Occupational Medicine & Health Affairs

Okokon et al., Occup Med Health Aff 2014, 3:1
http://dx.doi.org/10.4172/2329-6879.1000193

Research Article Open Access

A Comparison Study of Traumatic Occupational Injury Burden by Departments in an Industrial Establishment in South-South Nigeria

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Abstract

Objective: This study aimed to compare traumatic occupational injury burden by departments in an industrial establishment in the South-South geo-political zone of Nigeria.

Materials and methods: This was a 12-month descriptive longitudinal study of traumatic occupational injuries among workers in all the Departments of a paper-producing company in Nigeria. All workers traumatically injured at work were coded and enlisted into the study with their workers' identification numbers. Data obtained were analysed using the Statistical Package for Social Sciences for windows version 16.0. Regressional statistics was used to compare categorical variables while descriptive statistics were used to summarize other variables.

Results: The results show that the specific incidence rates for the two departments that were most injury-prone: Mechanical Engineering and Logging Departments were 77.4 traumatic injuries/1000 workers and 214.3 traumatic injuries/1,000 workers, with proportions of 3.8% and 5.7% involvement of the workers in the affected departments respectively, for severe injuries. The burden of injury in Logging department was statistically significant over that in Mechanical Engineering Department for all the traumatically injured ($p<0.05$).

Conclusion: Regular training of workers on the job regarding safety measures in general is recommended along with the use of ergonomic-oriented enhancements nationally, to forestall the occurrence of avoidable accidents. The opening of a National Occupational Injury Register in Nigeria is also recommended to keep track and stem the occurrences of injuries in workplaces. Currently, the services of Family Physicians in the face of critically few Occupational Health Physicians remain invaluable in industrial settings in the country.

Keywords: Traumatic occupational injury; Work-related traumatic injury; The chainsaw; Paper-producing industry; Forestry work; Wood processing; Sawmill injuries

Abbreviations:

BLS: Bureau of Labour Statistics; FMOLP: Federal Ministry of Labour and Productivity; ICD-10: International Statistical Classification of Diseases and Related Health Problems, tenth edition; ILO: International Labour Organization; NIOSH: National Institute of Occupational Safety and Health; NNMC: Nigerian Newsprint Manufacturing Company Limited; SIR: Specific Incidence Rate; USA: United States of America; WHO: World Health Organization; WONCA: World Organization of Family Doctors (formerly known as: World Organization of National Colleges; Academies and Academic Associations of General Practitioners and Family Physicians).

Introduction

Paper production and forestry work are two contiguous wood-related occupations, generally known to be fraught with human sufferings and immense hazards [1,2]. Traumatic occupational injuries constitute an area of serious concern globally. The National Institute of Occupational Safety and Health (NIOSH, 2014), Atlanta, USA, reported that 4,693 fatal occupational injuries occurred in that country in 2011 [3]. The same report added that 3.8 million non-fatal occupational injuries were suffered in 2011 in the USA. In a report of the International Labour Organization (ILO, 2014) presented at the XX World Congress on Safety and Health at work, held in Frankfurt, Germany, it was indicated that an estimated 2.3 million workers die annually from occupational accidents and diseases with a direct or indirect cost of approximately US$2.8 trillion globally [4]. Continuing in that conference, Guy Ryder (ILO Director-General) opined that work was claiming more victims than war. He made a clarion call for "a culture of intolerance towards risks at work," pointing out further that henceforth safety and health were going to constitute an integral part of ILO's work [4].

In the developing world, reliable literature on occupational health is poor [5]. Equally unhealthy is the impact of occupational injuries which has been estimated as being 10 – 20 times higher in the same part of the world [6]. In Nigeria, whereas Ezenwa reported that data on occupational health was easily available [7], Umeokafor et al. Have wondered whether such a position can still be sustained, when it was not possible to find records of occupational safety and health in the Federal Ministry of Labour and Productivity Inspectorate Division, Abuja, for two consecutive years (2005 and 2006) [8]. The reservation of Umeokaofor and colleagues notwithstanding, the official position of the Federal Government of Nigeria is to protect the interest of employees in industrial settings in the country [9,10].

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Received October 20, 2014; **Accepted** January 20, 2015; **Published** January 26, 2015

Citation: Okokon IB, Opreh OP, Ogbonna UK, John EE, Orok OE (2015)A Comparison Study of Traumatic Occupational Injury Burden by Departments in an Industrial Establishment in South-South Nigeria. Occup Med Health Aff 3: 193. doi:10.4172/2329-6879.1000193

Forestry work and paper-manufacturing at Oku-Iboku, Nigeria

The Nigerian Newsprint Manufacturing Company Limited (NNMC), Oku-Iboku, had a Forestry Division with estates at three locations and a base at Awi, all in the neighbouring Cross River State of Nigeria, from where it gathered soft wood (gmelina arborea). Gmelina was planted by workers of the Gmelina Nursery Department manually, with machetes, cutlasses and shovels but the harvesting was accomplished either with hand-held chainsaws or mechanized cutters called "feller bunchers" by workers in the Logging Department, both of the Forestry Division of the Company. When in use, the feller buncher would cut the gmelina, de-limb and skid it to a central place for cross-cutting into 4.2 metre long logs using chainsaws. Loading was done using carry-lifts on to strong forest vehicles called "forwarders" which conveyed the logs to in-forest roads where they were transferred to "Sisu" trucks for onward transportation to the mill site at Oku-Iboku in Akwa Ibom State of Nigeria. At the mill site, the logs were delivered to the wood-yard under the Operations Division for use by the Mill operators in the production of newsprint, after it would have been reduced to short fibre wood pulp and mixed with imported long fibre kraft pulp (Figure 1). This high level of mechanised processing of the wood reduced significantly the work that had to be done manually.

The NNMC was commissioned in 1986. This Company had a Health Department that was manned by Family Physicians. In a great number of instances, the health care of people of diverse occupations in our environment is borne by Family Physicians and general practitioners because the number of occupational medicine specialists is abysmally low in Nigeria [11].

The main aim of this research was therefore, to compare the burden of traumatic occupational injuries, in the two departments (Logging and Mechanical Engineering Departments) that presented with the largest incidences of traumatic occupational injuries from the two producing Divisions (Forestry and Operations) of the NNMC. The specific objectives were to determine: (i) the incidence rates of traumatic occupational injuries in those departments (ii) the factors responsible for the occurrence of these injuries, and as well (iii) which department was most injury prone in the Nigerian Newsprint Manufacturing Company Limited.

Materials and Method

Setting of the study

Data for this study was collated at the NNMC Medical Centre in Oku-Iboku, a rural town located on the bank of the Cross River in Akwa Ibom State of Nigeria. Oku-Iboku lies on latitude 5^0 16′ North of the equator and longitude 8° 6′ East of the Greenwich Meridian [12], within the South-South geo-political zone of the country. It had a population of 21,267 by the Nigerian national population and housing census of 2006 [13].

Study population

The departmental comparison focused on the two largest and mostly affected departments in the NNMC – Mechanical Engineering Department with a population of 155 workers out of a total of 810 workers in Operations Division and Logging Department with a population of 210 workers out of 306 in the Forestry Division.

Study design

This was a longitudinal morbidity study spanning 12 months.

Procedure

Information was collected and coded following the international Statistical Classification of Diseases and Related Health Problems [14], from all traumatically injured workers of the two producing Divisions of the Company, with worker identification numbers using interviewer administered structured questionnaires. The questionnaire had earlier been standardised by Okokon and colleagues [15] and had a Pearson's correlation coefficient of 0.8.

Incidence rate

The calculation of incidence rate for cases of traumatic occupational injuries in this study was adapted from: The Resolution concerning Statistics of Occupational injuries, adopted in 2013 by the 19th International conference of Labour Statisticians [16].

Inclusion criteria

All traumatic injuries sustained while at work at the Mill site and in the Company forests or at any assigned duty post of the Company by workers of the two test Divisions (Forestry and Operations) of the NNMC were included in the study, to ensure the determination of the most affected departments in the Company.

Exclusion criteria

All non-traumatic injuries and all cumulative trauma disorders like back-pain and carpal tunnel syndrome were excluded because they did not fall under the working definition of traumatic injuries conveyed by this study.

Data analysis

Information was entered on to the pre-structured data sheet designed for the study. Data obtained from this study were analysed using the Statistical Package for Social Sciences (SPSS) for windows version 16.0. Regression statistics was used to compare categorical variables, while descriptive statistics (frequencies, proportions, means, percentages, tables and standard deviation) were used to summarize other variables.

Working definition

For the purpose of this study, traumatic occupational injury was considered as sudden damage to any anatomical part of the body, by any external cause and arising in the course of the discharge of a worker's assigned duty.

This working definition was a modification of the ILO's (2013) definition of "occupational accident" [16].

Ethical issues

Ethical issues regarding this study were resolved with the relevant Company authorities.

Results

The Specific Incidence Rates (SIR) for Mechanical Engineering and Logging Departments when all injuries sustained by the workers in those departments were taken into consideration were: 122.0 traumatic injuries/1000 workers and 447.6 traumatic injuries/1000 workers respectively, for the 12 months of the study. Conversely, considering the

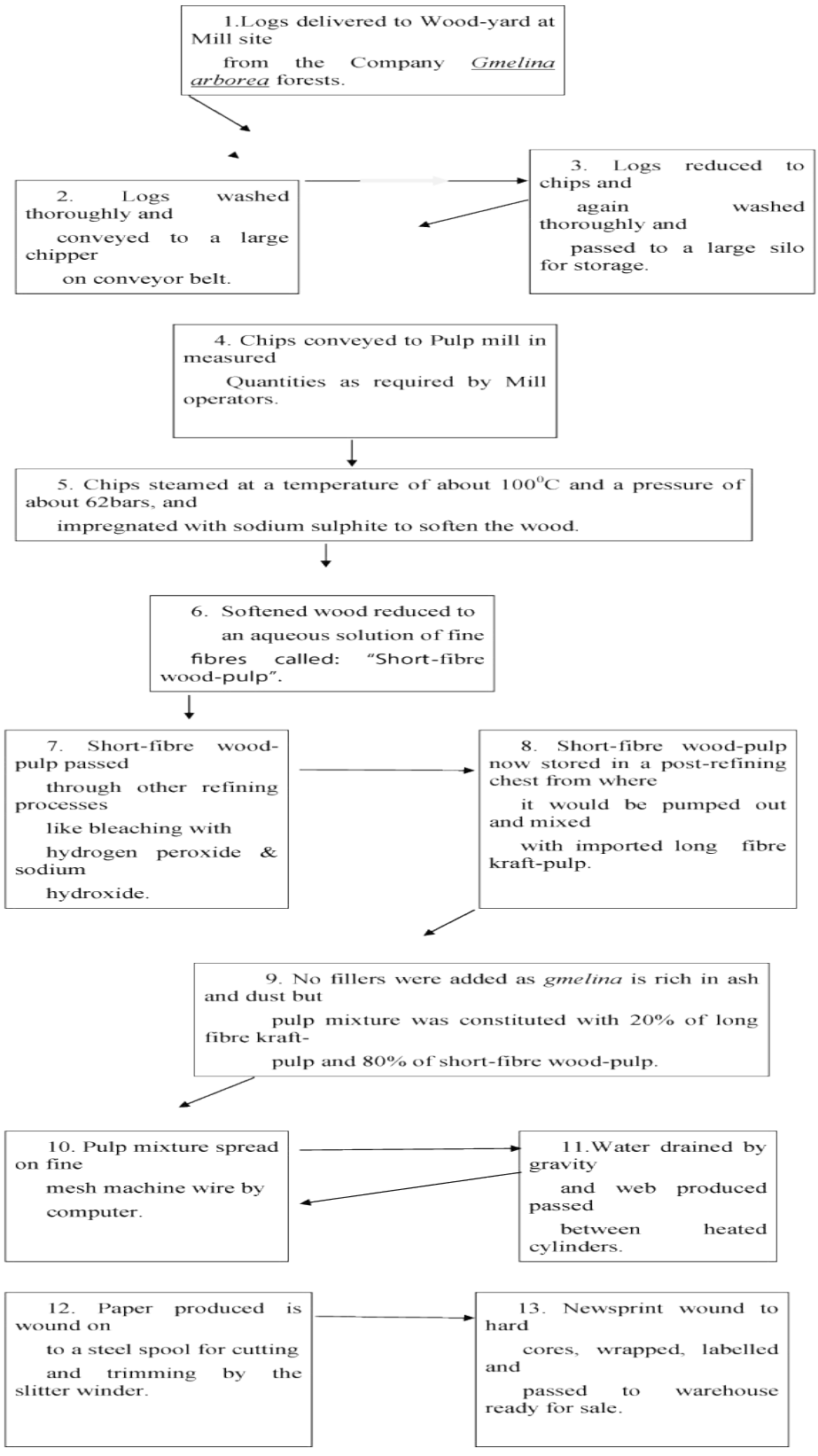

Figure 1: Flow chart showing the processes of production of Newsprint in NNMC, Oku-Iboku, Akwa Ibom State, Nigeria.

number of workers affected [16,17] (instead of injuries per population at risk) in the requisite departments, the incidence rates were: 11,612.9/100,000 workers for Mechanical Engineering Department and 27,619.1/100,000 workers for the Logging Department.

Specific Incidence rates for severe traumatic injuries, that is, traumatic injuries regarding which the workers were placed on sick-leave of three days and above [9,10] for the two departments were: 77.4 traumatic injuries/1000 workers for Mechanical Engineering Department and 214.3 traumatic injuries/1000 workers for Logging Department. Again, considering the number of affected workers, the rates were: 3,870.0/100,000 workers and 5,714.0/100,000 workers for Mechanical Engineering and Logging Departments, respectively. The proportions of affected workers were: 3.8% and 5.7% for Mechanical Engineering and Logging Departments respectively, for severe traumatic occupational injuries.

Table 1 shows the demographic characteristics of workers of the two departments that led in traumatic occupational injuries in the NNMC during the study period. Males were the only ones involved in the two departments and in the entire Company during the study period. This was predicated on the fact that workers in the two producing Divisions of this Company were all males. The mean age of all the affected workers in the two departments was 32.47 ± 5.60. The youngest subject in Mechanical Engineering department was 24 years old and the oldest 36 years. The youngest loggers as subjects were each 25 years old and the oldest was 49 years of age.

Most of the loggers had three years' experience (51.1%). One logger was virtually one year in the Company service. The majority of Mechanical Engineering workers had 4 years of experience but two had 6 months and 8 months respectively.

Applying regression analysis to the variables that were deemed to have possible influence on traumatic injury causation showed that occupation (type of work) and age of the subjects could predict whether or not a worker would sustain traumatic injury in the course of his service (Table 2). It also showed that body part affected and type of injury could not predict the cause of injury.

Carrying out a multivariate analysis of some variables employed in the study using general linear models (Table 3) showed that both the cause of injury and the age of the workers bore relationship with the departments that they served in. This suggested that the Departments where the workers served clearly accounted for the cause of the injury they experienced.

There was a statistically significant difference in the occurrence of injury between the Logging and Mechanical Engineering departments when all the subjects who sustained traumatic injury in the two departments were compared ($\rho<0.05$), but none existed when those who sustained severe injury [9,10] alone in the two departments were compared ($\rho>0.05$).

Primary medical care

Table 4 shows the extent of Primary Medical care offered to the different types of traumatic injuries that were sustained by the subjects. Most of the injuries were minor and 'wrist, hand and fingers' was the highest affected. Open wounds and fractures were suffered mainly by chainsaw operators (with ICD-10 coding: W_{29}). "Struck by thrown, projected or falling objects" (ICD-10 coding: W_{20}) was the highest cause of severe injuries overall (22.9%; not shown in table) and this represented the contribution of falling trees and branches of gmelina arborea. A subject in the Finishing Department also suffered fracture of his right ulna and radius when he placed his hand on the slitter winder out of inattention when the machine was in slow motion. He was pulled in by the rolling nips of the winder and his right forearm bones (ulna and radius) were fractured before the machine was turned off following the intervention of his supervisor.

There was no X-ray facility in the Company Medical Service and all subjects with fractures were offered analgesics and referred immediately after immobilisation of the fractured limbs to the neighbouring hospitals that were retained by the Company to give service to the workers in such situations. One truck driver slipped off and fell from his truck in the forest while trying to tie logs to the truck. The logs rolled down on his abdomen and he sustained massive intra-peritoneal

Unit in years	Logging Dept. N=210 Freq (%)	Mech. Eng. Dept. N=155 Freq (%)	Total N=365 Freq (%)
Age 21-25	5(8.6)	1(5.6)	6(7.9)
26-30	20(34.5)	5(27.8%)	25(32.89)
31-35	16(27.6)	11(61.1)	27(35.6)
36-40	10(17.29)	1(5.6)	11(14.47)
41-45	3(5.17)	0(0)	3(3.9)
≥46	4(6.9)	0(0)	4(5.8)
Total	58(100.0)	18(100.0)	76(100.0)
Mean(SD)	32.82 ± 6.55	31.33 ± 3.43	32.47 ± 5.60
Duration on job			
(Experience)			
≤1	1(1.72)	3(16.67)	4(5.26)
2	10(17.24)	2(11.11)	12(15.79)
3	30(51.72)	2(11.11)	32(42.11)
4	17(29.31)	11(61.11)	28(36.84)
Total	58(99.99)	18(100.00)	76(100.00)

Table 1: Demographic characteristics of subjects in the two largest and leading departments with traumatic occupational injury in NNMC for the 12-month study period.

Mode	Unstandardized coefficients		Standardized coefficients	t-values	Significant values
	B	Std. Error	Beta	B	Std. Error
(Constant)	16.814	1.951		8.620	.000
Occupation	-.097	.040	-.163	-2.415	.017
Part of the body affected	-.002	.023	-.006	-.096	.923
Type of injury sustained	-.119	.062	-.129	-1.922	.056
Age of worker at presentation	-.114	.047	-.162	-2.406	.017

Table 2: Regression analysis of the cause of injury as the dependent factor during the 12-month study period.

Source	Dependent variable	Type III Sum of Squares	Df	Mean Square	F	Significant value
Departments	Cause of Injury	738.439	18	41.024	1.833	.024
	Part of the body affected	4257.667	18	236.537	1.227	.242
	Type of injury sustained	456.829	18	25.379	.892	.589
	No of working days on sick leave	8963.887	18	497.994	.623	.879
	Age of worker at presentation	2339.184	18	129.955	3.145	.000

Table 3: Multivariate analysis of some variables considered during the 12-month study using general linear models.

Nature of Injury (type)	Equivalent ICD-10 Classification	Treatment offered	Outcome/further action
1. Superficial Injury (a) Contusion Head Eye and Orbit Thorax, Abdomen and Back Shoulder and Forearm Wrist, Hand and Fingers Thigh and Leg Ankle and Foot	S 00.0, .1 S 05.0, .1; T15.0,.1 S 20.2; S 30.0, .1 S 40.0; S 50.0, .1 S 60.0, .1, .2 S 70.1; S80.0,.1 S 90.0, .1, .3	Cleaning of affected area with water and savlon, then drying and administration of analgesics	Wounds healed. Subjects discharged.
(b) Other superficial injury Head Thorax and Abdomen Wrist, Hand and Fingers Thigh and Leg	S 00.3,.5,.7, .8,.9 S 20.3; S30.8 S 60.8, .9 S 70. 9; S 80.8, .9	Wound debridement, painting with tincture of benzoic compd. Analgesics and Tetanus toxoid.	Wounds healed. Subjects discharged.
2. Open Wound Head Abdomen Shoulder and Forearm Wrist, Hand and Fingers Thigh and Leg Ankle and Foot	S 01.0,.1,.2,.5,.7 S 31.1 S 41.0 ;S 51.9 S 61.0, .1,.8,.9 S 71.1; S 81.0,.9 S 91.0,.1,.3	As in 1(b) above as well as wound suturing, and administration of antibiotics.	Wounds healed. Subjects discharged.
3. Fracture Teeth Shoulder and Forearm Hand Multiple Regions of one Lower Limb Lower Leg	S 02.5 S 42.0,.1; S52.1,.2 S62.8 T02.3 S82.3,.4	Oral toileting for teeth fracture; Limb immobilisation and treatment as for 2 above for the soft tissue over bone fractures.	Dental fractures referred for dental consult. Bone fractures referred for orthopaedic consult.
4. Internal Injury Intracranial Injury Intra-abdominal Injury	S 06.9 S 36.0	Resuscitation and immediate transfer.	Subject with cerebral concussion recovered and was discharged after 48hrs. Subject with intra-abdominal injury later died in referral hospital from splenic rupture.
5. Crush Injury Thumb	S 67.0	Treatment as in 2 above.	X-ray showed loss only of the terminal phalanx. Subject recovered and was discharged.

Table 4: Primary medical care offered for traumatic occupational injuries during the 12 months of the study.

bleeding from the rupture of his spleen and died in the referral hospital despite resuscitation and prompt referral.

Discussion

The Specific Incidence Rates (SIR) for severe traumatic occupational injuries [9,10] for the two departments that were most injury prone were 77.4 traumatic injuries/1000 workers and 214.3 traumatic injuries/1000 workers for Mechanical Engineering and Logging Departments, respectively. The proportions of affected workers were 3.8% and 5.7% for Mechanical Engineering and Logging Departments, respectively. Specific incidence rates for severe traumatic injuries based on number of workers affected (instead of number of injuries sustained) yielded: 3,870/100,000 workers and 5,714/100,000 workers respectively for Mechanical Engineering and Logging Departments respectively.

In a report of the Bureau of Labour Statistics (BLS, 2012), the Incidence Rate for non-fatal occupational injuries requiring days from work for all the Private industries in USA was given as 3.2 cases/100 full-time workers [18] (equivalent to 3,200 cases/100,000 full-time workers). This Incidence Rate was reported to be an improvement over what was recorded in 2011 (3.3 cases/100 full-time workers). It must be admitted that the BLS Incidence Rate was a mean for all industries in that country, implying that there may have been some higher values and vice versa in the range. The findings in our report can therefore be taken as comparing favourably with the range in the BLS report.

It is of scientific interest to observe that the incidence of occupational injuries reported by Barss et al. [17] for the United Arab Emirate was as low as 136/100,000 workers. Nevertheless, the proportion of sufferers from severe traumatic occupational injuries in our report (3.8% and 5.7% for Mechanical Engineering and Logging Departments) were much lower than the upper limit (21.9%) allowed by the International Labour Organisation [19].

The second specific objective of this study was to determine the factors responsible for the causation of the traumatic injuries. Tables 2 and 3 clearly indicate that the departments where the injuries occurred were culpable, as well as the ages of the subjects. Literature is replete with information regarding the hazardous terrain of logging activities, the high risks associated with some occupations in the paper-producing industries and the involvement of workers of tender ages in these occupations [1,2,20-22]. The findings in the current study are therefore in agreement with those previous studies, although the highly mechanised system of the NNMC has doused what could have been a report of great concern.

Comparing the burden of traumatic occupational injury in the Logging and Mechanical Engineering Departments was the third and final specific objective of this study. In an attempt to unravel the section where accidents occur mostly in the paper-producing occupation, Riley (1978) carried out a review of 51 pulp, paper and paper-board mill fatalities in the USA to unveil the most injury prone

section/department in the industry [21]. At the end of his review, he concluded that there was twice the chance of being killed in the Pulp or Stock preparation department than in any other part of the Mill. In another report [22], Ross indicated that the nips between the rollers of the various process machines, including drying and felting rollers, calendar stacks, winders and re-winders, were a major source of injury in the paper-producing occupation. In the current study, a worker sustained fracture of his right ulna and radius when he placed his hand on the slitter winder in the Finishing Department out of inattention, thus confirming the position of Ross. There was, however, no record of traumatic occupational injury in the Stock preparation department contrary to the finding of Riley. In yet another report, the USA Department of Labour [23], in addressing selected occupational fatalities related to pulp, paper and paperboard Mills, showed that two categories of accidents in the paper-producing industry were responsible for nearly one-half of the 72 fatalities that were recorded in the course of their investigation. These included: "caught in or between rotating rolls, equipment and the like" (28%) and "struck-by falling, tumbling objects and equipment" (18%). Although the main thrust of the current study did not focus on causes of the accidents, we had however, noted the dangers posed by the various process machines in the causation of the fracture of the ulna and radius of a worker in the Finishing department. While there were many more severe injuries in the Logging Department with loss of life in one instance, the blast of an oxy-acetylene cylinder with deep lacerations of the face and fracture of two teeth of the welder, was the most impacting of all the injuries in Mechanical Engineering Department. Statistically, there was significant difference ($\rho<0.05$) when all traumatic occupational injuries suffered by workers of the two departments were considered. When subjects who were placed on sick-leave of ≥3 days [9,10] were compared, there was no statistically significant difference ($\rho>0.05$) between the two departments.

In many reports, logging activities have been shown to be highly injury prone [24,25]. This study is in agreement with those findings. The inability to establish a severity edge statistically between Logging and Mechanical Engineering may have to do with the fact that we were working with absolute numbers rather than with the gravity of the injuries – an observed defect of statistics.

Limitations of the Study

The 19th International Conference of Labor Statisticians (2013) recommended that in calculating the average number of workers, the number of part-time workers should be converted to full-time equivalents [17]. This study did not include part-time workers as it was originally conceived that their inclusion will present an amorphous picture of the data as they do not have identification marks of the Company.

The current study did not consider the incidence of work injuries in relation to feeding. The Catering Department of NNMC was serving meals to workers at highly subsidized rates. This was the Company's approach to checking the possibility of work injuries occurring as a result of hunger. However, the report of Bazroy et al. showed that the highest percentage of work injuries (43%) occurred within three hours of a meal [26], thus incriminating the full stomach as a source of sedation and decreased alertness.

The relationship between injury occurrence and remuneration was equally not explored. Although it was popular knowledge that the salary of the workers were good, a specific study designed to address the individual thinking of those workers, was the only way that their feelings relative to their pay would have been effectively harnessed.

Reporting to the Mill Clinic or the First-Aid post in mild cases depended on the individual workers concerned, and as some workers may have considered it a waste of their time in such cases, it is possible that some minor cases may have gone unrecorded.

Conclusion and Recommendation

Generally, the Incidence Rate of occupational traumatic injury at NNMC Oku Iboku, compared favourably with a vast national setting of Private industries in the USA [18]. This may have been because the Company was operating below 50% of its installed capacity (100 metric tonnes per annum) throughout the period of the study. Additionally, safety and health measures were always taken very seriously in that Company. The Company Safety Department was quite active in instituting investigations on accidents and guiding the Management to apportion blame, caution culpable workers and place more serious sanctions on them as the case may be. This is a well recommended approach to checking accident/injury causation in similar systems. While setting achievable targets for workers is a well endorsed means of actualizing proposed production levels, it nevertheless has been a recognised route of accident causation where such targets are too high. It is recommended as a means of prevention of accidents that Company Executives tamper targets setting with a humane consideration of the possible dangers that may attain such practices if placed at the extreme range.

The present study further underscores the need for: (1) The Federal Ministry of Labour and Productivity (FMOLP) to consider the enforcement of the installation of ergonomic-oriented enhancements nationally in industrial settings, to forestall the occurrence of avoidable accidents (2) The FMOLP to effect the opening of a National Occupational Injury Register to ensure that all injuries suffered at work are properly collated in Nigeria. (3) The FMOLP to strengthen her Inspectorate Division to effectively protect workers in industrial settings, especially for medium and small scale industries that are known to have minimum or no health care provisions in this country. (4) Family Physicians and General Practitioners in Nigeria and other developing countries with a dearth of occupational Specialists to show more interest in service and research in occupational settings.

Acknowledgement

The authors are grateful to the four Nursing Officers that were serving with the NNMC Medical Department, who assisted in the collation of the data for this report. They were: Messrs Bassey, Etim, Akpanekpo and Mrs. Hilda Chiazor (nee: Onyije).

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Citation: Okokon IB, Opreh OP, Ogbonna UK, John EE, Orok OE (2015)A Comparison Study of Traumatic Occupational Injury Burden by Departments in an Industrial Establishment in South-South Nigeria. Occup Med Health Aff 3: 193. doi:10.4172/2329-6879.1000193