

A Study on the Safety and Ergonomics for Construction Works in Chittagong

Muhammad, S., Amran, M.I.U.A., *Kabir, M.H., Hossain, M.M. and Kader, M.A.

Abstract - A large number of construction works are continuing everyday in Bangladesh as an emerging developing country where labor is plentiful and cheap. Ergonomics for construction works in Chittagong was carried out during June 2012 to November 2012 to observe the present status of practicing safety regulations and ergonomics principles by the constructions workers. A survey involving the use of questionnaire, participatory approaches, on-the-spot assessments and interviews were used as tools for investigation. The data collected were subjected to descriptive statistics. Those responding to the questionnaire had an average age of 30.1 years, 37% workers fall in the age range 20-30 years, worked an average of 42 weeks in a year, and had an average of 4.5 years work experience in building construction. The survey results indicated that low back pain back injuries constitutes 25% of total work related musculoskeletal symptom due to the manual handling of heavy materials followed by wrist and elbow injuries constitute 19.8% due to cutting operations. From the study it was found that total 19 construction workers reported seeing physicians for their musculoskeletal injury and 5.5% of total workers reported seeing physicians for lower back injury. Awkward postures, fixed posture, and working in the same position for long periods were identified as the leading causes of work-related musculoskeletal symptoms. Chi-square model showed that ergonomic risk factor prevails in all age ranges and major six works related musculoskeletal symptoms are not dependent on construction area.

Key words— Constructions, Ergonomics, Musculoskeletal Disorder, Ergonomics Risk Factor, Personal Protective Equipments, Safety

INTRODUCTION

The construction industry of Bangladesh has improved substantially during the last twenty years. About 10% of GDP of the country comes from this sector alone. It absorbs a very big labor force as well as enhances big job opportunities for engineers, architects, managers, foremen, supervisors, technicians, electricians, machine operators, drivers etc. At present this is a booming industry and people engaged in this sector are earning a reasonable salary and other benefits. And this is surprising to note that there is a dearth of trained personnel in this sector, in our country. Construction is a field of work that is very physically demanding. The work can be performed at a variety of different sites ranging from buildings and highways to demolition sites and tunnel excavations. Many construction workers have to control machines, move heavy objects, repair equipment, as well as monitor processes. This job requires an individual who has great manual dexterity as well as the ability to think quickly and intelligently. Since construction jobs are so demanding physically on a person's body, a variety of injuries can occur. Therefore it is important for employers to provide a safe environment for their construction workers.

There are regulations set by the government in the form of OSHA (The Occupational Safety and Health Organization) guidelines in order to ensure that all businesses follow a certain baseline of safety [1]. Construction-workers are the 'human capital' of the construction industry, and need particular care. This, related to the need for continuous improvement of skills (training), reduction of health risks and actualizing capacity and productivity (input/output) makes the construction worker appear as the centre of the construction industry [2]. Ergonomics combines knowledge of human abilities with that of tool design, equipment, and work organization. Occupational ergonomics has to do with the design or modification of the workplace and the organization of work to match the worker. The aim of occupational ergonomics is to decrease injuries at the workplace and to improve productivity. Ergonomics principles can be applied at many stages of work design. They can be used in tool and equipment design, work place layout, and the planning of work processes [3]. Numerous construction tasks pose significant risks to workers [4]. There are seven ergonomic risk factor (ERF) that have been identified on construction site that are awkward posture, force, static loading, vibration, repetition, contact stress and extreme temperature. It also shows that the most critical ERF on construction sites is vibration [5].

The most important safety, health, and ergonomically related problems in construction: accidents with construction tools; falling and tripping; manual handling, lifting, and carrying; noise; vibration; dust exposure; and poor design of tool interfaces [6]. Of the job factors which constituted major ergonomically related problems, the following were the top four

1. Bending or twisting the back
2. Staying in the same position for long periods
3. Working in the same position for long periods
4. Handling heavy materials or equipment

Research conducted among construction workers representing

*Corresponding author: Md. Humayain Kabir, Lecturer, Institute of Forestry & Environmental Sciences, University of Chittagong, Bangladesh, email: humayun@ifescu.ac.bd)

Saifullah Muhammad and Md. Iqram Uddin Al Amran are former MS student of Forestry, Institute of Forestry and Environmental Sciences, University of Chittagong-4331, Bangladesh (email: smsifescu@gmail.com, md.igramuddinalamran@gmail.com)

Mohammad Mozaffar Hossain, Professor, Institute of Forestry and Environmental Sciences, University of Chittagong, Chittagong, Bangladesh (email: mozaffarhm@yahoo.com)

Mohammad Abdul Kader, Lecturer, Department of Environmental Technology, Chittagong Polytechnic Institute, Chittagong, Bangladesh (email: makader.env@gmail.com)

six trades in the USA investigated inter alia, the extent to which 15 job factors constituted a problem on a scale of: minor-problem, minor-moderate problem, and major problem. Based upon a score out of 10, the following were determined to be the top five work-site problems resulting from little or no ergonomics input: working in the same position for long periods (5.7), bending or twisting the back in an awkward way (5.5), working in awkward or cramped positions (5.0), working when injured or hurt (4.7), and handling heavy materials or equipment (4.6) [7].

Work-Related Musculoskeletal Disorders (WMSDs)

When a muscle, tendon, nerve or joint is stressed and traumatized on a repeated basis for days, months or years, those body tissues eventually become damaged. This leads to a work related musculoskeletal disorder. Which are sometimes called repetitive strain injuries (RSIs), cumulative trauma disorders (CTDs) and overuse injuries [8].

When a WMSD develops a worker experiences:

1. Swelling, as tissues become irritated
2. Pain
3. Stiffness and loss of range of motion of surrounding joints.
4. Inability to work and function at home

Work-related musculoskeletal disorders (WMSDs) are the leading cause of disability for people in their working years.

METHODOLOGY

The research was conducted in three construction sites located in Chittagong City Corporation (CCC) and Chittagong University (CU) area during June 2012 to November 2012. Chittagong is the gate way and second largest city of Bangladesh with a substantial, self sustaining economic base which is lies between latitude 22°14' and 22° 24' 30" N Latitude and between 91°46' and 91° 53' E Latitude. The Chittagong University which lies between about 22°27'30" and 22°29'0" North latitudes and 91°46'30" and 91°47'45" East longitudes and covering about 509.24 ha land. [9]. To design an appropriate questionnaire, the researchers first conducted a reconnaissance survey in whole study area then the goes for collecting primary data. Total 90 workers were surveyed randomly from two study area of which 31 workers were surveyed from 5th Academic Building (Biological Science Faculty, CU) and its ancillary works at University of Chittagong, 34 workers from construction work of Law faculty at University of Chittagong and 25 workers from Chackreso Kanon (Baizid industrial area) under Chittagong City Corporation (CCC).

The chi-square distribution is used in the common chi-square tests for goodness of an observed distribution to a theoretical one, the independence of two criteria of classification of qualitative data, and in confidence estimation for a population standard deviation of a normal distribution from a sample standard deviation [10].

RESULTS AND DISCUSSION

Age structure of the worker

In this study total 90 male construction workers were surveyed from three different construction sites. Percentage distribution of age structure (Figure 1) of the worker which depicts that 37% of the worker fallen in the age class (20-30) years and 30% of the workers falls the age class bellow 20 years followed by age class (31-40) years and (41-50) years comprise 21% and 12% of workers respectively.

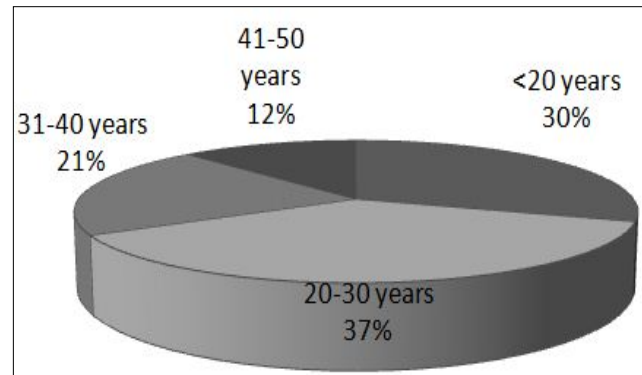


Figure 1. Percentage distribution of age structure of the worker

Construction work is labor intensive tedious job which require healthy, energetic and experienced worker. From Figure 2 it is seen that 37% worker fallen in (20-30) years age group which implies that construction work is suitable for middle aged people.

Personal protective equipments (PPE)

Construction firms found to provide gloves and dust mask in small quantity during the study time. According to the opinion of the construction workers, in studied area it was observed that most of the injury occurred due to the lack of personal protective equipments (PPE). In some case labor shows apathy to use PPE due to lack of awareness. In study area it was found that labor uses gloves when they engaged in steel finishing work and in heavy load work like handling rod and steel.

Table 1. Opinion of the worker on Personal Protective Equipments (PPE) used in construction area

Equipments	Opinion of the worker on PPE (%)		Availability of PPE (%)		Is PPE functioning (%)	
	Needed	Not needed	Yes	No	Yes	No
Helmet	66	34	10	90	00	100
Boots	40	60	05	95	00	100
Gloves	35	65	45	55	15	85
Eye protector	60	40	40	60	18	82
Ear protected	42	58	00	100	0	100
Dust mask	55	45	30	70	10	90

However, 66% worker think that helmet is needed and 60% of the workers demanding eye protector during rod cutting, steel finishing and steel tying task. 55% workers think that dust mask is needed and 42% worker opinion for ear protector is needed (Table 1). In the studied area it was found that most of the PPE are rarely provided by the construction firm and

workers show apathy to use PPE in working time.

At almost all companies, personal protective equipments were provided for staff and workers. Among the equipment provided the most cases is related to the safety helmets, gloves, safety shoes and safety harnesses; other equipment such as safety glasses are less supplied. It seems that the use of personal protective equipment is considered as an alternative way to control hazards and risks instead of eliminating hazards and reducing risks through more direct means. Personal protective equipment should be a last rather than first solution for risk management. But there are problems that overshadow the real role of these devices and their optimal implementation. Unfortunately, there is no legal obligation or supervision in the production, distribution and import of equipment and mainly low-grade products are made available for workers. Greater sophistication is needed with the design and use of personal protective equipment [11].

Safety Training

However, safety in construction area is burning issue in developing country like Bangladesh, from the study it is seen that no labor took any formal training from construction farm; they gather experience during the servicing period, which leads to the increasing rate of injury.

Training is one of the most important parameters of safety management. In construction sector, concerning hazardous nature of work, changing behavior and attitudes of workers toward potentially dangerous situations can be effective [11].

Mean age and mean experience of the worker

Mean age and mean experience of the workers were found 30.1 years and 4.5 years respectively (Figure 2). On the other hand mean age and mean experience of the unskilled workers are 28.7 years and 3.44 years, while mean experience of the skilled worker was found 6.15 years.

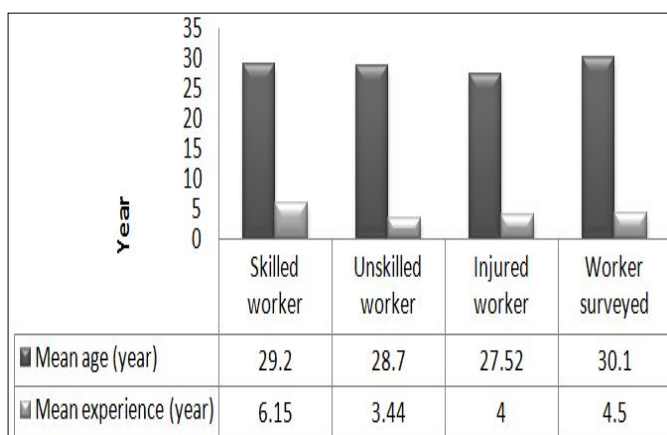


Figure 2. Categorization of worker based on mean age and mean experience

Mean age of the injured worker is 27.52 years which is lowest among other worker category. From the study it also found that workers worked an average of 42 weeks in a year.

Worker categorization based on age group

Figure 3, indicates the occupations categorized according to skills level. This categorization is most frequently used in the construction industry. Unskilled workers includes, for example general labor such as helper of the construction worker, scaffold erectors etc. Skilled workers included bricklayers, painter, rod cutter etc. From this it was found that 42% skilled worker fallen in 31-40 years age group which is the largest among different groups. On the otherhand 64% worker fallen in the 41-50 years age group.

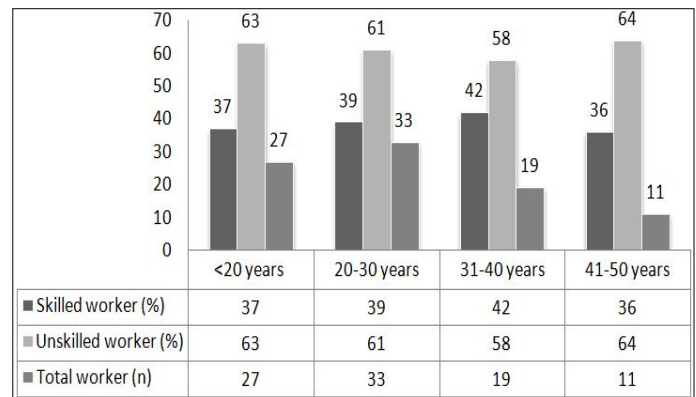


Figure 3. Skill categorization of the worker based on age group

Relationship between Age and Ergonomic Risk Factor (ERF)

In this segment, researchers tried to identify major age related ERFs using chi-square test which are liable for non-traumatic injury in construction site.

Test for independence

Table 2. Observed and expected frequency of the Ergonomic risk factors (non-traumatic injury) relative to age

Age class	Repetitive	Awkward Posture	Fixed Posture	Heavy work load	Total
<20	7 (6.75)	4 (4.22)	3 (3.09)	4 (3.94)	18
20-30	9 (9)	7 (5.63)	3 (4.13)	5 (5.25)	24
31-40	5 (5.63)	3 (3.515)	3 (2.58)	4 (3.28)	15
41-50	3 (2.63)	1 (1.64)	2 (1.20)	1 (1.53)	7
Total	24	15	11	14	64

Here, degree of freedom: 9

$\chi^2_{\text{actual}} = 2.0389$ and $\chi^2_{0.05, 0.95} = 16.92, 3.32$

From the above calculation it is seen that $\chi^2_{\text{actual}} < \chi^2_{\text{critical}}$, which implies major four ergonomic risk factors among different age class are independent, in other words these risk factors faced by different age range of the workers are prevalent on all age class of the worker.

Musculoskeletal symptom survey with major area of discomfort

From table 3 it is imply that most affected body part of the worker is low back pain which consist 25% of the total symp-

tom. Less injured body part of the worker is knee and elbow which consist 5.2 % of the total symptom. From Table 4 it also seen that total 19 worker visited doctor out of 90 workers were surveyed, it can also be seen that 5.5% of injured worker visited doctor for back pain, followed by upper back pain, wrist and feet injury which occupy 3.3% respectively. 1% of injured worker were visited doctor for elbow problem.

Table 3. Musculoskeletal symptom survey with major area of discomfort

Anatomical area of discomfort	Frequency of symptom	Percent with symptom	Frequency of visiting Physicians	Percent visiting Physicians
Neck	14	14.6	2	2.2
Shoulders	16	16.7	1	1.1
Upper back	11	11.5	3	3.3
Low back	24	25	5	5.5
Elbows	5	5.2	1	1
Wrist	14	14.6	3	3.3
Knee	5	5.2	1	1.1
Feet	7	7.3	3	3.3
Total	96	100	19	21.1

In a survey, more than one third of all respondents indicated that they had seen a physician for low back problems in the previous year, 11.5% reported missing work because of low back symptoms. The knees were the second most frequently reported work-related problem area [12].

Body parts injury in three construction area

In this segment of the research, researcher tried to identify whether major six problems in construction area dependent (test for independence) or not.

Test for independence

Table 4. observed and expected frequency of the body injury faced by the worker in construction area

Construction area	Body parts injured during construction works						Total
	Leg (Knee + Feet)	Low back	Upper back	Hand (Wrist + Elbow)	Shoulder	Neck	
Law faculty, CU	3 (5)	10 (10)	5 (4.58)	8 (7.9)	7 (6.67)	7 (5.8)	40
Biological faculty, CU	6 (3.88)	8 (7.78)	4 (3.55)	6 (6.14)	4 (5.17)	3 (4.5)	31
Chakreso kanon, CCC	3 (3.13)	6 (6.25)	2 (2.86)	5 (4.95)	5 (4.17)	4 (3.65)	25
Total	12	24	11	19	16	14	96

Here, degree of freedom: 10

$\chi^2_{\text{actual}} = 3.5696$ and $\chi^2_{0.05, 0.95} = 18.307, 3.94$

From the above calculation it is seen that $\chi^2_{\text{actual}} < \chi^2_{\text{critical}}$, that means the major six problems are construction area independent, in other words these injury occurred in different body parts are prevalent on three construction area.

CONCLUSION

Different construction agency and entrepreneurs have a difficult time being able to keep up with all the new regulations as

well as the proper safety equipment. Without designated safety personnel, it can become difficult to keep up training and education. This manual can provide small companies a few alternatives to particular injuries and the guidance necessary to implement an efficient safety plan.

WMSDs are very prevalent in manufacturing industries and it's a great challenge to mitigate this problem. The building construction industries of Bangladesh are no exception to this. Proper ergonomic intervention is a must to improve this situation. This thesis work has attempted to find out the major problems faced by the construction workers in construction work at CU campus and CCC area; there was no such attempt taken to work against WMSDs formally in the study area. The research has found out the major WMSDs and causes and recommendations are made which could be very handy in reducing the WMSDs and improving the health scenario. Work related specific injury and risk factor should be investigated prior to formulating and implementing ergonomic interventions in the construction work. These profiles can be used to assist with efficient and targeted intervention strategies. The next logical step in the ergonomic intervention process is to determine how specific tasks, processes, or tools can be modified to reduce the problematic job factors and decrease work-related musculoskeletal disorders. Further study is needed to develop efficacious interventions for the construction industry. The dynamics of this rapid urbanization in Bangladesh should be attributed to its demographic, economic and social fabric. Building construction is the most promising sector in Bangladesh. Proper care and surveillance may be taken to reduce the vulnerability of this sector. This sector will be much more beneficial for Bangladesh and this thesis paper can put some contribution to it.

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