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Evaluation of the Ergonomics of Carpentry and Furniture-Making Enterprise at the Illoabuchi Cluster Sawmill/Wood Market in Port Harcourt, Nigeria

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ABSTRACT: Over the years, forestry-related professions have been consistently considered as one of the most hazardous occupations around the world. Awareness to address this issue through ergonomic improvement interventions is increasing, yet insufficient information is available about ergonomic conditions of Nigerian carpentry and furniture-making (CFM) enterprise. This study evaluated the ergonomics of CFM at the Illoabuchi cluster sawmill/wood market in Port Harcourt, Nigeria using qualitative and quantitative approaches. The carpenters/furniture makers (CFMs) were exclusively males 51.9% of them were within the age of 26 and 35 years with 72.2% of them being married. The height of tables is weakly positively correlated with the height of CFMs ($r = 0.250$, $p < 0.026$), implying that a vast number of the tables used were not anthropometrically matched. The occupational hazard outcomes frequently suffered by the CFMs included bruised/hands cut (34.4%), back pain (25.9%), nasal infection (25.9%), muscle pain (8.6%), and eyes infection (5.2%). These findings provide evidence by which the ergonomical target interventions to reduce future hazards and also to lessen the impacts of previous hazards on CFMs can be implemented.

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The high consequent risk through exposure to occupational hazards has informed the ergonomic improvement interventions worldwide (Ohlander *et al.*, 2020). In countries, where data are available, forestry has consistently over the years been considered as one of the most hazardous occupations around the world (FAO, 1992; ILO, 1998; Klun and Medved, 2007; Ozden *et al.*, 2011; Melemez, 2015; Danilovic *et al.*, 2016; Grzywinski *et al.*, 2016; HSE, 2021). While the sustenance of quality of labour, in particular, those in forest-based industries has become one of the major global concerns, most studies mainly focused on forest personnel, logging and primary conversion operations (Mitchell *et al.*, 2008; Balimunsi *et al.*, 2011; Tripathi and Upadhyay, 2015; Yovi and Yamada, 2019). Regarding the situation of African forestry, the ergonomics of carpentry and furniture-making (CFM) operations belong to the less studied in Nigeria. While CFM is economically important and the most popular forest-based enterprise in Nigeria (Alao and Kuje, 2012), providing data on its ergonomics will contribute to existing global literature. The objective of the present study was to investigate the ergonomics of carpentry and furniture-making (CFM) enterprise at the Illoabuchi Cluster Sawmill/Wood Market in Port Harcourt, Nigeria.

MATERIALS AND METHODS

Research area: This study selected the Illoabuchi cluster-sawmill in Port Harcourt city, Nigeria as the research area. With the mass production of lumbers, the research area has long been changed and popularly known as the Illoabuchi cluster sawmill/wood market. The research area ranges from 4° 47′ 17′′ to 4° 47′

23´´N and 6º 59´ 08´´ to 6º 59´ 19´´E. It has a land area of over 2.5 hectares accommodating several wood-based entrepreneurs of whom 71.3% of them are CFMs (Aiyeloja *et al.*, 2022). The area has a tropical climate and moist rainforest experiencing heavy downpours throughout the year but with reduced frequency in the month of December to March. The average annual rainfall is greater than 2000 mm, with a minimum temperature of 22.54 °C and a maximum temperature above 30 °C. The minimum relative humidity is 58.97% and maximum relative humidity is above 94% (Uko and Tamunobereton-Ari, 2013). The Illoabuchi cluster sawmill/wood market is located in the core center of the Rivers State capital city and shares borders with the Rivers State University, and Eagle Island. This makes the research area a popular economic hotspot for city dwellers. The research area attracts a wide range of wood-based enterprises including CFM, and its associated businesses. The Illoabuchi cluster sawmill/wood market has a high number of CFMs and is very suitable for the ergonomic study of CFM.

Study design, population and data collection: The study was designed as a field survey among all the 79 CFMs who were owners of their workshops. The paid workers and apprentices were exempted from the study to avoid invalid questionnaires. The demographics, anthropometrics of the carpenters/furniture makers (CFMs), their working tables, as well as work environments and products produced were taken into consideration. These factors were considered in order to determine the primary causes which influence the degree of occupational hazard outcomes. Based on the results obtained, suggestions envisaging interventions for the reduction of occupational hazards were advised. The questionnaire covered demographics, measurement recording of heights of the CFMs and their work tables, as well as work environments and products produced. In order to reach an adequate number of respondents, a 100% sampling technique was used to investigate the 79 CFMs in the study area. During the reconnaissance survey, the consent of all the targeted respondents was sought and the questionnaires were pre-tested. The actual survey was conducted through a face-face interview, measurements, and on-site field observation with the aid of the pre-tested questionnaires. The data collected were related to socio-demographic information, anthropometric aspect of workers and working table heights, work environments, products produced, frequent occupational hazards, and safety knowledge.

Statistical analysis: The data recorded through the survey questionnaires were coded and entered into Microsoft Excel 2010 spreadsheet and statistical analysis was performed using IBM SPSS 23. Quantitative descriptive statistics were used to analyze socio-demographic, anthropometric, work conditions, products produced, frequent occupational hazards, and safety knowledge data. A Chi-square test was used to determine the level of association between the type of workshop and other sources of livelihood among CFMs. Spearman's correlation test was employed to evaluate the relationship between the heights of CFMs and their work tables. The statistical significance threshold was pegged at 5% ($p < 0.05$).

RESULTS AND DISCUSSION

Socio-demographic information: A total of 79 respondents were surveyed in this study and their socio-demographic information is contained in Table 1. CFM is previously known to be a male-dominated enterprise in Nigeria (Adedokun *et al.*, 2012; Alao and Kuje, 2012; Aiyeloja *et al.*, 2014). This research further established zero entrance of females into the CFM enterprise. The operations involved in the CFM products development have been stereotyped to culturally suit males labour (Aiyeloja *et al.*, 2014). The non-interest of females in the CFM enterprise might also be related to the associated potential occupational hazards. It was also discovered that productive active age bracket (26-55 years) were greatly engaged in the CFM enterprise. This finding is in agreement with Aiyeloja *et al.* (2014) who reported that 75.6% CFMs in other parts of Rivers State was within the productive active age range of 31-50 years. The majority of the CFMs' heights were between 161cm and 170cm. This finding is similar to the results of Eboh and Ohaju-Obodo (2019) who reported male height range of 157-189 cm, 156-188 cm, and 151-183 cm, for Esan, Kalabari, and Urhobo ethnic groups respectively, in the same Niger Delta region of Nigeria. These results indicate that anthropometric measurements such as total height can be used to identify ethnic groups or natives of the region thus helping to design appropriate work tools including tables. Wibneh *et al.* (2020) submitted that variations in age, ethnicity, and geographical factors could have a significant impact on the ergonomic design of equipment and workspaces of army personnel in Ethiopia, Africa. The CFM has been reported to be a gainful engagement of socio-economic importance in Nigeria (Aiyeloja *et al.*, 2014). This suggests that the enterprise promotes secured responsibility and supports the marital responsibilities of high proportions of married CFMs found in this present study. Numerically, the population of migrants in the CFM enterprise was greatly higher than that of natives (Table 1). ILO (2012) reported that in Africa the skills of crafts including carpentry and furniture making have an

ethnic character and that it is the informal setting that holds the traditional skills to produce products. This present study further confirmed this ILO submission as the majority of the respondents possessed little formal education (Table 1). The CFM skills acquisition has been largely through traditional apprenticeship (Onokerhoraye, 1977) and the result of this study indicates that its content still largely remains an informal heritage in Nigeria. The reliance of nearly all the CFMs only on the enterprise as sustenance indicates that their existential needs were adequately secured or met through the proceeds accrued from the CFM enterprise.

Table 1: Socio-demographic information of respondents (n = 79)

Variables	Response	Frequency	Percentage (%)
Sex	Male	79	100.0
	Female	0	0.0
Age	25 and below	3	3.8
	26-35	35	51.9
	36-45	26	25.3
	46-55	13	16.5
	56 and above	2	2.5
Height	150cm and below	10	12.7
	151cm – 160cm	11	13.9
	161cm – 170cm	27	34.2
	171cm – 180cm	20	25.3
	181cm above	11	13.9
Marital Status	Single	22	27.8
	Married	57	72.2
Origin	Native	16	20.2
	Near Migrants	48	60.8
	Far Migrants	15	19.0
Educational Qualification	Non Formal	4	5.0
	Primary	15	19.0
	Secondary School Certificate	42	53.2
	Post-Secondary Cert.	18	22.8
Primary occupation	No	0	0.0
	Yes	79	100.0
Other sources of livelihoods	No	75	94.9
	Sculpture (Carving wood)	1	1.3
	Selling of lumbers	3	3.8
Training acquisition	Apprenticeship	63	79.7
	Technical School	16	20.3
Years of experience	1-5	13	16.5
	6-10	25	31.6
	11-15	10	12.7
	16-20	9	11.4
	21 and above	22	27.8

Table 2: Work conditions

Variables	Response	Frequency	Percentage (%)
Types of Workshop	Block Shop	6	7.6
	Wood Shop	8	10.1
	Open Shed	65	82.3
	Total	**79**	**100.0**
Height of Table	75cm and below	4	5.1
	76cm – 80cm	5	6.3
	81cm – 85cm	11	13.9
	86cm – 90cm	47	59.5
	91cm and above	12	15.2
	Total	**79**	**100.0**

Work conditions and significant tests of association and relationship between variables: The CFMs' workshops were mostly open sheds (Table 2), and they were considered as poor shelter conditions that could promote vulnerability to stress and diseases associated with hot sun, rain, and cold weather. In addition, most of the shelters were found to be poorly maintained, with poor floor hygiene (moisture saturated floor during long raining season), and this, in turn, could likely have a deleterious effect on the respondent's health as well as their productivity. Other sources of livelihood were found to be influential on the type of workshops used by the CFMs. The significant association revealed that those who had no other sources of livelihood used more safe workshops type (Table 3). This indicates that CFMs who had no other

sources of livelihood were making more profits, and could afford safer workshop types than those that had other sources of livelihood. As the height of the work tables varied considerably (Table 2), the variability has an important relationship with respondents' heights (Table 4). Though the relationship was significant but was weakly positively correlated (Table 4), implying that a vast number of the tables used were not anthropometrically matched with the CFMs' heights. This result suggests that many respondents have been working in awkward postures.

Table 3: Association between type of workshop and other sources of livelihood among the respondents

		Type of work shops			Total	Chi-square Sig	Df
		Block shop	Wood shop	Open shed			
Other sources of livelihood	No	6	6	63	75	0.024*	2
	Yes	0	2	2	4		
	Total	**6**	**8**	**65**	**79**		

Table 4: Relationship between the heights of respondents and their work tables

		Height of Table (cm)					Total	Spearman's	Sig.
		< 75	76 – 80	81 – 85	86 – 90	91 >			
Workers Height (cm)	Below 150.00	1	2	1	6	0	10	0.250	0.026*
	151.00 - 160.00	2	0	2	5	2	11		
	161.00 - 170.00	1	2	3	18	2	23		
	171.00 - 180.00	0	0	4	13	3	23		
	181.00 above	0	1	1	5	4	11		
	Total	**4**	**5**	**11**	**47**	**12**	**79**		

CFM products and frequent occupational hazards: The CFM products results recorded that frame has the lowest frequency of mentions, while school table/desk/stool, and office table/chair frequency of mentions were high. This result (Figure 1) indicates that among the demanded CFM products, school table/desk/stool, and office table/chair were the highest demanded products in Port Harcourt. This finding is agreeable with those reported by Odoh and Eyeh (2015) that Executive Cushions, School Lockers, desks and chairs well as dining tables with seats were the three bestseller products of the Furniture-manufactured company in Owerri, Imo State, Nigeria. Several studies on ergonomics of furniture construction have been reported across the globe (Imbus and Dyson, 1987; Mirka *et al.*, 2002; Nejad *et al.*, 2013; Top *et al.*, 2016; Ayak *et al.*, 2017; Akyuz *et al.*, 2018; Ozkaya *et al.*, 2018; Colim *et al.*, 2019; Fazeli *et al.*, 2021), and all of them except Fazeli *et al.* (2021) confirmed frequent and high incidences of occupational hazards. According to the present study, the results (Table 5) of the frequent occupational hazards suffered by the CFMs were in accordance with those previously reported across the globe above. The frequent occupational hazards recorded in this study may be attributed to the non-utilisation of PPE (e.g., hand-gloves, nose cover, protective eye Goggles, protective clothing, and footwear), and utilisation of un-matched or wrong standing work tables.

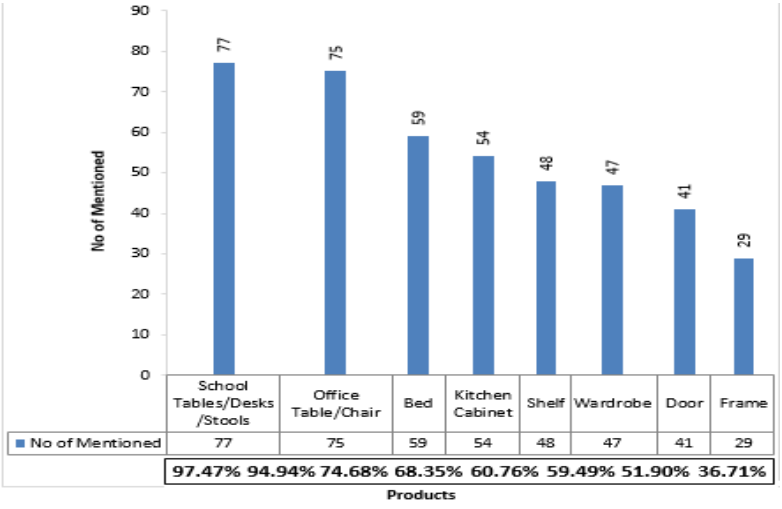

Fig. 1: Types of CFM products

Table 5: Relative frequent occupational hazards

Occupational hazards	frequency	Relative frequency (%)
Bruised/hand cut	28	34.4
Back pain	20	25.9
Nasal infection	20	25.9
Muscle pain	7	8.6
Eyes infection	4	5.2
Total	**79**	**100**

Safety knowledge and compliance to safety precautions: The results of safety knowledge and compliance to safety precautions were presented in Table 6. While the routine activities or operations of manufacturing CFM products cause high hazards (risks) exposures, the use of the PPE could provide an important approach to reduce safety occupational hazards. Though the respondents were fully aware of the importance of PPE usage, discomfort due to heat generation and heaviness was a reason on one hand and the cost is another reason on the other hand. This finding is totally agreeable with those reported by Garrigou *et al.* (2020) that cost, availability, and dangerous discomfort may make instructions to use PPE inapplicable during agricultural pesticide application. In addition, Varghese *et al.* (2018) in their extensive review raised an increasing concern about occupational illness, injury and productivity losses due to hot weather in a changing climate. Since safety and regulatory actions were missing, it was not surprising that some CFMs suffered from varied occupational hazards. Regulatory actions are important factors for compliance to safety policy but are loose in developing countries (Lette *et al.*, 2018) including Nigeria as in the case of this study.

Table 6: Safety knowledge and compliance to safety precaution

Variables	Response	Frequency	Percentage (%)
Awareness of PPE usage	No	0	0.0
	Yes	79	100.0
	Total	**79**	**100.0**
Non compliance	Heat and heavy	35	44.3
	Expensive	26	32.9
	Heat	18	22.8
	Total	**79**	**100.0**
Utilisation if given	No	13	16.5
	Yes	66	83.5
	Total	**79**	**100.0**
Labour inspections	No	79	100.0
	Yes	0	0.0
	Total	**79**	**100.0**

Conclusions: This study systematically investigated 79 CFMs. The CFMs experience varying incidences of work-related injuries and health hazards with non-utilisation of PPE and utilisation of unmatched standing work tables as main causes. To reduce the occupational hazards, CFMs should conform to utilisation of appropriate tables matching their heights and PPE which promote comfort during unfriendly weather.

Declaration of Competing Interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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