sawmills visited. In spite of the high total suspended particulate concentration in the sawmill sites, none of the workers used face masks.

The relationship between the workers knowledge about the job hazard and their practice of personal protection though significant was poor. The workers on the average had moderate knowledge but poor practice. Several studies have highlighted a wide gap between knowledge level and practices regarding the use of protective equipment. In spite of majority of the workers in wood furniture factory in the study of Soongkhang and Laohasiriwong (2015) had high level of knowledge and attitude of dust prevention, the overall dust preventive behaviour was reported to be at middle level. The observation that knowledge does not necessarily translate to practice is corroborated by studies among other worker groups also. Yu et al (2005) in their study of Knowledge, Attitude and Practice regarding organic solvents among printing workers in Hong Kong reported that neither good knowledge nor appropriate attitude had a significant effect on safe practice. Ahmed and Newson-Smith (2010) in their study of Knowledge and practices related to occupational hazards among cement workers in United Arab Emirates observed that despite the relatively high knowledge of the cement factory workers about the adverse health effects of exposure to dust, the use of respiratory protective equipment was poor. Khoso and Nafees (2015) in their study on the knowledge, attitude and practices regarding respiratory symptoms among textile workers of Karachi, reported that a significant proportion of the textile workers had good knowledge and appropriate attitude towards cotton dust exposure, but appropriate protective practices were not being adopted by most of them.

The wide gap between knowledge level and practices regarding the use of protective equipment indicates that there are factors other than knowledge and attitude influencing the adoption of safety practices in workers. The reasons mentioned by workers who were not using PPE in this study were mainly unavailability of the device and discomfort. Reasons given in other studies include high cost, non-availability and noncompulsion (Bolaji, 2005), financial reasons, non-availability and not being provided by the employers (Kripa et al., 2005), carelessness, discomfort, cost or unavailability (Yassin et al., 2002). According to the BASNEF model of health education, the combination of attitude toward the behaviour and abstract norms leads to the formation of a decision for adopting a new behaviour (behavioural intention) but factors like skill, money, cost, etc., can be influential in changing behavioural intention to a behaviour; these factors must already be present for a behaviour to be formed (enabling factors). Availability of the protective device constitutes an enabling factor because no matter how high the level of knowledge and positive the attitude of a worker, if the equipment is not available, there is no way the behaviour can be adopted. Tetemke et al (2014) reported a huge gap between the knowledge and usage of personal protective equipments mainly due to the non-availability of safety device and safety device not provided by the employers. Another enabling factor from the foregoing is safety training (skill). Almost three-quarters (74.9%) of the workers have not had any form of training on the use of respiratory protective equipment. Ahmed and Newson-Smith (2010) reported that receiving information about the job-associated hazards and attending a training course about occupational health and safety had significant influence on the practice of workers about occupational hazards. Tetemke et al (2014) also reported that training had significant association with personal protective equipment usage.

The poor personal protection practice may also be possibly related to lack of monitoring or law enforcement. Yu et al (2005) highlighted that even though the traditional health education model emphasizes the sequence of imparting knowledge, changing attitudes and altering behaviour, this is often not the case in actual practice. They corroborated the fact with the well-known case that the use of seat belts in cars depends more on legislation and law enforcement than on adequate knowledge and appropriate attitude. Ahmed and Newson-Smith (2010) reported that one of the factors that influence the individual to use the personal protective equipment is compliance of the individual with the safety regulations regardless of the education level.

Personal protection practice of workers in this study did not differ across the various demographic categories (gender, level of exposure, job categories and educational level) contrary to some previous reports. Tetemke et al, (2014) reported that male workers tend to use PPE two times more than female workers. Ahmed et al. (2001) in Saudi Arabia reported that the use of hearing protection devices was directly related to the years of education while Ahmed and Newson-Smith (2010) reported that years of education was inversely related to the use of respiratory protection devices by the workers in their study.

The findings are however, similar to the report of Mitchual et al, (2015a). The respondents in that study highly rated their willingness to use personal safety equipment at work and their rating was not significantly influenced by the departments they belonged to. The implication of the present findings is that all the workers would be similarly susceptible as level of practice was not different across the different categories.

Personal protection practice of workers in this study was neither related to age nor work experience. This is contrary to the report of Onajole et al, (2004) who found compliance with preventive measures to be good among those who were recently employed in the industry implying that staffs may become complacent in their usage of safety precautions and PPEs while on duty as their service year increases. The difference in the present study may be attributed to the poor practice of those who have been on the job for long so the newly employed ones would not see a good example to emulate.

4.3.8 Effects of the basnef model-based respiratory protection education on knowledge about wood dust hazard, personal protection and equipment among the sawmill workers

The training group (TG) and non-training group (NTG) were comparable in knowledge attitude and practice before the health education intervention. This confirms that sawmill workers are generally not very knowledgeable about the hazards of their occupational exposure to wood dust, generally do not care and as such do not engage in appropriate safety behaviour by using necessary protective devices. The trend appear to be global as it had been so reported in studies from other parts of Nigeria (Okwari et al, 2005; Osagbemi et al, 2010), different parts of West Africa (Ochire-Boadu et al, 2014; Mitchual et al, 2015a&b) and beyond (Taha, 2000).

The Non-Training group that were not given any health education also showed a little but significant improvement in KAP on repeat assessment. Arefi et al, (2015) investigated the effect of educational intervention based on BASNEF model on decreasing the cesarean section rate among pregnant women in Khomain Country. They reported that the mean knowledge score of pregnant women about the benefits of vaginal delivery in the two groups (experimental and control) after the intervention were significantly raised. The improvement in KAP observed in the present study may be because the encounter they had with the questionnaire items became good information for them on various issues such that their knowledge was improved, attitude modified and practice motivated to certain extent. This is suggestive that their initial knowledge; attitude and practice level was due to lack of information or education while they were actually open to advice. Taha (2000) had observed that occupational health services, especially health education, for workers are often limited or non-existing. The results of Mitchual et al (2015) suggested that it is more likely for woodworkers to be willing to use personal protective equipment when they are aware of the safety and health implications on their occupation.

The training group (TG) showed marked improvement in KAP on repeat assessment. A significant increase in the mean KAP scores indicates the possible retention of knowledge, modification of attitude and improvement in practice. This result is in line with the general report of the efficacy of the BASNEF Education model in producing positive health behavioral changes (Mohamaei et al., 2004; Hazavehei et al., 2008; Sharifirad et al., 2011; Charkazi et al., 2013; Hazavehei et al, 2014). BASNEF-based educational intervention was also effective in increasing women's knowledge, attitude, and practice concerning the selection of a contraceptive method in women (Sarayloo et al, 2015).

The training group (TG) in this study showed greater and significant improvement in KAP post-training compared to the non-training (NTG) group. This is not unexpected since they were actually furnished with information and trained on the use of the protective equipment. Similar observations had been reported earlier. Solhi et al, (2013) investigated the effect of health education on the use of personal respiratory protective equipments based on BASNEF Model among Workers of Block Carbon Factory in Ahwaz. The mean knowledge, attitude and performance score of experimental group was significantly higher than the control group after the intervention. The goal of occupational health which is prevention of ill health can be achieved through health education (Adebola, 2014). Osonwa et al (2013) had opined that education and proper training on PPE use is an effective strategy in promoting PPE use among workers at their workplace. According to Mitchual et al. (2015), improved safety performance could be achieved when workers at all levels have high levels of awareness and are prepared to practice safety in their work.

CHAPTER FIVE
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

The wood processing industry, more specifically the sawmill industry is one of the commonest major primary industries providing direct and indirect employment for thousands of Nigerians. The process of cutting or shaping the wood (sawmill) leads to the creation of wood dusts of inspirable sizes which pollute the environment, hence sawmill workers have been severally reported to be vulnerable to developing pulmonary diseases. Several studies have shown associations between dust exposure and both respiratory symptoms and decreased lung function.

Previous studies in Nigeria have reported a poor knowledge of the danger of sawmill dust and health effects of the dust among exposed workers as well as lack of safety education training programs, protective measures or accident prevention for workers. There is however, a dearth of literature on how these workers' knowledge and safety practices can be improved. The Believe, Attitude, Subjective Norms and Enabling Factors (BASNEF) model of health education had been reported to be effective in workers' safety training but its effect on an occupational group from Nigeria has not been reported.

This study assessed the knowledge; attitude and practice (KAP) of sawmill workers concerning the hazard posed by wood dust, the need for personal protection and the various personal protective equipment (PPE). It also assessed the impact of a BASNEF model-based PPE education programme on the workers' knowledge, attitude and practice.

Four hundred sawmill workers (SW) recruited consecutively from four randomly selected sawmills in Ibadan metropolis and 400 non-sawmill workers (NSW) controls participated in the study's cross-sectional survey phase. The second phase was a two-group quasi-experimental pre-test-post-test study where the four sawmills were randomly divided into two training and two non-training centres using the fish-bowl method. Forty-five participants were proportionately randomly selected from the training centres (Training Group, TG) and non-training centres (Non-training Group, NTG). Participants' respiratory health, knowledge, attitude and practice concerning personal protection and lung function indices (forced vital capacity (FVC), forced expiratory volume in the first second (FEV_1), peak expiratory flow rate (PEFR) and FEV_1/FVC%) were assessed using the Respiratory Health Questionnaire (RHQ), Personal Protective Equipment Knowledge, Attitude and Practice Questionnaire (PPE-KAPQ) and Micro Medical spirometer respectively. All participants completed the RHQ while the sawmill workers additionally completed the PPE-KAPQ. The training group thereafter received the educational intervention utilising the Basic Training Course in Personal Breathing Protection materials (Volumes 1 and 2) produced by the International Society for Respiratory Protection (ISRP) following the BASNEF concept. The PPE-KAPQ was re-administered to both groups four weeks after the intervention. Data were analysed using descriptive statistics, independent t-test, paired t-test, chi square and Pearson correlation and Spearman correlation at $\alpha=0.05$.

The mean age, weight and height of the sawmill workers (SW) and the apparently healthy control participants (NSW) were 38.77±11.11years, 65.82±12.10kg, 1.63±0.08m and 37.35±10.94years, 65.78±9.55, 1.69±0.11m respectively. The control subjects were taller than the sawmill workers but the two groups were matched in age and weight. Majority of the sawmill workers (SW) and the control subjects (NSW) were married. Majority of the sawmill workers had only secondary school education and below and had been on the job for between one and sixty three years. They worked 10.44±1.75 hrs/day, 26.39±3.58 days/month and 11.88±0.87 months/year. The job description of the sawmill workers in this study varied widely but more than half operate one type of wood processing machine or the other constituting those at high wood dust exposure. The others are mostly plank sellers and carpenters constituting those at moderate level of wood dust exposure. There were more current cigarette smokers among the sawmill workers (5.50%) than the control subjects (1.30%). There were those who once stopped smoking but resumed after one year among both sawmill workers and control subjects. A lower proportion of the sawmill workers were current cigar smokers (0.50%) while none was currently smoking pipe. The SW's FVC, FEV_1, FEV_1/FVC PEFR (2.52±0.60L, 1.73±0.49L, 0.69±0.10 and 270.77±91.02L/min respectively) were significantly lower than for NSW (3.35±0.70L, 2.64±0.60L, 0.79±0.06 and 402.43±94.18L/min respectively). The SW had significantly higher prevalence of cough, phlegm production, breathlessness and other chest illnesses. The SW had moderate knowledge score (65.44±14.37%), negative attitude score (61.63±11.86%) and poor practice score (15.58±22.77%). The TG's pre-training knowledge, attitude and practice scores (62.92±16.01, 60.28±12.76 and 15.33±17.91 respectively) were not significantly different from NTG's scores (63.19±14.37, 62.02±11.99 and 14.67±16.73 respectively). The improvements of 28.47%, 23.40% and 76.00% in knowledge, attitude and practice scores respectively for the TG were significantly higher than 2.22%, 0.90% and 2.22% respectively for the NTG.

5.2 Conclusions

Based on the results obtained from this study, the following conclusions were made:

1. The sawmill workers generally had moderate knowledge score (65.44±14.37%), negative attitude score (61.63±11.86%) and poor practice score (15.58±22.77%).
2. The sawmill workers (SW) had significantly lower lung function indices (FVC, FEV_1, FEV_1/FVC and PEFR) than the control group (NSW).
3. The reduced lung function indices (FVC, FEV_1, FEV_1/FVC and PEFR) among the sawmill workers is suggestive of a mixed pattern (combined restrictive and obstructive patterns) of lung function impairment.
4. The combination of symptoms observed is suggestive that both upper respiratory tract and lower respiratory tract involvement are likely
5. Smoking at the level engaged in by the sawmill workers in this study did not significantly impact on the lung function indices (FVC, FEV_1, FEV_1/FVC and PEFR)
6. The inflammation of the airway caused by wood dust exposure in these sawmill workers was not dose-dependent and therefore dose-dependent inflammatory response to wood dust exposure may be tree-type dependent.

7. The inflammatory reaction of the airway to wood dust exposure is non-progressive
8. Exposure to wood dust impacts negatively on the respiratory health of sawmill workers.
9. The knowledge of the sawmill workers concerning the hazard posed by wood dust, the need for personal protection and the various personal protective equipment was moderate; their attitude towards the hazard posed by wood dust, the need for personal protection and the use of personal protective equipment was negative and their actual practice of personal protection was poor
10. BASNEF Model-based Respiratory Protection Education programme was suitable and effective in improving the following among sawmill workers:
    a. Knowledge about wood dust hazard, respiration protection and equipment
    b. Attitude towards wood dust hazard and respiration protection
    c. The use of respiratory and other personal protective equipment

5.3 Recommendations

Based on the findings of this study, it is recommend that:

1. Appropriate health education of sawmill workers should be done regularly to stem the hazard of respiratory illnesses from their occupational exposure.
2. BASNEF Model-based Respiratory Protection Education programme should be adopted for use in such health education.
3. Efforts should be made to make respiratory protection equipment accessible to sawmill workers.
4. Sawmill workers should be taken through respiratory protection training on a regular basis.
5. Comparative efficacy studies between the BASNEF model and other health education models may be carried out to assess for preference.