International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2017): 7.296

Ergonomic Risk Factors in Building Construction Sites in Mombasa County, Kenya

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Abstract: ***Safety is, without doubt, the most crucial investment we can make. And the question is not what it costs us, but what it saves. Work in the construction sites is ergonomically hazardous. Construction work requires numerous awkward postures, heavy lifting and other forceful exertions. Workers in the construction industry require physical stamina as their duties often require prolonged standing, bending, stooping, material handling, working in crowded/confined spaces and sometimes exposure to uncomfortable weather conditions. The overall aim of this research was to study Ergonomic Risk Factors (ERFs) in relation to Musculoskeletal Disorders in selected occupations; Carpenters, Mason, Roofers and Iron workers in both commercial and residential buildings in Mombasa County. Specifically, the study sought to establish the prevalence of musculoskeletal disorders in construction sites, establish awareness levels to ergonomic risk factors by the construction workers and also to determine the extent to which health and safety management system in building construction affects the occurrences of ergonomic injuries. With a sample size of 286 respondents (n=286), the study used questionnaires, interviews and observation to collect primary data. Both descriptive and inferential statistics were used in data analysis using SPPS version 20.0. Regression analysis was used to determine the strength of relationship between respondents' characteristics (age, gender, education) and the prevalence of ERFs. Differences in age, weight, education and employment status were significantly associated with the prevalence of ERFs and hence MSDs. The findings showed that majority of the construction workforce are men at 94.5% and are hired on temporal & casual basis representing over 93% of the total workforce. The correlation coefficient (R)/beta value β of 0.786 at p=0.00 indicated that the ERFS ERFs leads to MSDs. The coefficient of determination R-Square of 0.618 means that 61.8% of the variance in ERFs was explained. From the result, there exist a statistically positive influence between ERFs that causes MSDs and workers experience, age, gender and education. It should be noted that, 178 (80.77%) of the workers termed construction sites as unsafe. It was established that 116 (52.56%) of the respondents reported inappropriate work method as the main cause of accidents in the construction sites. Regression analysis determined that when workers are exposed to ergonomic risk factors, the prevalence of MSDs would be at 70.8% (0.708) and further exposure to additional ERFs would lead to a 66.4% (0.664) increase in the prevalence of MSDs to construction workers. In addition, the study further established Chi value of 0.719 (p=0.000) showing a strong and undoubtable relationship between ERFs and MSDs. This study recommends the adoption of a more proactive and comprehensive management mechanism to enforce the existing safety and health regulations in construction sites. This should be achieved through regular training of all the workers with regards to ergonomic risk factors, and Work Related Musculoskeletal Disorders and enforcement of both NCA 2011 and OSHA 2007 by the respective agencies.***

Keywords: Ergonomics, Ergonomic Risk Factors (ERFs), safety, Musculoskeletal Disorders (MSDs)

1. Introduction

Among the known construction types in the world, building construction is one of the fastest growing industries and it has endeavored to employs a considerably large number of workers accounting for 10% of the Gross Domestic Product (GDP), and providing 7% of global employment. (Nubi, 2008). The Kenya construction industry is set to grow steadily for the next decade attributed to an increased number of projects being carried out in the country (KNBS 2017). Recently, Kenya's construction industry has experienced considerable growth in construction activities especially in Major cities; Nairobi and Mombasa. Official figures showed that construction industry, which comprises buildings, roads and railway, grew 9.2 per cent in 2014 compared to 13.9 in 2015 and 13.1 a year earlier (KNBS 2017). This is as a result of the increased demand for housing facilities with high demand for labor (Murie, 2007). Unfortunately as Murie, 2007 established, construction industry contribute greatly towards occupational accidents and work related ill health. The high rate of urbanization has heightened demand for residential and commercial consumers in these cities which in return has increased the number of construction activities. This has been reflected by immense increase in employment opportunities for laborers, both skilled and unskilled and the urban poor who do not have many job options. Construction work is not safe, the International Labour Organization (ILO, 2005) estimates at least 60,000 fatal accidents a year on construction sites around the world that is one in six of all fatal work related accidents. Compared to other labor intensive industries, construction industry has reported high rate of injuries and fatalities. In a study by Rwamamara et al., 2007, and Agumba et al 2008, these studies found out that construction workers experience two times more work-related injuries than other industry workers. Construction by its very nature is ergonomically hazardous, whose works typically require the adopting of awkward postures, lifting of heavy materials, frequent bending and twisting of body, working above shoulders height, manual handling of heavy and irregular-sized loads, working below the knee level, staying in one position for a long period and pushing and pulling of loads (Odunjo et al., 2015). In Kenya, data available from Directorate of Occupational Health and Safety Services (DOHSS Annual Report Kenya 2011) indicates that between 2005 and 2009, there were 7769 fatalities across all industry sectors. The same report indicated that construction

industry accounted for 16% of fatal accidents and 7% of non-fatal cases (DOHSS Annual Report, 2011). Fatalities and deaths have become common place in Kenya and Kenyans seems to resign to this fate (Omukubi, 2012). But the corresponding information for most developing countries, Kenya being one of them is rare. This makes it difficult to quantify the problem and put necessary ergonomic intervention in workplaces to alleviate causes of work-related musculoskeletal disorders (Bao 1997)

In Kenya, non-compliance of appropriate work methods such as working with vibrating machines, manual handling of materials, and awkward posture among others has been found to be prominent in most construction sites (DOHS Annual Report 2014). In Mombasa in particular, due to high demand for housing, safety standards have been compromised and this has seen an upsurge of accidents in construction sites, thus the need for this study.

2. Statement of the Problem

Construction is a basic pillar for global competitiveness and foundational enabler to Kenya's Vision 2030. To some purpose it is argued that, the construction industry and their extent is economic indicator of all the country's performance. It shows the level of development, also the state of the country economic status. However, the big amount of works has seen an increase in the number of accidents in construction sites. Occupational injuries continue to place tremendous burden on workers globally with an estimated 100 million occupational injuries occurring worldwide each year (Leigh 1997). Ergonomic risk factors that causes ergonomic injuries also referred to as musculoskeletal disorders remain prevalent and often result in a substantial burden of disability and high associated cost (Palmer 2012). In US for instance, the Bureau of Labor Statistics (BLS, 2005) reported over 2.8 million cases of nonfatal occupational injury of which MSD accounted for 33%. Developing countries have also recorded very frequent injuries and risks associated with construction work. Jason 2008 stated that the risk is 3-6 times greater as compared to developed countries. It should be noted that unemployment and poverty has driven majority of Mombasa County populace to working in construction sites despite having full knowledge of how risky the industry can be. Despite the steady growth in the construction sector, the industry is a very accident prone. In 2011, construction industry accounted for 16% of fatal accidents (40 cases reported for 100,000 workers) and 7% of non-fatal cases (DOHSS Annual Report, 2011).

Because of the failed enforcement of risk management system and generally construction health and safety management, there are numerous accidents and incidences of fatalities in many construction sites in Kenya (DOSHS, 2009). DOSHS states that most accidents in construction sites go unreported. In addition, most construction workers have no information and or training on matters of health and safety that is pegged to as their rights. Unfortunately in Kenya and Mombasa County in particular, there are no reliable data on accident cases in housing construction because most contractors do not report all the accidents (DOHSS Annual Report, 2011). Many workers have met their deaths in construction sites while others have become permanently crippled from construction related injuries. Further, laws on occupational safety and health are not strictly enforced. Safety rules in most construction sites do not exist and if they exist, the regulatory authority is weak in implementing each rule effectively. It is against this background that the study sought to evaluate ergonomic risk factors and musculoskeletal disorders in building constructions in Mombasa County.

Study Objective

To evaluate Ergonomics risk factors and musculoskeletal disorders in building construction sites in Mombasa County.

Justification

Construction industry plays an important role in improvement of countries' economic growth. Despite its immense contributions to economic growth, construction industry has always been blamed for the high rates of accidents and fatalities; this issue has placed the construction industry among the industries with unreasonable rates of accidents, permanent and non-permanent disabilities and even fatalities (Hughes & Ferrett, 2011). A study done by Charamba in 2006 established that majority of the accidents don't just happen, instead, people who perform unsafe acts and creates unsafe conditions cause accidents to happen and hence accidents. Since most of these workers in this industry are considered young and vibrant, the expectations from family and community at large are high. But due to poor health and safety standards in construction sites, these young generation are subjected to poor health and high cost of treatment when accidents occur. Consequently being bread winners, they end up losing their source of livelihood and support to their families. This study therefore has provided data that will help in stemming the tide of ergonomic risk factors that have led to MSDS in the construction industry among workers in Mombasa County and Kenya at large.

3. Methodology

Research Design

The study used descriptive and inferential research design. The research design hence focused on gaining an understanding of the ergonomic risk factors in construction industry and its relation to Musculoskeletal Disorders in Mombasa County. It specifically established which ergonomic risk factors are prominent with building construction workers. A descriptive research design also enables generation of factual information about the study (Saunders, 2004)

Population

The study targeted a population of 1364 workers that comprised of construction workers from selected trades; carpenters, roofer, masons, ironworkers and site managers drawn from registered construction sites by National Construction Authority in the four sub-counties in Mombasa. (**Table 1**)

Table 1: Population per sub-county

Sub-County	Number of Registered Building Construction sites	Total numbers of workers
Kisauni	27	916
Changamwe	12	298
Nyali	5	78
Jomvu	7	72
Total	51	1364

Sample and Sampling Frame

In this study, stratified random sampling was used with specification on job categories and level of construction. According to Cooper and Schinder (2000), a stratified random sample is a population sample that requires the population to be divided into smaller groups, called "strata". Random samples was taken from each stratum, or group. Then simple random was used to select the skilled and unskilled workers. These groups formed both the skilled and unskilled workers. Yamane (1967:886) provides a simplified formula to calculate sample sizes. This formula was used to calculate the sample sizes.

A 95% confidence level and P=.0.05 are assumed for:

$$n = \frac{N}{1 + N(e)2} \quad (1)$$

Where *n* is the sample size, N is the population size, and e is the level of precision. When this formula is applied to the above sample, the values obtained was;

$$n = \frac{1364}{1 + 1364(0.05)2}$$

$$n = 286$$

4. Results and Discussion

Response rate

286 (100%) questionnaires were distributed to the targeted group. The questionnaires were distributed to the workers on convenient basis in each site. The different sample from different construction sites in this study was a representative of the population of workers in each particular construction site. Out of the 286 (100%) questionnaires distributed, 220 (77%) copies were returned and had the questions responded to correctly. Sixty six (66) responses were invalid owing to inconsistency in the responses and were discarded. Babbie (2007) suggests that in research a response rate of at least 50 per cent is considered adequate for analysis and reporting and a response of 70 per cent is very good. Hence the research 77 per cent was appropriate for data analysis.

Demographic characteristics of workers was captured in order to have a detailed correlation between ERFs and the demographic characteristics of the workers. Majority of the respondents were male [208(94.5%)] while female were very few [12(5.5%)]. This is because most construction work is strenuous and requires strength that's why it attracts more males than females as seen in this study. This can also be explained by the culture in community's stereotyping men as being superior than women and hence preferring construction work to male rather than female. Hard work with high occupational risk is usually done by men according to Jeanne (2007) and WHO (2010). With β=0.663 with *p=0.01*, the study revealed that there is indeed a significant correlation between gender and ERFs. The study further sought to investigate the ergonomic risk factors that the respondent thinks are the main causes of injuries during their duties performance. From the findings, respondent view repetitive motion as the main cause of musculoskeletal disorder at 37.73% (82), awkward posture at 27.27% (60) fixed/static motion 17.73% (39) vibration at 10.45% (23) forceful motion 3.64% (8) and others at 3.18% (7). From Table 1.1 and 1.2, the correlation coefficient (R) or β of 0.742 at *p=0.00* indicates that there exist statistically significant relationship between ERFs and occurrences of MSDs. The coefficients of determination, R-square (r^2) of 0.564 implies 56.4% of workers MSDs is attributed to ERFs irrespective of work experience, age, education or gender. The significance value of 0.001 which is less than 0.05 means the model is statistically significant in predicting how ERFs affects construction workers.

Table 1.1: Regression of ERFs and Work Experience

Model	R	R Square	Adjusted R Square	Df
1	.786[a]	0.618	0.606	1

Table 1.2: Regression coefficients

Model		Unstandardized Coefficients		Std Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	16.708	0.918		7.631	0
	Ergonomic Risk Factors that causes MSDs	0.664	0.34	0.156	13.954	0.001

a. Dependent Variable: Occurrences of MSDs

The ergonomic risk factors causes several physical health problems/MSDs. The researcher went further to enquire with the prevalence of the risk factors how the physical health problems affect the respondents. From **Figure 1**, it was established that basing on the ergonomic risk factors present at the work place, 42.7% (94) experienced backaches, 27.7% (61) muscle and joint pain, 16.4% (36) shoulder pain, 5.5% (12), 4.5% (10) neck pain and only 3.2% (7) reported headache. The fact that backache and muscle & joint pain occurred most frequently among the participants could be attributed to their work postures, as most of them either being in awkward posture or repetitive motion (**Plate 1**).

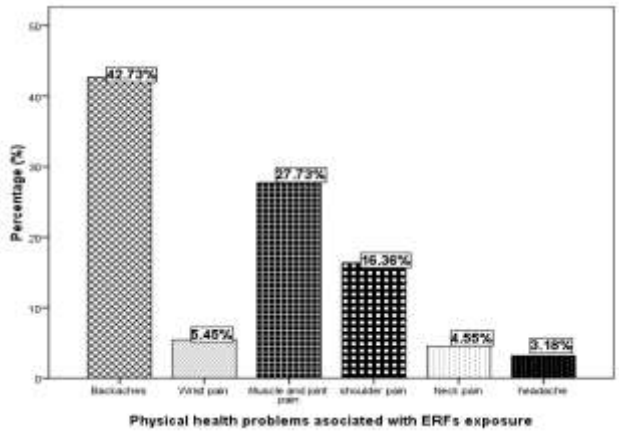

Figure 1: Physical health problems associated with ERFs exposure

Plate 1: Iron workers without PPE and in bending/stooping posture

A similar study by Latza (Latza 2000) revealed that back pain is most frequently injured or reported in construction sites. This result can be concluded as being attributed to manual handling when performing tasks.

The study sought to establish the main causes of accidents in the construction sites. From the findings, 116(52.56%) respondents mentioned that inappropriate work methods was the main cause of accidents in the construction sites, 44(19.87%) mentioned workers negligence, 49(22.44%) mentioned faulty equipment and 11(5.13%) mentioned workers incompetence. The appropriate selection of construction methods to be used during execution of construction project is major determinant of productivity and health and safety of workers. Hence, just like the study findings, appropriate work methods is the main factor affecting workers health and safety as well as their productivity (Thomas, 2010). Safe work methods are the employers' ways of identifying and controlling health and safety hazards and risks. It's important for an occupier to train his workers on appropriate work methods to avoid incidences of accidents occurrences. Just like safety plans, safety methods must be reviewed regularly to make sure they remain effective (Steve, 2013).

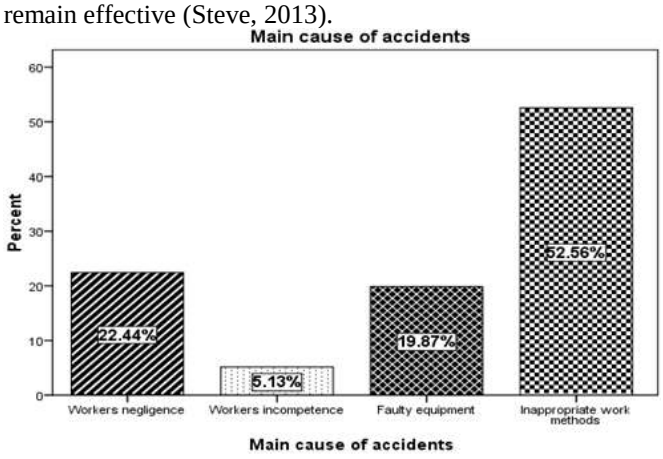

Figure 2: Causes of accidents on construction sites

The study also sought to establish the use of PPE in construction sites. A significant number of respondents (86.9%) did not have or use appropriate PPE **(Plate 2)**. The availability and usage of PPE was in connection with the type of work and the type of hazard a worker is subjected to. The OSHA (2007) stipulates that it is the responsibility of the occupier/contractor to provide safe working environment to the workers and this include the provision of appropriate PPE. The workers who were not utilizing the provided PPE stated that they did not feel comfortable using PPE because of weather (too hot) a result supported by Truong *et al*.,2009.

Plate 2: Roofer working without appropriate PPE

The study also wanted to establish if workers take breaks or rotation during work. The result obtained indicated that most respondents 193 (87.8%) take break during the day and only 27 (12.2%) do not take breaks. On further enquiry it was established that breaks are only granted by the supervisors/developers during lunch hour and work resumes thereafter. These workers reported that in most days they work between 10-12 hours a day. According to the Labor Act 2007, workers are required to work for 8 hours a day. Working long hours continuously without any break causes fatigue as well as safety and health problems (Roger, 2004). Fatigue impairs workers ability to perform, it affects judgment, productivity, work efficiency and quality. Fatigue may even lead to serious occupational accidents resulting in injury to workers and even loss of lives.

It was established that 86.3% of the respondents did not have job rotation. This means that they work for extremely longer period daily (NIOSH, 2004). Breaks is a vital element in every work productivity. In this study, it shows that workers value brakes and that its importance can be seen from their work performance. Contractors should endeavor to give their employees brakes and it minimizes fatigue and work stress and the same time prevent mistakes that can occur when working.

5. Conclusion

From the study, it can be concluded that construction workers are experiences ERFs every day during their task performance and hence making them susceptible to MSDs. In addition, this study concluded that due to unenforced OSHA 2007 Act, majority of the construction sites do not adhere to set regulations of protecting their workers on health and safety matters. Hence efforts should be made by relevant agencies to see to it that the already set regulation are followed to the later for the protection of construction workers.

6. Recommendations

The study recommends regular training of all the workers with regards to Ergonomic Risk Factors, and Work Related Musculoskeletal Disorders (MSDs).This should be conducted regularly by qualified professionals who are licensed by DOSHS. The training should encompass all matters relating to construction safety and health. The study further recommends the enforcement of both NCA 2011 and OSHA 2007 through adoption of a more proactive and comprehensive management mechanism to enforce the existing safety and health regulations in construction sites. In addition, the employers /owners of construction sites should play a key role in managing the safety and health programs in the construction sites.

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