CONSTRUCTION ERGONOMICS RELATED TO SAFETY

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ABSTRACT

Ergonomics is a significant factor in achieving and maintaining high levels of worker productivity and one of the procedures that eliminate the hazards and risk in construction industry. The aim of this paper is to assess and understand the level of ergonomics awareness in the construction industry and to identify current safety practices. The method used in collecting the data was by sites observations and Interviews with safety engineers, contractors and labors. The study indicates that strains and sprains are the most prevalent types of injury resulting in the back being the part of the body mainly affected. The majority of these injuries are due to overexertion in lifting and carrying heavy materials. In general, safety and ergonomics measurements in Gaza are not applied in construction firms; ignoring safety rules by the employers and lack of their knowledge of ergonomics principle are the main causes of real and fatal injury and illness. Ergonomics, work related musculoskeletal disorder, workplace, construction ergonomics, and good practices.

KEYWORDS: Ergonomics, workplace, construction ergonomics, and good practices.

INTRODUCTION

Ergonomics is a significant factor in achieving and maintaining high levels of worker productivity and healthy. Construction industry is one of the largest industries in Palestine, It is about 10 % of the nation product and there are a lot of workers employed in construction industry. construction employee work in cleaning and preparing the sites, digging, operating power tool, loading and unloading of material, mixing and placing concrete and also work at different times, evening weekend or holidays, to finish his work. These factors lead him to ergonomic risk and serious injuries such as strains, sprains and work related to musculoskeletal disorders that caused by carrying heavy loads, repetitive movement, awkward postures and contact stress vibration. Ergonomics one of the procedures that eliminate the hazards and risk in construction industry. The objective of this report is to provide an overview of ergonomic exposures in building construction work, to assess and understand the level of ergonomics awareness particularly in Gaza construction industry and to identify current safety practices associated with the prevention of ergonomic injuries and illnesses in the construction field.

LITERATURE REVIEW

Ergonomics background

Before speaking about construction ergonomics, a definition of ergonomics itself must be introduced. One of the definitions is ‘the since of fitting the job to the worker to avoid injuries and improve health, safety and comfort’ [1]. ‘Ergonomics is a science concerned with the ‘fit’ between people and their work. It puts people first, taking
account of their capabilities and limitations. Ergonomic aims to make sure that tasks, equipment, information and the environment suit each worker’ [2]. The OROSHA defines ergonomics as ‘The scientific study (Greek - nomos) of human work (Greek - ergon)’[3]. ‘The goal of the science of ergonomics is to find best fit between worker and job conditions. Ergonomic tries to come up with solutions to make sure workers stay safe, comfortable, and productive. These usually involve changing tools, equipment, materials, work method, or the workplace itself. Ergonomics is anew topic for the construction industry, but ideas have been around for many years’ [4]. Karwowski (2005) definition is’ A scientific discipline with a very broad scope and a wide range of interests and applications, encompassing all aspects of human activity, including labor, entertainment, reasoning, and dedication’ [5].

‘Ergonomics is fitting the task to the person. Too often employees perform job tasks that expose them to potential injuries and illness due to the poor design of a workstations or tool they are using. Ergonomics involves the assessment of job tasks to identify ergonomic risk factors and appropriate engineering or work practices controls to reduce or eliminate the identified risk factors. Generally, ergonomic changes are made to improve the fit between the demands of the job tasks and the capabilities of the employees’ [6]. The Occupational and Industrial Orthopaedic Center, NYU Hospital for Joint Diseases Orthopaedic Institute, Graduate Program in Ergonomics and Biomechanics (2003) said that ‘Ergonomics is the science that looks at the interaction between the laborer and the work that they do’[7]. ‘Ergonomics is the study of people while they use equipment in specific environments to perform certain tasks. Ergonomics seeks to minimize adverse effects of the environment upon people and thus to enable each person to maximize his or her contribution to a given job’ [8]. Ergonomics involves the application of knowledge about physiological psychological and biomechanical capabilities and limits of the human body [9]. ‘Ergonomics can be defined simply as the study of work. Ergonomic is the science of designing the job to fit the worker, rather than physically forcing the worker’s body to fit the job’ [10].

**Ergonomic risk factors**

‘Ergonomic risk factors are characteristics of a job that facilitate ergonomics stress on the body’ [11].We need to know about ergonomics to help employers if they work at manufacturing, construction, maritime, or agriculture. Risk factors occurs at different jobs and tasks. The greater exposed to these risk factors the greater probability of ergonomics injury and this what is called work related musculoskeletal disorders (WRMD). As mention in Department of Employment and Industrial Relations the main five ergonomics risk factors are [12]:

**Forceful exertions** which is include the quantity labor lifting ,how pushing ,pulling or using excessive force to perform tasks ,these tasks which required forceful exertion place higher loads on the muscles, tendons, ligaments, and joints. Force requirement may increase with:

- Increase weight of load handled or lifted.
- Increase bulkiness of the load handled or lifted.
- Used of awkward posture.
- The speed of movement.
- Increased slipperiness of the objects handled (requiring increased grip force).
- The presence of vibrations.
**Repetition** which is repeating the same movement through the workday (how often the employer perform the task), Repetitive actions as a risk factor can also depend on the body area and specific act being performed.

**Awkward postures** the body position determined which joints and muscles are used in an activity and amount of force used (spinal discs expose to more stress when lifting heavy object, other tasks requiring repeated or sustained bending of the wrists, knees, hips, or shoulders also increase stress on these joints).

**Vibration** occurs when a specific part of the body contact with vibration tool like operating heavy duty vehicles or large machinery.

**Duration** the amount of time person is continually expose to risk factor, and using the same muscle or motion increase the probability of WRMD.

And another factors like contact stress, sustained exertion, and extreme temperature.

**Ergonomics hazards control**
To Make effective ergonomic program we must target the risk factors appear on tasks and meet the needs of workers. Ergonomics program is a systematic process for anticipating, identifying, designing, developing, analysing and controlling ergonomics risk factors to ensure the health and safety of the workers.

Hagg(2003) describe Elements of ergonomics programmes [13]:

- **Workstation design and choice of tools**
  Hagg (Hagberg et al., 1995) agree that Even if definite limits still do not exist in many cases, there is a good basis for the identification of definitely adverse conditions.

- **Product design**
  The design of a product is essential for the working conditions when producing it, influencing the load on the workers as well as production costs and quality outcome.

- **Organisational design**
  Work organisation is an important part of the modern broad ergonomics concept. In particular, the opportunities for job variation, rotation and enlargement are of great importance for the prevention of MSD.

- **Quality aspects**
  Major point is that poor working conditions are related to quality deficiencies and vice versa. Thus, improved ergonomics is one way of achieving better quality.

- **Participative aspects**
  Hagg (Noro and Imada, 1991) agreed on the participation of the employees on all levels in the development of the work and its environment is another important concept in modern ergonomics. The worker is supposed to be an expert in what he/she is doing the whole day.

- **Health surveillance**
  Good health among the staff is a basic objective in ergonomics. Medical health care directly provided by the employer is common in many large corporations

- **Training and information.**
  A key issue when implementing an ergonomics programme in an enterprise is the training of the staff. In several programmes, the training efforts have been declared in more or less detail, aiming at various staff groups.
There are many types of ergonomics programs like orientation, ergonomics training, monthly/yearly inspection, risk assessment, ergonomics campaign, ergonomics representatives, publicity campaign and ergonomics topic of the month. Ergonomics program ought to contain basic of ergonomics principles, how to recognise symptom and risk factors of MSD. In addition, top management has to ensure optimum functioning of the system components (human operator, equipment, task, workplace, environment, management). Ergonomics program involving reactive and proactive measures have increase the ergonomics awareness among all levels of workers. Worker commitment can be achieve by training and education. The responsibilities of commitment are to identify and evaluate jobs, develop and implement solutions in managing issues related to MSD and to ensure appropriate use of human resources in the plant.

As mentioned in HSE, a lot of things workers can do to reduce ergonomic hazards like:

- Use lifting device to carry heavy loads.
- Don’t use the upper body or back to lift load, replace it with leg.
- Don’t twist the body during a lift step.
- Don’t work on knees if necessary, use knee pad.
- Avoid repeated twisting hands and wrists.
- Avoid stretching or unnecessary stress to do overhead work where possible.
- When using vibration tool wear gloves to help absorb energy.

### Ergonomics improvements

To improve the fit between a job and the capabilities of the employee performing ergonomics improvement must be implemented. We have three categories:

#### Engineering improvements

Contain rearranging, modifying, redesigning, or replacing tools, equipment, workstations. At the phase of planning it could be the best time to select engineering improvements. These improvements may reduce or eliminate the factor lead to workplace injuries effectively. ‘An example of an engineering improvement is raising or lowering the work surface for the employee, thus reducing bending, reaching and awkward postures. Other examples of engineering improvements include: using cut-out work surfaces to allow employees to get closer to their work; reducing visual effort and awkward postures; repositioning the work to reduce bending and reaching; and reconfiguring the work station to replace lifting and carrying with sliding and rolling. Providing adjustable equipment, providing close, convenient storage for frequently used materials, parts and tools, providing lifting aids and mechanical aids for transporting materials and products, all help reduce force, repetition and awkward positions in everyday tasks. Finally, providing tools with rounded, soft padded handles for employees reduces the pressure points on the hands and fingers’ [14].

#### Administrative improvements

Usually require to be managed continuously and employee feedback to be sure that the new practices and policies are effective. These improvements include change practices in work site or change the way of work is prepared. Some improvement options include a variety of jobs for each employee, controlling their work schedule and work pace, give them muscle relaxation time, and make sure about housekeeping and maintenance of work spaces, tools and equipment. Using signs to notice heavy or unstable loads and encouraging exercise, as well as training [15].
The use of safety gear, or personal protective equipment (PPE), includes gloves, knee and elbow pads, footwear and other protective items. It is wear to protect a specific body part and should be worn by employees at all times to reduce the risk of a MSD [16]. The level of ergonomics application and general awareness are low in many countries including Palestine. Furthermore, no specific statistic on ergonomics risk such as MSD and Carpal Tunnel Syndrome (CTS) to show the severity of ergonomics injury in Gaza. Hence, the emphasis is not yet placed within the core of the legislation even though some researchers mentioned that better health and well-being for employees are contribute towards improving productivity. It has been proven to play an important role in providing the safest and healthiest work environment possible for employees, and ergonomics is still not a hot issue to be considered by many companies. Existing national and international ergonomics standards and guidance have some deficiencies including narrow focus on some physical hazards, inadequate coverage of issues related to effective program implementation and inadequate attention given by document designers to document usability.

Methods and Procedures
To achieve the study objectives, first of all injury and illness trends in the construction fields have been researched. This research was conducted through many different sources: books, electronic copies of books, scholarly journals articles, magazines, abstracts from safety conferences, and web sites. Upon the completion of the literature reviews field observation is made to addressing the current workplace ergonomic issues in the construction industry by visiting some sites, observing workers and their practices on doing their jobs and what ergonomics issues they exposed to and by taking some supplementary photo to the way the worker done their work. After that Debriefing interviews were carried out with some workers, engineers, contractors, supervisors and managements at the end of each observation period where critical decisions and respective problem made by the workers during their work activity were reviewed. At the time of the observations, there were also informal interventions by the analysts to clarify some points, based on the questions used in the debriefing interviews. These conversations were transcribed along with the verbal communications of workers. Because the limitation on time depending on interview and observation only to reach to the result. This method is the best in our country because the lack of knowledge and existing information about this subject.

Results of safety and Ergonomics Programs
The companies were asked whether or not safety/ergonomics programs were maintained at their companies. All of the firms surveyed (8 of 8) had a written safety program, and no one of the firms had an ergonomics program. Thirty –eight percent of the respondents (3 of 8) said they had a lifting training program. No one of them had weight restrictions on single-person lifting. Of the eight companies no one indicated that they employed personal protective equipment (e.g. anti-vibration gloves) for vibrations. All of the firms surveyed (8 of 8) had at least one full time safety professional in their company. All participants expressed that there was a low level of concern and no matter if safety procedures were not adhered to.

Injuries and Illnesses
Companies were asked to give common injuries that occur on their work sites. Answers included sprain/strain, back injury, fractures, burns, cuts, and Carpal Tunnel Syndrome (CTS). Sprain/strain was the majority of the selected injuries totaling 32% (90 of 281 total cases) of the listed types of injuries. Back injury followed with 25%, and cuts made up 20% of the selected injuries. The other types of injuries reported contusions (7%), eye injury (8%), fractures (4%), and CTS (5%) (See Fig. 1).

![Figure (1): Number of injury cases by type of injury](image)

According to the result made in Wisconsin the majority also of injuries is sprain/strain it was 32% in We have more than them because the lack of knowledge in this field, at this study the writer explain that there is little spread of the best practice although they do the best to provide to labors all comfort ways and safe equipment we differ from them they have injuries in contusions equal to eye injury but at general we have the same order there is similarity in result [17].

And we asked about the source of injury answers included overexertion, motion/position, slip/trip, tools/machinery, and chemicals. The most prevalent source of injury was overexertion totaling 39% (92 of 235 total cases) of the selected sources, followed by motion/position (25%) and slip/trip (25%), respectively. Other sources included tools/machinery (6%), and chemicals (2%) (See Fig. 2).
Also at the same research they have 28% injury because overexertion, because our labor didn’t committed to safety and ergonomics measure we exceed them in number of injury. Labor didn’t know the effect of bad position of his body on his health it seen that at the result of investigation they need to training programmers to improve practices and lead them to good culture in do their job.

Thirty-eight percent of the respondents (3 of 8 companies) selected a range of 4-10 m as the most common distance traveled for a manual carry (see Fig. 3). Other responses included a range of 11-15 m (25%), 16-20 m (25%), less than 4 m (12%), and more than 20 m (0%), respectively. They differ from us that 44% respond that the distance 4-10 m and 36% from 11-15 m it is clear that our employee had the greater manual distance traveled and they only have 8% 16-20 m carrying distance we have 25% carrying distance.
this in the study done in Wisconsin this could be clear that this issue didn’t wide spread in this state like our country.

![Figure (4): Weight of load lifted/carried](image)

**CONCLUSION**

This study highlights that work in construction continues to have high potential risks for work-related musculoskeletal disorders and injuries, the report indicates that strains and sprains are the most prevalent types of injury resulting in the back being the part of the body mainly affected. The majority of these injuries are due to overexertion in lifting and carrying heavy materials.

The workplace health promotion will reach its aim if it is oriented along the following guidelines:

- Increase the knowledge among the construction employee by training and increase the understanding with the problems will caused by bad behaviour
- Establish organization to flow up all construction participants and apply some rules to follow
- A comprehensive approach is needed to handle the problem of musculoskeletal disorders among construction workers, especially those most affected.
- The construction workplace system model takes into account the technology used at the workplace, the organizational culture, the work environment, task, the planning and the individual worker. As far as the individual worker is concerned, it is his musculoskeletal health that is the focus.

With the implementation of an effective comprehensive ergonomics program, not only may the construction company’s health and safety improve, but also the company’s profits by decreasing the worksites related injuries and illnesses. However, it should be noted here that the results of the present study might be different from the other parts of the country when the survey is limited to one region. In the future, it is useful to make survey with a larger sampling of firms in an effort to develop a national database of ergonomic information for the construction industry. Overall, the findings of this study could still provide helpful direction and insights into ergonomic work practices.
RECOMMENDATION

Lifting hazards can vary from job site to another, thus lifting training programs must be site-specific. Adequate amounts of the proper mechanical material handling equipment such as forklifts and hand carts should be available so that workers do not feel they have to move everything manually. The employees should be trained on what material handling equipment is on-site, how they work and any other types that they could request if they feel it is necessary. Excessive hand and arm vibrations were another concern for the construction contractors. This is because there tends to be extensive usage of power tools on a daily basis. Without the proper protection, construction workers may develop injuries and diseases in the hands and arms, which can be painful and/or disabling. The most common type of personal protective equipment used when handing vibrating tools was anti-vibration gloves. These may help to lower the amount of vibration that affects the worker on a day-to-day basis. Using equipment that may produce less of a vibration would be the best solution before using personal protective equipment.

Findings of the interview also point out that all of the construction contractors did not have a site-specific ergonomics program. The application of ergonomic principles and methods is of primary importance for reducing the burden of occupationally related injuries and illnesses among construction workers. The construction workplace is always changing which makes it hard to reduce ergonomics injuries when new risks are created each day.

The solution for ergonomics in the construction buildings must contain these elements

- New materials
- New tools and equipment
- Improved work practices
- Improved work organization and planning
- Education and exercise
- Personal protective equipment

New materials

Construction materials have changed over the past few decades. Poured concrete has replaced a lot of brick walls. Sometimes the changes are beneficial from an ergonomic point of view. The trend in newer materials can be useful when lightweight materials are designed. The use of fibreglass ladders reduces the weight of handling compared with wood ladders. Plastic piping has also reduced the weight of materials for plumbers.

New tools and equipment

New tools and equipment are constantly being used to make construction work easier. These tools are designed to reduce the need for bending, allow for work from a standing height. Carts and dollies can be used to help move materials around a site and reduce the need of manual handling. Pulleys and hoists make it easier to lift materials. Power tools can be purchased with vibration dampening to reduce the amount of vibration transmitted to the hands. The design of any new tool or equipment should include on evaluation to demonstrate reduced risk of injury, at least, a reduction in risk-factor exposure.

Improved work practices

Improved work practices involve changing how the work is done. By substituting a scissors lift for a ladder, workers can get to overhead work more easily and position themselves closer to the work, requiring less work with arms above shoulder level. For those tasks where manual handling is unavoidable, teaching better work technique is important.
For example, lifting heavy bags from ground level should be done from a kneeling position by sliding the bag into the knee and then standing. Training in these techniques could help reduce the risk of musculoskeletal injuries although it is unclear at this point how effective such training is.

(The Occupational and Industrial Orthopaedic Center, NYU Hospital for Joint Diseases Orthopaedic Institute & Graduate Program in Ergonomics and Biomechanics 2003)

**Improved work organization and planning**
This means changing the way work is organized to reduce the risk of injury. The site managers, work supervisors and health and safety representatives have a major role to play in the proper planning of the construction work to make sure the work tasks gets done under healthy work conditions. They need to make sure that materials are delivered on time and as close to the work area where they will be used as possible. Sufficient materials handlers should be available to make sure workers are supplied with the materials and equipment they need when they need it. A proper break schedule is also critical. Insufficient rests lead to fatigue and reduce productivity as well as increasing risk of injury. The distribution of workload is another important work organization issue that needs to be addressed.

**Training and exercise**
In the last years the programs of the exercise or the warm of the muscle became very popular by construction workers from some countries from Europe. For increasing the flexibility/elasticity of muscles, increase the circulation to warm the muscles improving mental alertness, and reducing fatigue. When to stretch: prior to starting your day; during short breaks (at last once per hour) after breaks or lunch to prevent fatigue; if tension or stress is apparent, after lengthy task duration or an extended awkward posture. Labeling of the weights of materials to be manually handled may also help reduce the risk of musculoskeletal injuries. It has been suggested that construction materials be labeled where possible with the weight and color coded labels to indicate whether it is safe to lift manually and/or alone.

**Personal protective equipment (PPE)**
While some work can be modified to allow work to be done from a standing height, there will still be some work required at floor level. Kneeling will have to be done at some point. Large amounts of time spent kneeling has been correlated with knee disorders in
construction. The problem is that workers don't like to wear kneepads. The straps used to keep them on bind against the back of the legs and make them uncomfortable to wear.

**Shock absorbing shoe inserts**
To absorb some of the shock and stress of your feet against the hard ground, thereby lessening the amount that travels up your legs and to the spine.

**Anti-vibration gloves**
To lessen the amount of vibration that is passed from power tool to the hand and arm.

**Shoulder pad**
To protect the sensitive structures of the shoulder when carrying loads against that area and distribute the load across a larger area.

**Knee pads**
To lessen the amount of stress on the knee joint from the contact with a hard surface.

(The Occupational and Industrial Orthopaedic Center, NYU Hospital for Joint Diseases Orthopaedic Institute & Graduate Program in Ergonomics and Biomechanics 2003)

**LIMITATION OF THE STUDY**
Lack of knowledge of this issue in our country is the big problem it was difficult to collect data about this subject, limiting time is also cause to not include wider range of company to be more comprehensive and significant.

**REFERENCES**