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Identification of Immediate and Remote Health Hazards and the Need for Health Hazard Assessment in the Nigeria Sawmill Industry

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ABSTRACT

This research was carried out to identify immediate and remote health hazards, including the need for health hazard assessment in the sawmill industry in Enugu State, Nigeria. A quantitative research approach was used and 300 well-structured questionnaires were directly administered to five sections of sawmill workers. Interviews and observational studies were also used to acquire data. The data was analyzed with IBM SPSS Statistics 20 software using basic percentages and inferential statistics from chi-square test analysis. The significance level was set at 0.05. Respondents in this study identified several immediate and remote health hazards, including accidents and injuries, that were linked to the various tasks they do in the sawmill. Machine operators and carpentry/furniture workers, on the other hand, were shown to be more exposed to these hazards. Asthma, dermatitis, sequoiosis, respiratory problems, heart problems, and skin disorders are among the hazards reported. Others included cuts, piercings, crushed injuries, fractures, dislocations, bruises, falls, etc. There was a significant difference in the types of ailments suffered by different categories of workers. The study also found that the total cost of fire-related losses in sawmills between 2004 and 2014 was 4.09 billion Naira. Notwithstanding the hazards and medical concerns indicated by the workers, their use of PPE was unsatisfactory. Occupational safety and health legislation, such as the Occupational Safety and Health Framework Directive, which requires employers to adopt appropriate precautionary measures to make work safer and healthier, should be implemented in all sawmills.

INTRODUCTION

Industrialization, along with poor safety legislation and precautions in industries/factories, has resulted in numerous forms of industrial health hazards among workers, as well as the release of different forms of corrosive, hazardous pollutants, or radioactive toxins into the surroundings. The adverse impact of industrial activities on the health of workers and the environment has recently become a subject of discussion (Ugbede and Benson, 2018). Because of the negative impact on health, occupational hazards are indeed a global concern. The importance of occupational health hazard information is usually ignored, which has slowed the development of occupational health legislation in developing countries (Eyayo, 2014). Many workers in this part of the world are usually exposed to one or more forms of industrial hazards, including those in Nigeria (Chineke et al., 2016; Okafoagu et al., 2017; Afube et al., 2019; Hafeez et al., 2020). Machines and equipment are used in industry operations to turn raw resources into finished goods. In the working environment of various companies in Nigeria, several types of hazards have been identified (Okon and Osesie, 2017). Chemical, biological, radioactive, electrical, fire and explosion, noise and vibrations, and falls from heights are only a few examples of industrial hazards (Afube et al., 2019). These hazards offer a substantial danger to industrial workers and may result in fatal accidents, machine and equipment damage, and productivity loss (Courtney et al., 2001). On the global scene, there are 2.9 billion workers who are exposed to hazardous threats at work (Eyayo, 2014).

Occupational ailments and injuries cause two million mortalities annually and also cost the government 4% of its Gross Domestic Product (Eyayo, 2014). If industrial health hazards are not adequately and properly controlled and monitored by the management of an industry or firm, it could influence the health and well-being of the workers. It is evident that industrial employees and management avoid identifying the health concerns that are frequent among workers. However, most occupational ailments resulting from exposure to hazards in companies in Nigeria and most developing countries are mostly the consequence of ignorance. Psychological hazards and ergonomic hazards Chemical hazards and biological hazards are both types of industrial hazards. Environmental elements such as extreme heat, intense light, UV radiation, a contaminated atmosphere, and sound can all cause ergonomic hazards.

A broad range of contaminants and health hazards are constantly linked to the existence of industries at various stages of the process of transforming raw materials into industrially finished goods. Industries such as oil exploration, petrochemicals, steel, paper mills, textiles, food, wood, pharmaceuticals, quarries, and cement generate huge amounts of pollutants that threaten the health of workers and people residing near these factories. Several industrial hazards, apart from pollution, have been identified in these industries (Adhikari and Ozarska, 2018). The manufacturing process for wood products which includes log extraction to finished products can cause work-related hazards and have an impact on the environment. Ramasamy et al. (2015) observed that various gases such as CO, CO_2, NO_x, N_2O, SO_2, and CH_4 were released into the environment, with the consequences being acidification, eutrophication, human toxicity, photo-oxidant production, and global warming in Malaysia.

Wood processing and manufacturing involve a wide range of machines and procedures such as machining, sawing, jointing, gluing, drying, and finishing, among others, which can be related to both environmental, occupational health, and safety dangers. Workers are exposed to different hazards as they use machinery during its lifespan. Different solvents are used in the wood production process, particularly in preservative treatment, adhesive application, and final product coating. Though these solvents have increased the life of wood products, they can also have negative environmental effects due to the toxic chemicals they contain. Although adhesives are essential materials composed of both natural and synthetic elements for joining wood parts into wood products, they may have certain detrimental health and environmental effects (Zhang et al. 2013; Yang and Rosentrater 2015; Adhikari and Ozarska, 2018). As a result, there is a growing need for the use of environmentally friendly adhesives (McDevitt and Grigsby 2014). Apart from chemicals used for wood preservation, Traumann et al. (2013) and Black et al. (2005) have reported various health hazards caused by processing different types of timber. The disposal of wood products has a wide range of environmental effects, especially in urban areas (Taylor and Warnken 2008). When wood wastes are disposed of instead of reused, recycled, or refurbished, they contribute to environmental pollution in many ways. Similarly, burning waste produces smoke and particulates which are emitted into the environment. The consequences of improper wood waste disposal on the environment are severe. Furthermore, burning wood waste releases greenhouse gases into the atmosphere, resulting in many health problems among sawmill workers (Udokpoh and Nnaji, 2023).

Generally, the sawmill industry has had a poor reputation for health and safety. For many years, death and serious accident rates were roughly four times higher than in the whole wood industry. The sawmill industry's fast development, combined with a lack of information regarding possible occupational health and safety dangers, has shown a need to know more about the industry (Ceballos et al., 2015). Aside from the obvious dangers of saws and other machinery, there are many other threats at sawmills, such as those posed by conveyors and mobile plants. As a result, many woodworkers have inadvertently suffered severe health hazards during their careers, believing that other factors are responsible. This is why a thorough assessment is necessary since it will reveal any hidden or ignored dangers associated with sawdust and sawing. Controlling occupational health hazards is also needed. The assessment of hazards is crucial for controlling and managing these hazards. It entails a thorough analysis of how job actions may harm workers. Many health risks are associated with wood and wood processing. Some are immediate, while others are remote.

Nigeria is blessed with numerous forest reserves, of which the majority are found in the mangrove region of the country (Nnaji and Udokpoh, 2022). This has resulted in the establishment of sawmill industries. A good number of these sawmill industries are situated in the southern states of the country. The states with the highest numbers of sawmills are Cross River, Akwa Ibom, Edo, Delta, Enugu, Imo Lagos, Ekiti, Osun, Ondo, Oyo, and Ogun, accounting for more than 90 percent of all sawmilling activities in the country (Bello and Mijinyawa, 2010). The number of sawmills in this region has significantly increased (Nnaji and Udokpoh, 2022). This is due to the growing demand for wood for furniture and other applications in this region. This demonstrates that sawmill location in the country is heavily influenced by guaranteed log supply. As a result of their widespread distribution, notably in the southern region of Nigeria, sawmills may be considered one of Nigeria's major industries. A sawmill is a factory where timber is sawed by machine into planks or boards of various sizes and shapes (Omobude-Idiado et al., 2013). In Nigeria, however, furniture and carpentry firms are incorporated into sawmills due to their proximity to the site, which reduces transportation costs.

The sawmill industry and the furniture sector have made significant contributions to Nigeria's socio-economic growth over the years. Thousands of people are directly and indirectly engaged in wood processing in sawmills around the country (Njimanted and Nkwenta, 2015; Awosan et al., 2018). As correctly stated by Ajibefun and Daramola (2004), the sawmilling sector, among other microenterprises, is at the forefront of driving Nigeria's economic progress. Apart from the petroleum industry, the sawmilling industry contributed more to the country's GDP compared to any other sector in the early 1960s (Egbewole et al., 2011; Olawuni and Okunola, 2014). Okunomo and Achoja (2010) examined the impact of the African Timber and Plywood Sector in Sapele, Nigeria. They concluded that the sawmill sector had a substantial influence on Sapele by providing social amenities and wood supply.

Sawdust, wood offcuts, wood rejections, wood backs, and plain shavings are among the wood wastes in a typical sawmill (Akinbode and Olujimi, 2014; Udokpoh and Nnaji, 2023). One of the striking environmental issues confronting sawmills in Nigeria is the improper disposal of waste generated (Akinbode & Olujimi 2014). Work and health are inextricably linked (Lucas and Gillies 2003). It goes without saying that a man's employment might have an impact on his health (Omobude-Idiado et al., 2013). Sawmill workers employ some crude methods to dispose of waste generated near sawmills and plank markets (Funmbi, 2015). Occupational activities have been shown to cause environmental and ecological problems that harm people's health and well-being. Tools and machines produce physical conditions in the workplace, such as continuous noise and vibration (Funmbi, 2015).

Thus, this research aims to assess the immediate and remote health hazards associated with sawdust, sawing, and wood processing in Enugu sawmills. The following objectives were established: i) To identify specific health hazards and injuries associated with sawdust, sawing, and wood processing machines; ii) To determine the rate of occurrence of health hazards in the industry and ascertain the compliance of woodworkers with the necessary health and safety measures.

MATERIALS AND METHODS

The Study Area

The research was carried out in the Enugu sawmill industry (Figure 1). The sawmill is located in Maryland, in the Enugu metropolis of Enugu State, with a latitude and longitude of 6.4229E and 7.4985N. The state is the geopolitical headquarters of southeast Nigeria. The sawmill occupies a vast landmass of about 15 hectares (0.15 km^2). The industrial sawmill consists of 1100 shops and approximately 1970 workers, 970 of whom are registered as members of the Enugu sawmill trade union, which regulates the activities of its members, and the remaining 49.2% are simply registered as market casual workers who do not identify with the sawmill trade union. It was selected because of its higher level of business activities, where most wood processing for the region is done, which made it a good focal point for the study. A lot of machines are installed in the shops for diverse wood-processing purposes. Examples of machines common in the mills are the electric circular saw, the planning machine, the mortising machine, the grooving machine, the sam-papering machine, the chamfering machine, the curving machine, etc. Also, most of the common hand tools available in the mills include a saw, a hammer, a measuring tape, a jack plane, calipers, gauges, mallets, etc.

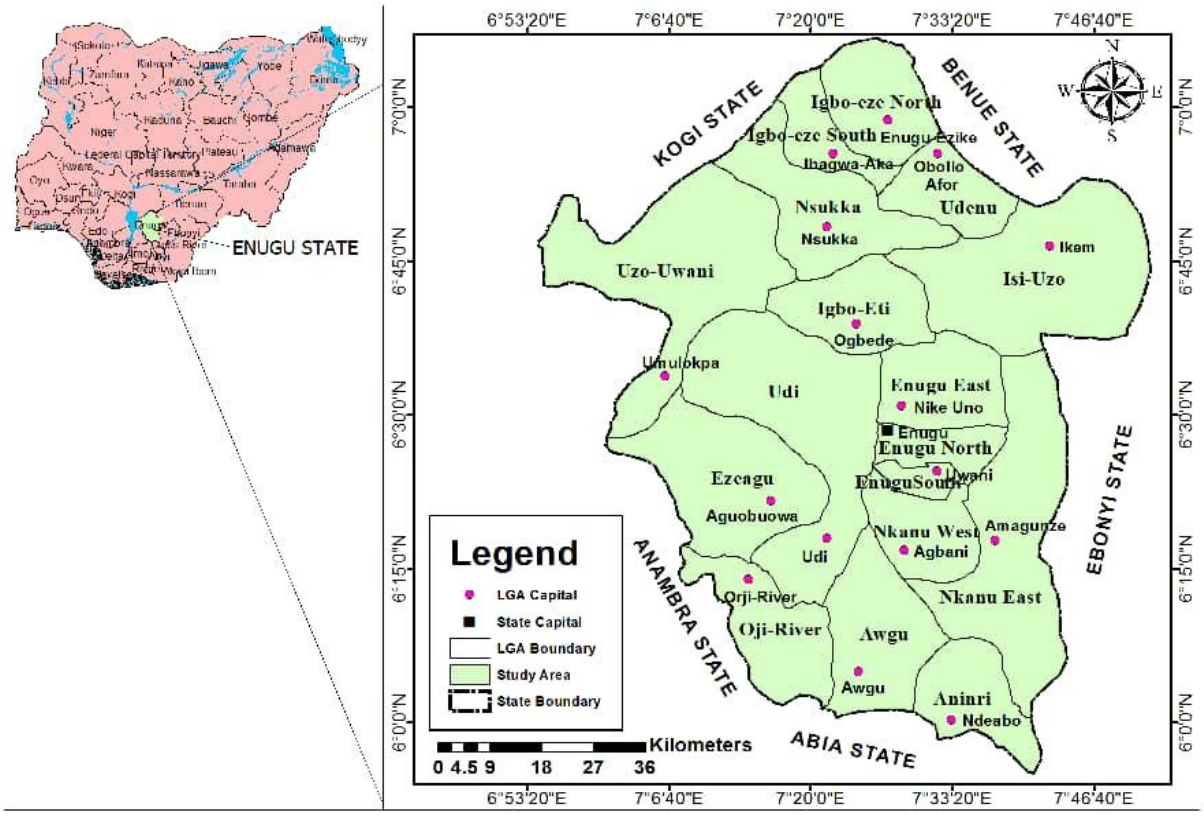

Figure 1. Map of the Study Area

Data Collection

The exploratory and descriptive research design was adopted due to the nature of the study. The two research designs were appropriate for the present study, as it was important to determine the specific health hazards associated with sawdust and sawing and also the safety measures necessary to curb or curtail the dangers. Secondary and primary sources were used to collect the data. Primary data were sourced from the study area, and the techniques used in this research study were questionnaires, semi-structured interviews, and group discussions. Secondary data were obtained mainly from government publications (for example newspapers), technical documents, and annual reports of the sawmill market. Secondary data covered different sources and provided an essential preparation for the interviews. Some participants who were not included in the questionnaire were interviewed by telephone at their homes or in a private area at their workplace. The interview was a series of standardized questions developed from discussions with sawmill workers, supervisors, and health and safety professionals with experience in the industry. Moreover, the observatory method of data collection was also employed, along with photographs. However, three working days were dedicated to studying the sawmill operations in different sheds. This was to determine the extent to which the workers in the Enugu timber market comply with the prevailing safety rules. Also, to investigate the working conditions and operations to propose a possible solution to the prevalent hazards in the Enugu timber market.

Sample Size

The sampling method used for selecting the participants in this study is stratified random sampling. The stratification was based on the arrangement pattern of the market (the market has six partitions normally referred to as lines). Within each section, the selection of staff was done by simple random sampling. This technique was employed to ensure a fairly equal representation of the variables in the study. The sample size is determined using Susan Rose's statistical formula for determining sample size based on a proportion with a confidence level of approximately 95%. The formula is:

$$n_r = \frac{(1.96)^2 pq}{d^2} \quad (1)$$

Where p is the proportion of the population that has the characteristic, $q=1-p$, d is the degree of precision, and n_r is the required sample size. The proportion of the population (p) may be known from prior research or other sources; if it is unknown, $p=0.5$ is used, which assumes maximum heterogeneity (i.e., a 50/50 split). The degree of precision (d) is the margin of error that is acceptable. Setting d=0.02, for example, would give a margin of error of plus or minus 2%. If the sample size is more than 5% of the total sample, it is adjusted using the finite population correction formula:

$$n_a = \frac{n_r}{1+\frac{(n_r-1)}{N}} \quad (2)$$

However, the sample size for this research work is calculated as follows:

However, the sample size for this research work is calculated as follows:

At $p=0.5$, $q=1-0.7=0.3$ at a 95% confidence level, let $d=0.05$. Using equation 1, $n_r=323$. Therefore, the minimum sample size is $n_r=323$.

Using an approximate population of 2000, 5% of the population is 100. Therefore, 323>100, we applied the finite population sample thus: $n_r=278$. So an approximate sample size of 300 was used in the study.

Data analysis

The questionnaire contained two sections: Section A dealt with the demographic characteristics of respondents, while Section B consisted of four sections that was developed on “Often Encountered,” “Seldom Encountered” and “Never Encountered”, alternative responses specific health hazards and injuries with sawdust, sawing, and wood processing machines; the rate of occurrence of health hazards; and the compliance of woodworkers with the necessary health and safety measures. The questionnaire was validated by experts. The reliability of the instrument was established using the Chi-Square (χ^2) method of statistical analysis. The data for the study was gathered through the personal distribution of the questionnaire to the 300 respondents with the help of three research assistants, and the filled-out questionnaires were collected back on the spot. Data collected were coded and analyzed using frequency distribution, simple percentages, and inferential statistics of Chi-Square (χ^2). Inferences were made at the 0.05 level of significance. These data were collected via questionnaire and analyzed using the Statistical Package for Social Sciences (SPSS). The detailed calculation of the Chi-Square (χ^2) method of statistical analysis is expressed below:

$$x^2 = \frac{(f_o-f_e)^2}{f_e} \quad (3)$$

Where, f_o is the frequency observed; f_e is the expected frequency.

Hypothesis

The hypothesis states that some ailments are more pronounced among workers in certain categories than others. This accounts for the differences in percentages of respondents in different categories suffering certain ailments.

H_0: There is no difference in the types of ailments suffered by different categories of workers.

H_1: There is a difference in the types of ailments suffered by different categories of workers.

If the calculated Chi-Square (χ^2) value is greater than the tabulated value, we reject the null hypothesis and accept the alternative hypothesis. If the calculated Chi-Square (χ^2) value is less than the tabulated value, we accept the null hypothesis and reject the alternative hypothesis.

Ethical Considerations

It is imperative to identify and adhere to the ethics guiding this kind of research. To this effect, the authors acknowledged and protected the rights of persons, animals, and places without failing in our specific responsibility. Consequently, the study was conducted fairly, with appropriate measures taken to eliminate all potential risks. The respondents were aware of their rights. This study's ethical issues include the right to anonymity, informed consent, confidentiality, and respect for people. However, permission to carry out this research in the facility was obtained from the trade union executives.

RESULTS AND DISCUSSION

Table 1. Demographic Information of Respondents

Variables	Frequency (N)	Percentage (%)	Cumulative %
Gender			
Male	290	97	97
Female	10	3	100
Age			
15-18	5	2	2
18-30	157	52	54
30-40	79	26	80
40-50	39	13	93
Above 50	20	7	100
Qualification			
FSLC	212	71	71
SSCE	54	18	89
OND	19	6	95
HND/BSC	9	3	98
Others	6	2	100
Work Section			
Machine operators	130	43	43
Carpenter/furniture workers	65	22	65
Wood dealers	50	17	82
Loaders	35	12	93
Hawkers	20	7	100
Work experience in the wood industry			
Less than 5 years	150	50	50
5 – 10 years	55	18	68
10 – 20 years	45	15	83
Above 20 years	50	17	100
Daily work duration			
0 – 2 hours	22	7	7
2 – 5 hours	29	10	17
5 – 8 hours	228	76	93
Above 8 hours	21	7	100

Table 1 shows the preliminary analysis results, which include demographic information from respondents. The high number of male workers shows that sawmill industries are dominated by men because of the strenuous tasks involved. The few female workers in the market were sales representatives and secretariat staff who were not involved in wood processing. The survey further reveals that the majority of workers are between the ages of 18 and 30. People within this age range can do strenuous work. Studies in other regions suggest that the large population of males in this age range could be related to the strenuous nature of their job, which involves operating delicate machines in a noisy and hot work environment and carrying heavy timber logs. Elderly people and women, on the other hand, are less likely to be able to deal with such situations (Awosan et al., 2018). Furthermore, owners of sawmills prefer to hire young people over older ones due to lesser labor costs and greater flexibility in terms of work hours (Hasluck, 2012; Awosan et al., 2018).

Many respondents, however, have a first school leaving certificate (FSLC). This implies that work processing in the study area does not necessarily require higher qualifications. The survey also reveals that the majority of workers in the market are machine operators and that most of these workers have less than 5 years experience working in the wood processing industry. Interestingly, it was observed that 76% of respondents work 5 to 8 hours continuously to meet up with customers' demands. These indicate that they resume work by 8:00 and close by 17:00 daily. The personal information of respondents in this sawmill is similar to that of sawmill workers in other regions of Nigeria (Agu et al., 2016; Onowhakpor et al., 2017; Awosan et al., 2018; Johnson and Umoren, 2018). Similarly, the age and gender of wood processing industry workers in Mutare, Zimbabwe, and Dar es Salaam, Tanzania, are reported to be young, with a male preponderance (Jerie, 2012; Rongo and Leon, 2005). Additionally, respondents in another study reported starting work in a sawmill at the age of 13.5 (Siew et al., 2012). However, the demographical details may influence their safety precautions, especially for workers with less work and educational experience.

Table 2. Prevalent Wood Processing Machines in the Sawmill

Machine	Wood waste	Particle size
 Plane jack	 Wound wood shaving	100 to 300mm length. A carpentry/furniture tool used to smoothen the surface of workpiece (timber)
 Circular sawing machine	 Sawdust and Off cuts	1.18mm to 2.36mm. A circular saw is used to produce timbers of different dimensions
 Stenner machine	 Sawdust	0.5mm to 1.18mm. Used for sawing or splitting lumber into various sizes.
 Wood lathe machine	 Sawdust	0.15mm to 0.5mm. The sander is a power tool used to smooth surfaces by abrasion with sandpaper.

 Planner/Thicknesser	 Planer shavings	5mm to 30mm. The planer is for smoothening the surface of planks and some other forms of timber.
 Mortising machine	 Wood shaving/Wood fragments	1.7mm to 12 mm. A mechanized machine that employs an auger and chisel to produce a square or rectangular mortise in timber.
 Curving machine	 Sawdust	0.5mm to 0.71mm. Used for cutting small timber into desired shapes. It carves out specified designs from a piece of lug.

In addition, one cannot identify and assess the immediate and remote causes of health hazards and injuries in a sawmill without identifying the wood processing machines in the mills. Table 2 presents the results of the prevalent types of wood processing machines and tools in the Enugu sawmill industry. The study further reveals that the industry in this region uses outdated machines that were not designed and manufactured with modern and current machine safety precautions. Secondly, these machines still require 50 percent to 70 percent human labor. Some of these wood processing machines and tools are no longer in use in most developing and developed countries. Categorically, using these crude machines and tools will enhance and pose various degrees of occupational hazards. Awosan et al. (2018) reported the use of non-automated wood processing machines and equipment in a typical sawmill in Sokoto, Nigeria, which also accounted for various levels of injuries sustained by workers.

Moreover, the owners of these machines attributed the non-usage of modern, automated wood processing machines to the high cost of these machines. However, the authors' on-the-spot evaluation of these machines revealed that the operational and maintenance costs of these machines are sufficient to purchase modern machines. This ignorance persists because there is no government agency regulating or enforcing the activities of sawmills in the region. Apart from injuries that will be sustained by workers while using these machines, some of these machines rely on fossil fuel for operation. The disadvantage is that they will emit harmful substances into the environment, which will be eventually inhaled by workers or residents of the area.

Health Hazards and Injuries with Sawdust, Sawing and Wood Processing Machines

Accidents from wood processing activities

Table 3. Accidents Encountered by Workers

Hazards	Often encountered (%)				Seldom encountered (%)				Never encountered (%)			
	MO	C/F	WD	WL	MO	C/F	WD	WL	MO	C/F	WD	WL
Accidents from falls	43	26	18	12	65	20	14	16	22	20	18	7
Cuts from blades	90	39	0	0	40	26	0	0	0	0	100	100
Finger pounding	14	46	0	0	29	20	10	4	87	0.	40	32
Wood chips/ fragments fall into the eyes	117	7	0	0	13	10	8	9	0	48	42	26
Clothes caught by machines	0	0	0	0	7	0	0	0	123	100	100	100
Long hair caught by machines	0	0	0	0	0	0	0	0	100	100	100	100

MO-machine operators; C/F-carpenter and furniture workers; WD- wood dealer; WL- wood loaders

Table 4. Injuries Sustained by Workers

Injuries	Often encountered (%)				Seldom encountered (%)				Never encountered (%)			
	MO	C/F	WD	WL	MO	C/F	WD	WL	MO	C/F	WD	WL
Cuts	95	46	9	12	34	15	11	17	1	4	30	6
Piercing	38	49	5	15	72	14	18	10	20	2	27	10
Crushed injuries	55	38	2	5	40	19	9	3	35	8	39	27
Fracture	66	27	0	0	35	10	8	9	29	28	42	26
Dislocation	75	25	0	15	53	30	5	16	2	10	45	4
Bruises	49	35	0	18	78	25	7	13	10	5	43	4

MO-machine operators; C/F-carpenter and furniture workers; WD- wood dealer; WL- wood loaders

Tables 3 and 4 outline the prevalent accidents and injuries associated with wood processing and their rates of occurrence as encountered by each category of respondents. Some workers often encounter certain accidents, but others seldom encounter them, and some never encounter certain accidents. In this context, daily and weekly incidents are common, whereas accidents that occur once a month or once a year are uncommon.

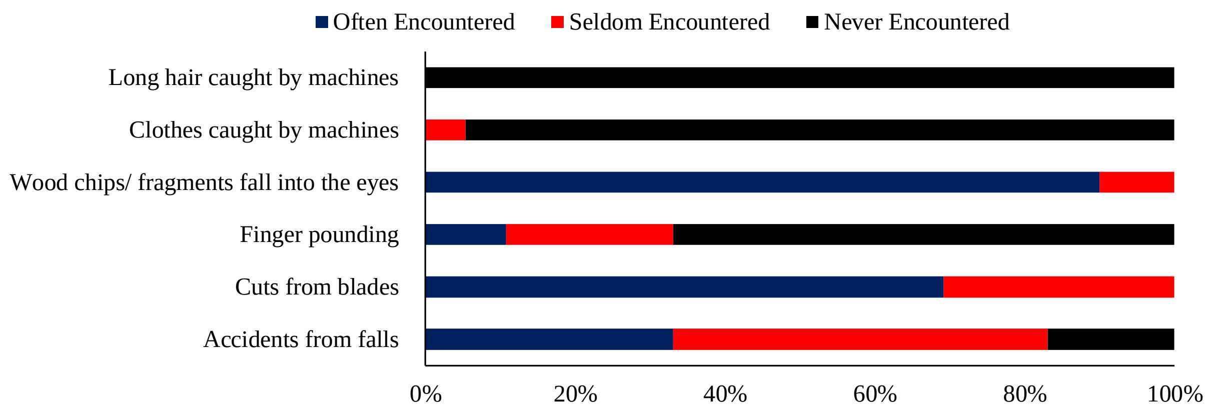

Figure 2. Injuries Encountered by Machine Operators

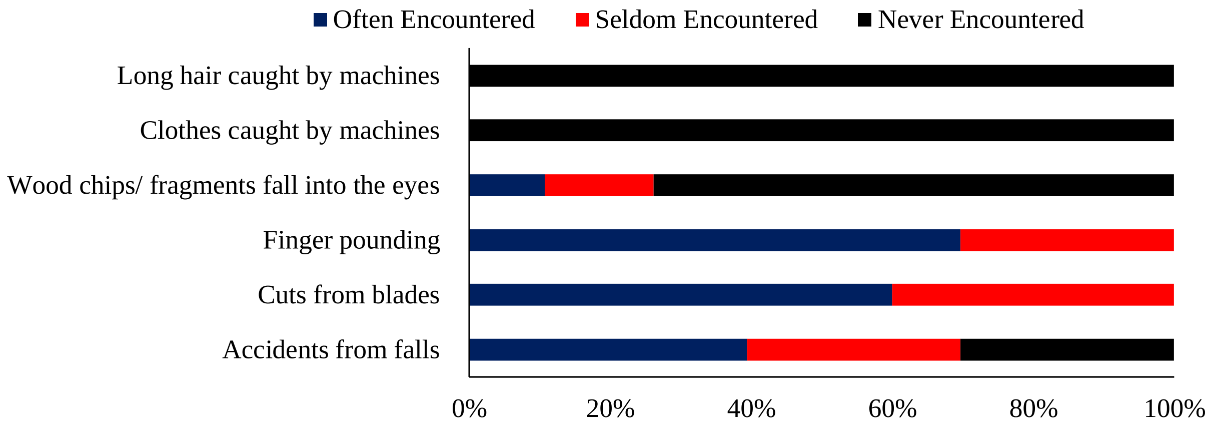

Figure 3. Injuries Encountered by Carpenters and Furniture Workers

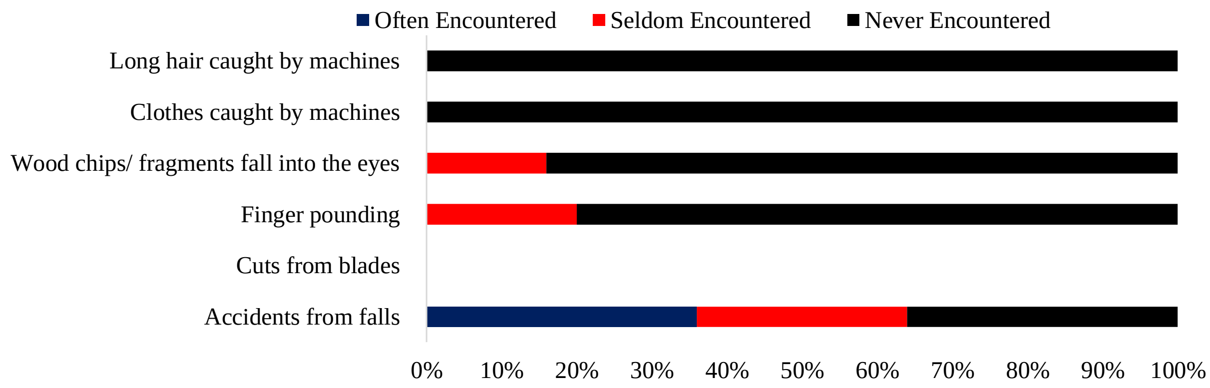

Figure 4. Injuries Encountered by Wood Dealers

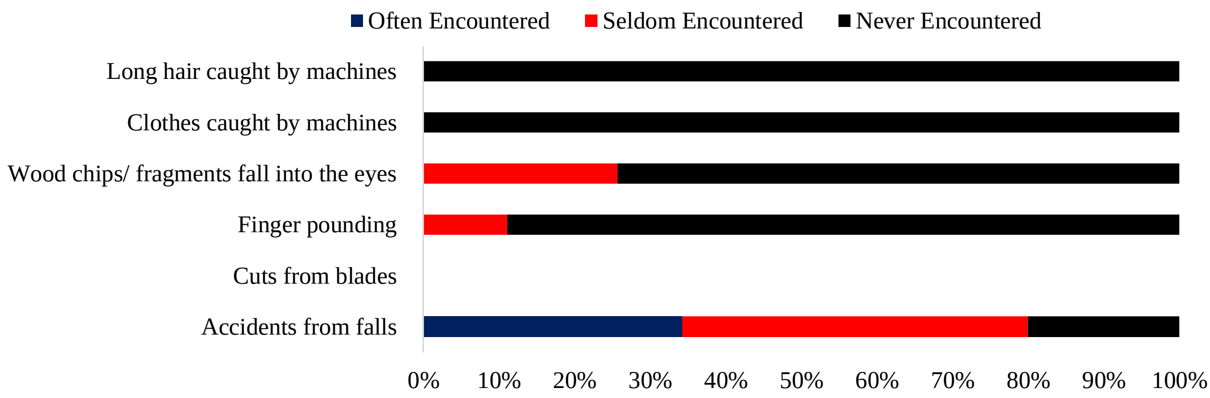

Figure 5. Injuries Encountered by Wood Loaders

Figures 1 to 5 show the various percentages of occurrence of each of the accidents for the respective categories of respondents. Accidents from falls and cuts from blades and wood chips falling into the eyes are more pronounced among machine operators, while finger pounding is more common among carpenters and furniture workers. Moreover, wood chips falling into the eyes is the accident with the highest rate of occurrence among machine operators. This is proven by the high number of machine operators that often encounter accidents. This study also revealed that machine operators and carpentry and furniture workers sustained the highest number of injuries among woodworkers in the mill, ranging from cuts to bruises. The degree of injuries sustained by workers was severe and usually causes a manpower shortage, which leads to delays in work delivery. It was also observed that these injuries, if not properly and urgently treated, could lead to mortality or permanent loss of limbs. Wood dealers and wood loaders encounter fewer injuries because of their limited involvement with wood processing machines and tools.

The high occurrence of accidents and injuries in this sawmill could be due to their low educational attainment, as the majority of the respondents had only primary education or below. Furthermore, none of the respondents have ever received occupational safety training (Agbana et al., 2016; Ankamah-Lomotey et al., 2018). A study conducted among sawmill industry workers in Nakuru County, Kenya, by Mburu and Kiiyukia (2017) showed that there was no occupational health and safety training for 80 percent of workers in the sawmill. Also, Bello and Mijinyawa (2010) reported that in a typical sawmill in southwestern Nigeria, no worker has ever attended any safety training during the course of their job. The knowledge they acquired was based on their apprenticeship training and the experience they gained on the job. They opined that many entered the industry as traders but not as trained wood industry workers with the requisite professional knowledge. An intriguing cause of frequent accidents in the mill could be linked to worker experience and daily work duration. It was observed that most of them had less than five years' experience on the job. Enough experience on the job will expose them to some hazards, and they will learn preventive measures (Diwe et al., 2016; Awosan et al., 2018). On work duration, it was observed that most workers could mount a particular machine for 8 hours without any structured break. Working under such conditions will expose them to certain threats (Agu et al., 2016).

According to Adei and Kunfaa (2007), employees in the wood processing industries are exposed to a variety of hazards ranging from physical to chemical hazards. They also observed that ergonomic hazards (including fractures and dislocations) were caused by the lifting of heavy loads in the sawmill. Fractures and dislocations were linked to fall accidents in our study. Similarly, Adeoye et al. (2015) and Osagbemi et al. (2010) both observed a dominance of bruises and lacerations among sawmill workers, whose causes were traced to machine saws, failure to switch off machines during maintenance or attempts to remove jams, falls due to heavy lifting, and repetitive movements that had all been shown to cause these injuries.

Immediate Health Hazards Linked to Wood Processing

Table 5. Immediate Health Hazards Suffered by Wood Workers

Health hazard	Often encountered (%)				Seldom encountered (%)				Never encountered (%)			
	MO	C/F	WD	WL	MO	C/F	WD	WL	MO	C/F	WD	WL
Nose and throat infection	43	0	0	4	32	16	12	5	55	49	42	26
Tiredness and headache	88	27	8	30	36	30	16	5	6	8	26	0
Skin disorder	0	0	0	5	6	7	0	4	124	52	50	26
Heart problems	36	16	0	7	32	17	0	12	62	33	50	16
Impaired hearing	0	0	0	0	17	10	0	0	113	55	50	35
White fingers and numbness	22	5	0	11	29	13	4	11	79	47	46	14
Sleeplessness	0	0	0	0	22	0	0	0	108	65	50	35
Pink/ red eyes	29	0	0	0	32	13	0	7	69	52	50	28

MO-machine operators; C/F-carpenter and furniture workers; WD- wood dealer; WL- wood loaders

The different immediate health hazards suffered by woodworkers in the sawmill are presented in Table 5 and Figures 6 to 9. It shows the prevalence and rate of occurrence of each health hazard among the respective categories of respondents. From the table, it is evident that some ailments are prevalent in the specific wood processing section. For instance, nose-and-throat infections and heart problems are more common among machine operators: 43 (33.33%) and 36 (27.78%), respectively. Similarly, wood loaders are more predisposed to skin disorders (25%) than other workers. Also, the result shows that some ailments are rarely suffered by woodworkers. These include impaired hearing and sleeplessness, which are rarely suffered by woodworkers. Furthermore, some of these ailments are caused by the sound of the machines, while others are caused by the wood itself. However, Traumann et al. (2013) reported in their study that trace ailments in wood processing factors are linked to the types of timber used.

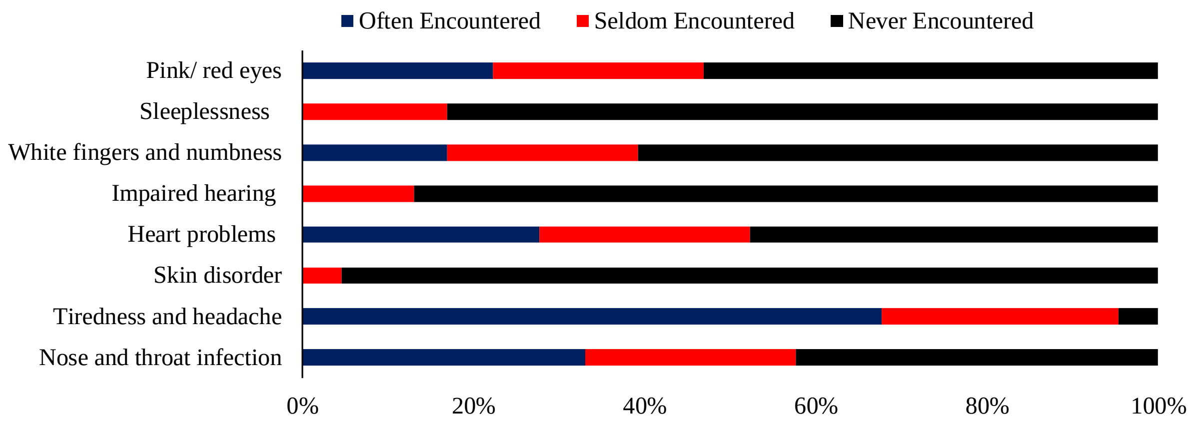

Figure 6. Immediate Health Hazards Suffered by Machine Operators

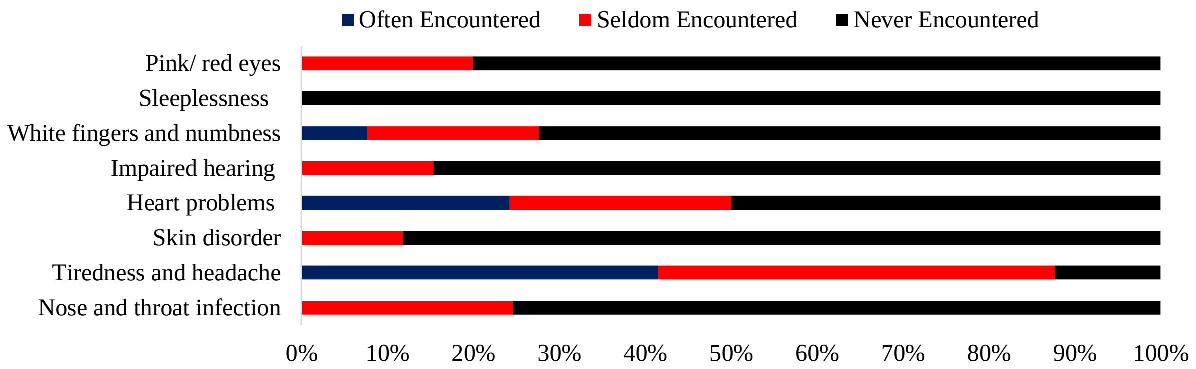

Figure 7. Immediate Health Hazards Suffered by Carpenters and Furniture Workers

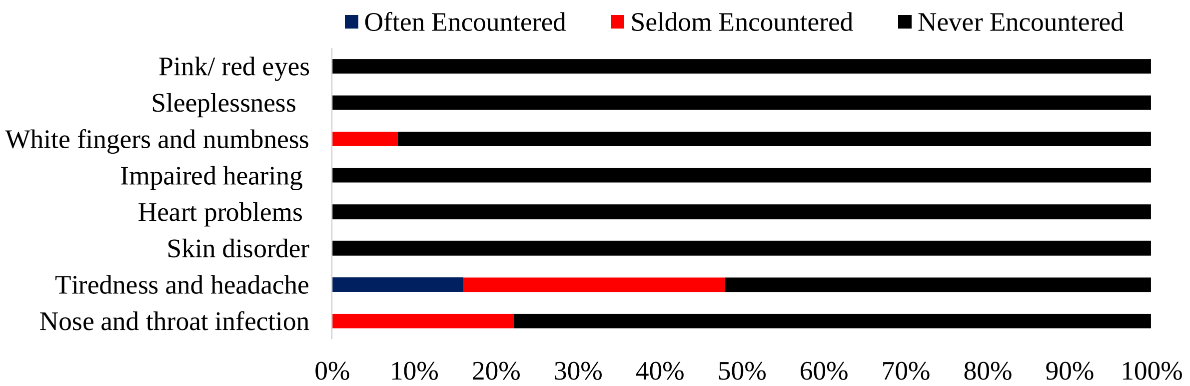

Figure 8. Immediate Health Hazards Suffered by Wood Dealers

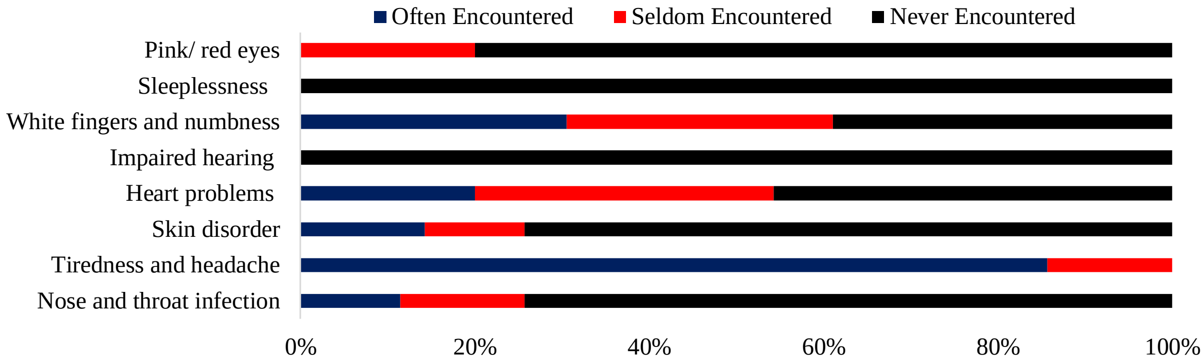

Figure 9. Immediate Health Hazards Suffered by Wood Loaders

Remote Health Hazards Allied with Wood Processing

Table 6. Remote Health Hazards Suffered by Wood Workers

Health hazard	MO n =130	C/F n = 65	WD n = 50	WL n = 35	Hawkers n = 20
Asthma	50	28	10	14	8
Dermatitis	2	3	2	10	0
Sequoiosis	7	9	0	2	0
Asthma/ Dermatitis	15	12	2	3	0
Asthma/ Sequoiosis	16	5	0	2	0
Dermatitis/ Sequoiosis	15	4	0	0	0
Asthma/ Dermatitis/ Sequoiosis	22	2	0	1	0

MO-machine operators; C/F-carpenter and furniture workers; WD- wood dealer; WL- wood loaders

Table 6 and Figure 10 display the predominant remote health hazards suffered by sawmill workers. Among machine operators, asthma is the most prevalent remote health challenge, followed by sequoiosis and dermatitis. For carpentry and furniture workers, asthma recorded the highest occurrence, followed by dermatitis and sequoiosis. A similar occurrence of health hazards was observed among wood loaders. In contrast, no employee in the wood dealer section has ever had senoquoiosis in their entire career. Similarly, no hunter was ever diagnosed with sequoiosis or dermatitis; this may be attributed to their indirect involvement in wood processing. When assessing workers diagnosed with more than one remote health hazard, the result revealed that some workers in all the sections of the sawmill were diagnosed with asthma. However, some workers in four sections (MO, C/F, WD, and WL) of the sawmill were diagnosed with dermatitis, while workers from only three sections (MO, C/F, and WL) were diagnosed with sequoiosis. We also noticed that workers diagnosed with asthma or dermatitis were cutting across MO, C/F, WD, and WL sections in the mill. Workers from only two sections (MO and C/F) were diagnosed with dermatitis/sequoiosis.

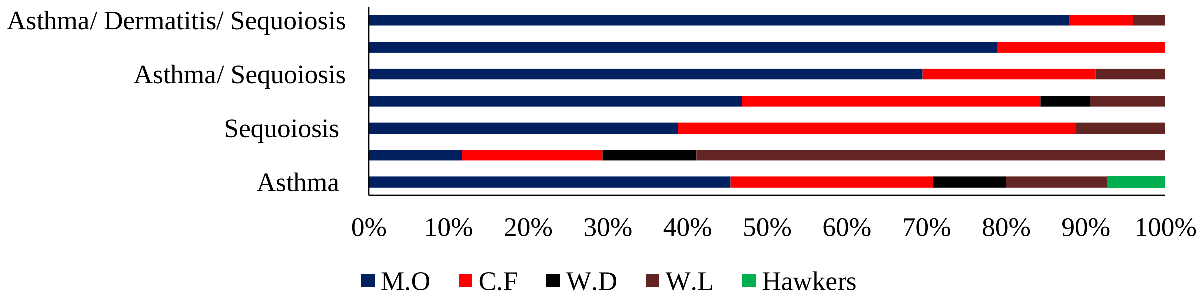

Figure 10. Remote Health Hazards Suffered by Wood Workers in Enugu Sawmill Industry

Furthermore, asthma/sequoiosis and asthma/ dermatitis/sequoiosis were diagnosed in workers from three sections of the sawmill (Table 6). Moreover, the reason why workers in machine operations, carpentry, and furniture operations are diagnosed with all three ailments is linked to their greater direct involvement in wood processing than other workers.

Similar to the findings of this study, studies conducted in Nigeria (Njinaka et al., 2011; Bamidele et al., 2011; Tobin et al., 2016; Johnson and Umoren, 2018) and other developing countries (Jacobsen et al., 2008; Chandra et al., 2011; Thepakson et al., 2018) reported high prevalence rates for immediate and remote health conditions, with severe negative impacts on the quality of life of those affected (including their families) and their efficiency.

Fire Hazard in the Sawmill

Table 7. Major Fire Hazards Recorded in Enugu Sawmill Industry

Date	Incurred Losses	Cost (₦)	Cause
March, 2004	20 shops	1 million	Sawdust ignition
February, 2004	25 shops with machines	3 million	Unknown
March, 2007	150 shops with several machines	320 million	Electricity spark
March, 2009	200 shops gutted	400million	Unknown
December, 2011	100 shops and several machines burnt	300 million	Electricity spark/Sawdust ignition
February, 2014	20 shops and many machines gutted	5 million	Electricity spark

The fire hazards encountered in the industry since 2004 are presented in Table 7. This data was obtained from the industry logbook. It was observed that the major incidents happened in 2007, 2009, and 2014, which resulted in the loss of lives and property. The prevalent cause of these hazards was electrical sparks from electrical machines. Even when the causes were identified, no preventive measures were taken to avert future occurrences. Workers' disregard for electrical safety was also evident; all electrical fixtures, including the electric switchboard, electric boards, and changeover, were not properly sealed, and wires and fittings were carelessly and dangerously exposed. Also, sawdust, shavings, and offcuts were carelessly piled in open areas. Wood dust particles that have accumulated are easily combustible and can cause fire explosions. Surprisingly, none of the sawmills had fire extinguishers.

Compliance of Woodworkers to Health and Safety Measures

Table 8. Use of Personal Protective Equipment (PPE) by the Woodworkers

Respondents	Personal protective equipment					
	Eye/nose/ face protection	Head protection Hair enclosure	Hand protection Fabric gloves	Feet protection	Body protection	Hearing protection and foot protection
Machine operators	47	15	49	6	4	Nil
Carpenter/ furniture workers	2	5	4	2	Nil	Nil
Wood dealers	3	Nil	Nil	3	Nil	Nil
Wood loaders	2	4	6	4	Nil	Nil

The level of compliance of workers in different sections of the sawmill with the use of personal protective equipment (PPE) is shown in Table 8. The findings show that less than 40% of workers in each section wear either of the listed PPE. Workers in machine operations had the highest compliance rate, while wood dealers had the lowest compliance rate of the four sections. It is worthy of note that some of the PPE used by workers was not standard or recommended PPE used in a typical sawmill setting. They used improvised kits to protect them from common injuries.

Some of the safety measures taken by the workers include the use of a hair enclosure for head protection. These head enclosures include caps and hats, while some workers also tie their heads with thick clothes. For limb protection, some workers were seen wearing hand gloves made of fabric. Most of these gloves used by the workers are very old and worn out, though some workers use other means to protect their hands from damage. Most of the workers do not use appropriate equipment for body protection while working. They seem not to see the need for wearing aprons, overalls, or other body-protective wear. From all the workers considered in this study, only four machine operators use aprons and coveralls for body protection. Others wear their ordinary clothes while working. We also observed that some of the workers in the mill wear protective gear. The prevalent footwear found in the mill includes leather shoes, canvas shoes, and some plastic shoes. Even though these boots are not normal safety boots, the number of workers using them is small compared to those who do not wear foot protection. Shockingly, it was observed that no worker used ear protective equipment despite the harsh sound produced by machines. It was gathered that most of the workers were unaware of this particular PPE, and those who were aware of it couldn't afford it.

In general, the major reasons for the noncompliance by some workers with the use of PPEs are financial constraints and ignorance. Since the nature of work in the sawmill is considered "casual", workers are expected to provide themselves with these PPEs. Most workers admitted that the high cost of these PPEs forces them to use improvised or inferior kits. They complain bitterly about their low earnings, which makes it difficult for them to buy the necessary PPE required for their work. Furthermore, citing ignorance as a reason for noncompliance, some workers are unaware of some of these PPEs because the industry lacks a safety awareness program. In fact, in the entire industry, there was no single member of safety personnel. Interestingly, it was observed that some workers neglected the use of PPE because, according to them, it causes discomfort and is sometimes boring to wear them. The reason why this is encouraging among workers is because there are no safety regulations or enforcement in sawmills. However, employers in the mill shy away from all these responsibilities (PPEs, safety awareness, and safety enforcement) to avoid incurring costs. This is due to the fact that they are not responsible for any mill casualties; it is solely the responsibility of the workers involved.

Faremi et al. (2014) concluded that most sawmill workers in Ile-Ife, Nigeria, have never used any safety equipment. In another investigation, Osagbemi et al. (2010) found that less than 20% of sawmill employees in north-central Nigeria used safety equipment. However, Johnson and Umoren (2018) and Agu et al. (2106) noted in their study that about two-thirds of the respondents were aware of at least one type of PPE, but only one-third reported using any. They also observed that about 10 percent of the respondents use face masks and goggles, which are the most common PPEs in use. No respondent reported using ear muffs despite the high level of noise identified by most of them.

Testing of Hypothesis

Null hypothesis: There is no difference in the types of ailments suffered by different categories of workers.

Alternate hypothesis: There is a difference in the types of ailments suffered by different categories of workers.

Table 9. Testing of Hypothesis

Work section	f_0	f_e	$x^2 = \frac{(f_0 - f_e)^2}{f_e}$	*df*	Tabulated value ($p \leq 0.05$)
Machine operators	217	217	19.48	2	5.99
Carpenters/furniture workers	88	88	15.99	2	5.99
Wood dealers	16	16	26.91	2	5.99
Wood loaders	39	39	8.77	2	5.99
Hawkers	8	8	15.98	2	5.99
Total			87.13		29.95

Since the calculated Chi-Square value in Table 9 is greater than the tabulated value, therefore, the null hypothesis was rejected and the alternate hypothesis was accepted. Thus, there is a significant difference in the types of ailments suffered by different categories of workers.

Conclusion

The dangers of sawdust and sawing activities in general are enormous and equally hazardous. There is a need to assess and identify the immediate and remote health hazards among workers in the sawmill industry in Enugu State, Nigeria. A comprehensive national policy addressing safety and health concerns should regulate the Nigerian sawmill industry. Woodworkers seem to be unprotected by national safety and health legislation. Employers are not paying close attention to the hazards associated with wood processing. The subject requires specific information, and the various exposure levels must be assessed and monitored. In this study, sawmill workers identified several hazards in their workplace. They also reported varying health problems. Many of them were engaged in strenuous activities for 5-8 hours daily with no occupational safety training. Poor safety practices were also evident in this study. Therefore, continuous and sustained workplace training of sawmill workers on workplace hazards and the importance of adhering to hazard control measures are advocated to maintain positive health.

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