

## **A Literature Review of Ergonomics Programs**

Haval M. Selki

*Civil Engineering, Ishik University, Erbil, Iraq*  
*havalcm1@gmail.com*

doi: 10.23918/iec2017.21

### **ABSTRACT**

Ergonomics can be defined as the study of work. It is the science of designing the job to fit the worker, rather than physically forcing the worker's body to fit the job. Ergonomic is not a new science, for the first time it was used in 1857 by a polish scholar. However it is still a new science for the most under developed countries including Iraq. The main aim of this study is overviewing of Ergonomic program. The objective is to define ergonomic clearly. From the study, it was found that ergonomic save money and improves quality, productivity, employee morale and create better safety culture. It is very essential that employees shall recognize the ergonomic risk factors and solutions to minimize such risks. The researched believes that the most important elements of successful ergonomic program are management and training program.

**Keywords:** Ergonomic, science, Job, Worker, money, quality, productivity, ergonomic risk factors.

### **1. INTRODUCTION**

Generally, term 'fit' between people and their work has been concerned by Ergonomic program since long time ago. Limitations and capabilities of people have been taking account as a priority. The main aims of Ergonomics are making sure of fitting workers with the environment, information, tasks and equipment (1, 2, 3 & 4). Based on many researchers, the common definition of Ergonomics is "the study of work" More specifically, "it is the science of designing the job to fit the worker, rather than physically forcing the worker's body to fit the job" (5, 6, 7, 8 & 9). It can be applied in many scientific disciplines such as industrial hygiene, psychology, kinesiology, physiology and anthropometry (10 & 11).

Additionally, Ergonomic is not a new science, it was firstly used by a polish scholar in 1857. However it is a new for the most under developed countries including Iraq. Inyang (12) believes that it is a global issue. The nature of work plays an important factor having risk level. Thus, the ergonomic is not only specified to one industry. Vice versa, it can be applied in many industry, for instance it is very useful program for construction industry to prevent or at least minimize the accident.

## **THE AIMS**

The main aim of this study is overviewing of Ergonomic program and studying ergonomic risk factors.

## **2. LITERATURE REVIEW**

### **2.1 HISTORY OF ERGONOMICS**

In fact, the term ergonomics comes from the two Greek words “ERGON” which means labour or work and “NOMOS” which means natural laws (13). In 1857, the word ERGONOMIC has been used for the first time by a Polish scholar which is called “Wojciech Jastrzębowski” and published a book with title “Ergonomics or Science of works” (14). Through the history, in the age of Roman, Egypt and Greek, the work related health problem always have been reported. Moreover, an Italian physician which is called “Bernardino Ramazzini” (1633-1714), he stressed that the most systematized from occupational health perspective is the right link between pathology and working condition.(15).

Another scientist from Poland which is called “Józefa Joteyko”, published a book in English and titled with “The Science of Labour and Its Organization”, in 1919. In his book occupational fatigue and principles have been explained in detail. In 1921, a good paper “Research of Efficiency: Ergonomics” was published by a Japanese scientist, Kan-ichi Tanaka (16). In the 1950s, many good textbooks have been published by American scholars such as Sanders, McCormick and Woodson. Another good book “Fitting the Task to the Man” published by Grandjean, in 1963 (17).

The “International Ergonomics Association” (IEA) was founded in 1959 (18), is one of the most famous organization which works on ergonomic program and it has published many manual, guidelines and papers related avoiding work related risks. In addition, many international conferences have been held by this organization every three years in different countries around the world including Birmingham, Stockholm, Sydney, Tokyo, Beijing and many mores.

### **2.2 MUSCULOSKELETAL DISORDERS (MSD)**

Any injury or disorder related to musculoskeletal system is called “musculoskeletal disorders” which the consequences of workplaces’ risk factors (19). The MS consists of bones, muscles, ligaments, tendons, joints ... etc (20). Alternative terms which have been used in other studies instead of MSDs are “Repetitive Strain Injury, Musculoskeletal Injury, Cumulative Trauma Disorder, Occupational Overuse Syndrome, or Strain or Sprain” (21). All parts of body likely to be impacted by MSDs including lower and upper limbs, for example feet, legs, wrists, shoulders, neck and so on (22).

## **2.3 ERGONOMICS RISK FACTORS**

Any biomechanical stress on the workers, resulted from their jobs or tasks is called ERF. The balance between Individual's ability and soft tissue fatigue is the key factor to be recovered from MSD's formation. To prevent such injuries, recognizing ergonomics principles is very important. Thus, employees shall be familiar with ERF in regards to their works and methods of reducing such hazards (23).

### **2.3.1 REPETITIVE MOTIONS**

For such tasks that have motion cycle less than a minute for a period more than two hours without taking rests, fatigue can occur and this will lead to accumulate muscle strain (24). Pain, visible swelling, numbness, red ness, loss of strength and flexibility of affected area, tingling are resulted in "repetitive motion disorder" (25).

### **2.3.2 POSTURE**

#### **a. Awkward Postures**

One of the primary ERF is awkward posture, when the working surface height is not correct, the worker is likely to expose awkward posture. Body's part could be affected seriously with working at too high which may need to put body part such as shoulders, neck, arms and so on in uncomfortable condition. Unlikely, working with too low surfaces will the lower back and neck in a terrible ways (26).

#### **b. Static Postures**

Unlike Awkward postures, Static postures means to keep a part of body for a period of time unmovable or when a part of body required to be stopped in movement for a period of time for such task. For instance, when someone works on computer for few hours without taking rests, it absolutely impacts his or her neck and leads to disorder (27).

### **2.3.3 VIBRATION**

When a part of body subjected to a vibrating object, it leads to injury and other health's discomforts. To give a clear example, fingers and wrists could be injured or subjected to some other health problem due to the using power hand tool without considering ergonomic principles. Another example, Loaders or excavators could be a source of whole body vibration to the operator, if he or she does not practice ergonomic program (28 & 29).

#### **2.3.4 EXCESSIVE FORCE**

Muscles, joints, ligaments and tendons could be overloaded or subjected to a higher mechanical load by working with high force. As a result, fatigue will occur and this will seriously impact of the capacity of physical works and reduce productivity of workers. Can cause acute effect or long term effect (chronic) if excessive load are not handled correctly. Example: Lifting heavy loads, pinch grips, operating levers/buttons (30).

#### **2.3.5 COMPRESSION OR CONTACT STRESS**

When soft tissues have been pressed by an object, compression will occurs. Obviously, when a small area of body affected by a force, it minimize nerve transition and blood flow of particular area and its soft tissues could be damaged. To give a clear examples; Leaning or pressing against hard edges, sharp surfaces, or corners; supporting excessive weight; Gripping tools (31).

#### **2.3.6 EXTREME TEMPERATURES**

Workers likely to expose various health issues when working in extreme temperatures. Hot temperatures can lead to dehydration and muscle fatigue, especially in conjunction with high humidity. Internal body temperature increases, when working in high-heat environment. Thus, blood circulation increases in order to regulate body's temperature. As a result, other major part of body such as brain and muscles will receive less blood it will reduce concentration and muscle strength and leads to fatigue in a short time. If this process last for long period or in other words the body attempts to cool down, it will spend more and more energy, increase reduce and reduce productivity rate (32). On the other hand, working in cold environment could be the source of many problems including sensory sensitivity, fatigue, reduced grip strength and dexterity, trouble breathing and so on (33)

#### **2.3.7 PSYCHO-SOCIAL ISSUES**

Psychosocial risk factors is about fitting between employees and their job demands, and also interaction among employees. Job controls, work demands, mental loads, and social supports can be the main sources of PRF. This could lead to sources of stress which increases muscle tension, decreases break frequency and directly impacts on work techniques. In short, Individuals' productivity can be impacted by PRF (34).

## 2.4 THE BASIC ELEMENTS OF ERGONOMIC PROGRAM IN ANY WORKPLACE

The main aim of safety program is eliminating or decreasing incidents, accidents and injuries by removing or reducing of their root causes. Based on many organization with good safety performance, ergonomic program is the best choice to achieve this goal. Having successful ergonomic program depend on several elements. Especially, training and education are considered as critical element of a successful ergonomic program, as it can familiarize workers with such principals such as risk identification, risk reduction, injuries management etc, which are essential for ergonomic improvement process. It can increase the worker's potential regarding skills, abilities and knowledge to execute their intended obligations. Besides training and education, management, employees' participation, development of solutions and program evaluation are also essential elements of successful ergonomic program (35). It can be seen in the following table (36).

TABLE 1.

Key elements in successful ergonomic program (Source: (37) )

Key elements	Successful ergonomic program
Management	Focusing the employer's belief on necessity of ergonomics program Appointing persons in charge for ergonomic program execution Establishing goals
Training	Increasing knowledge of ergonomic Improving skills & abilities in reducing ergonomic hazards
Employees participation	Enhancing Job satisfaction Enhancing motivation Creating team Improving communication
Program evaluation	Auditing of targeted performance Evaluating of program efficiency
Development of solution	Ergonomic hazards identification Controlling development to mitigate hazards Appropriate engineering Appropriate work practice controls PPE ( Personal Protective Equipment) Administrative controls

## 2.5 THE IMPORTANCE OF ERGONOMIC

- a. **Saves money:** Based on many studies, 1\$ out of 3\$ of worker compensation costs are due to MSDs related problem (38 & 39).
- b. **Improves productivity:** Increase the workability of labors by fitting the jobs to the workers (40).
- c. **Improves quality:** stress on training courses, emphases on using high quality tools and equipment. This leads to improve the skill of workers (41).
- d. **Improves employee engagement:** employees get interested when the company attempt to compliance with standard of health and safety. This increase morale and labor involvement. As a result, it reduces absenteeism and turnover (42).
- e. **Creates a better safety culture:** the cumulative of above point shows the commitment of company or employers and this change employees view towards safety to safety culture (43).

## 3. RESULTS AND DISCUSSION

As it has been mentioned, this study is based on the previous researches (paper review) to define ergonomic, describe ERF in brief. The writer has explored many reliable sources including books, journals, electronic reports, safety guide and so on. As a result, the researcher summarized ERF and divided by three to upper limb, Vertebra and lower limb. In each part, he illustrated in a way to be simple and clear for readers. For instance, any injury occurs, its symptoms ERFs and diseases' names have been showed and also who will be affected. For further detail see figure (1, 2 &3).

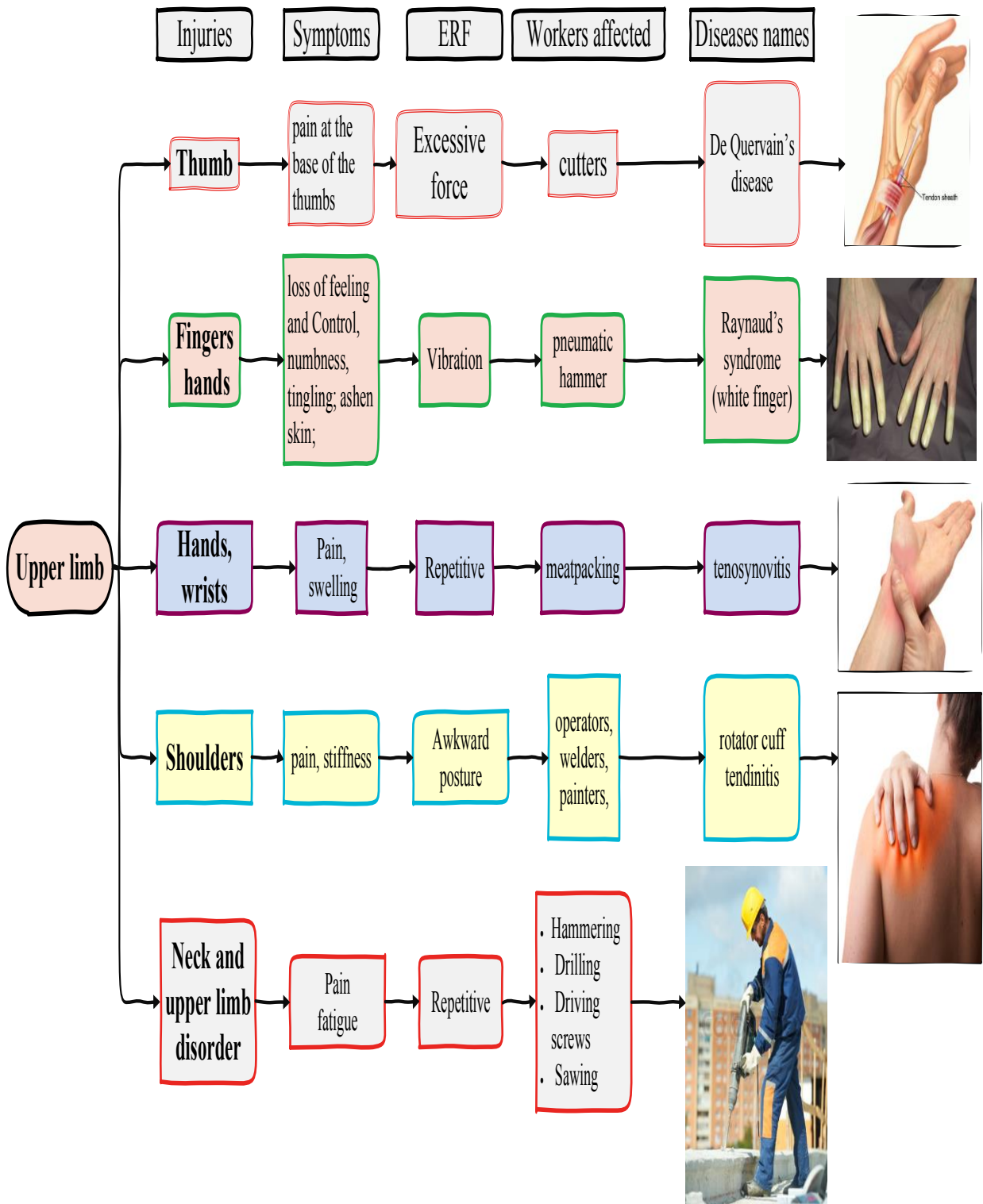


FIGURE 1. Musculoskeletal Disorders examples, Upper Limb.

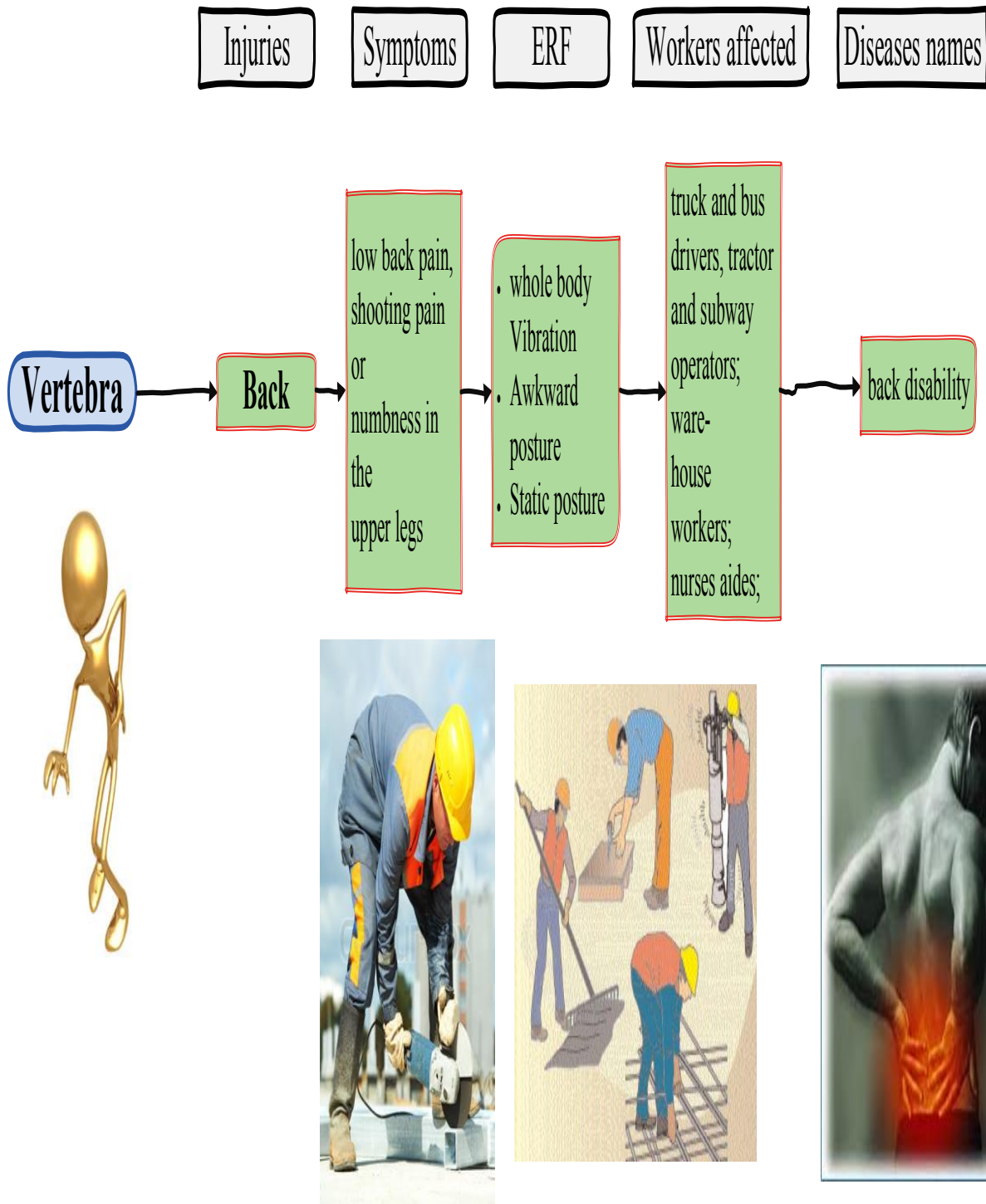


FIGURE 2. Ergonomic Risk Factors, Vertebra Limb.



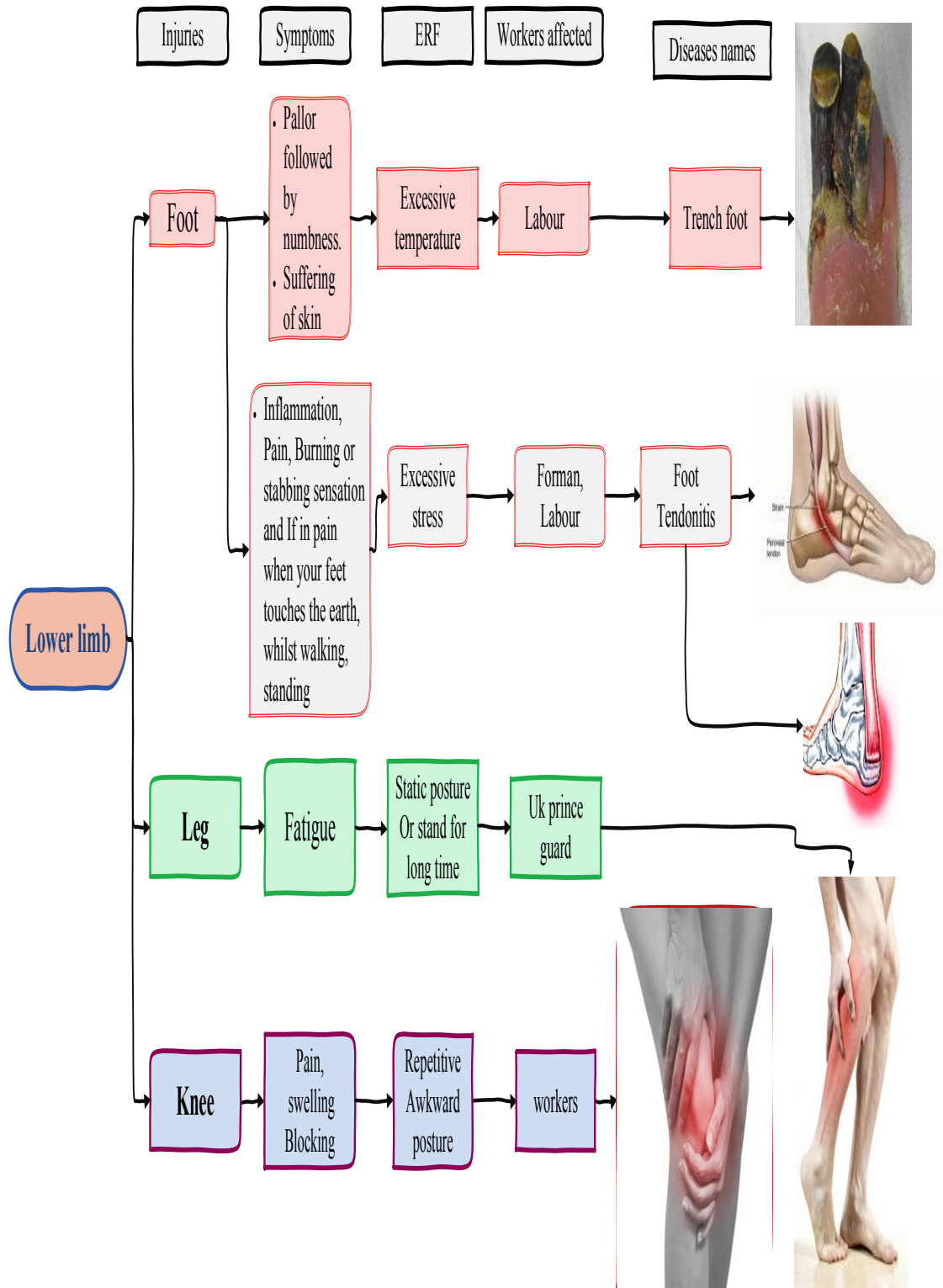


FIGURE 3. Ergonomic Risk Factors, lower Limb.

#### **4. CONCLUSION AND RECOMMENDATIONS**

In conclusion, as it has been mentioned, Ergonomics is “the study of work”, the term ‘fit’ between people and their work has been concerned by Ergonomic program since long time ago. Limitations and capabilities of people have been taking account as a priority. The main aims of Ergonomics are making sure of fitting workers with the environment, information, tasks and equipment. Based on this, each employee needs to understand the ergonomic risk factors related to his or her work tasks and solutions to minimize such risks namely “repetitive motions, awkward postures, static postures, vibration, excessive force, compression or contact stress, extreme temperatures, psycho-social issues”. To mitigate or avoid those risks, it is the responsibility of employers and employees to cooperate each other to have successful ergonomic program. First of all, management must establish goals to achieve ergonomic principles. Secondly, the key elements of any ergonomic program is training in order to enhance ergonomic program and improve skills and abilities in reducing work related hazards. From previous studies, Ergonomic improve the morale of employees and this leads to have a better quality and reduces errors which improves productivity. Eventually, it save a big amount of money which considered as 30% of total worker compensation costs.

## REFERENCES

- [1] Ergonomics Definition. safe computing tips. [Online] Sept. 3, 2016. <http://www.safecomputingtips.com/ergonomics-definition/>.
- [2] Simple Definition of ergonomics. Merriam-Webster. [Online] 2016. <http://www.merriam-webster.com/dictionary/ergonomics>.
- [3] Bridger, R. S. Introduction to Ergonomics. Third. s.l. : Taylor & Francis, 2009.
- [4] Ergonomic. Canadian Centre for Occupational Health & Safety. [Online] 2016. <https://www.ccohs.ca/oshanswers/ergonomics/>.
- [5] OSHA. Ergonomics: The Study of Work. Washington : U.S. Department of Labor, 2000.
- [6] Human Factors and Ergonomics Society. [Online] Tecra Systems, Inc., Sept. 3, 2016. <http://www.hfes.org/web/educationalresources/hfedefinitionsmain.html>.
- [7] Defining Ergonomics/Human Factors. Dempsey, P. Wogalter, M. and Hancock, P. s.l. : Taylor & Francis Group, LLC, 2006.
- [8] New developments concerning the occupational safety and health act. Te-Hsin, P. and Kleiner, B. 201, Journal of Managerial law, pp. 138-146.
- [9] Pritchard, B. The Study of Ergonomics. s.l. : Ezinearticle, 2006.
- [10] Ergonomic Analysis and the Need for Its Integration for Planning and Assessing Construction Tasks. Inyang, N., et al. 2012, Journal of Construction Engineering and Management, pp. 1370-1376.
- [11] Applying ergonomics to systems: Some documented “lessons learned”. Hendrick, H. K. 2008, Applied Ergonomics, pp. 418-428.
- [12] Ergonomic Analysis and the Need for Its Integration for Planning and Assessing Construction Tasks. Inyang, M., et al. 2012, JOURNAL OF CONSTRUCTION ENGINEERING AND MANAGEMENT , pp. 1370-1376.
- [13] Ergonomics and Usability – key factors in Knowledge Society. Nunes, I. L. Monte de Caparica, Portugal : New University Lisbon, 2006. International Conference on Foresight Studies on Work in the Knowledge Society. p. 88.
- [14] Budnick, P. A Brief History of Ergonomics ... or Human Factors. 2012.
- [15] Japan Ergonomic Society. History of Ergonomics. [Online] 2016. [https://www.ergonomics.jp/e\\_index/e\\_outline/e\\_ergono-history.html](https://www.ergonomics.jp/e_index/e_outline/e_ergono-history.html).
- [16] Arezes, M. P. and Carvalho, P. V., [ed.]. Ergonomics and Human Factors in Safety Management. s.l. : Taylor & Francis Group, 2016. p. 122.

- [17] Meister, D. The History of Human Factors and Ergonomics. USA : Lawrence Erlbaum Associates, 1999.
- [18] Ilkka, K. and Liu, D. History of the International Ergonomic Association: The first Quarter of a Century. s.l. : the IEA, 2000.
- [19] Sanders, M. J. Ergonomics and the Management of Musculoskeletal Disorders. s.l. : Butterworth-Heinemann, 2003.
- [20] Sandra, Q. Quantifying Localized Muscle Fatigue of the Forearm during Simulations of High Pressure Cleaning Lance Tasks. Blacksburg : Virginia Polytechnic Institute and State University, MSc., 2005.
- [21] Musculoskeletal Disorders. Toronto : Public Services Health & Safety Association, 2010.
- [22] Wigham, R. How to Avoid MSD's at Work. s.l. : SafeWorkers, 2015.
- [23] Ergonomics: Risk Factors. Blink. [Online] UC San Diego, 2016. <http://blink.ucsd.edu/safety/occupational/ergonomics/awareness.html>.
- [24] HSA. Ergonomics in the Workplace. 2008. p. 11.
- [25] Eustice, C. What Are Repetitive Motion Disorders? s.l. : VeryWell, 2016.
- [26] EHS. Awkward Postures. Iowa State University. [Online] 2015. <https://www-ehs.sws.iastate.edu/occupational/ergonomics/awkward-postures>.
- [27] Chaffin, B., Andersson, G. and Martin, B. Occupational Biomechanics. Forth. s.l. : Wiley, 2006.
- [28] Myers, J. Ergonomic risk factors. s.l. : University of Cape Town, 2015.
- [29] HSE. Vibration at Work. HSE. [Online] 2016. <http://www.hse.gov.uk/vibration/>.
- [30] OSHA. Ergonomic. Occupational Safety and Health Administration. [Online] 2016. <https://www.osha.gov/SLTC/ergonomics/identifyprobs.html>.
- [31] Reiher, M. and Krajewsk, J. T. MSD Risk Factors – Contact Stress & Torque Reaction. 2012.
- [32] Torma-Krajewski, J., et al. Ergonomics and Risk Factor Awareness Training for Miners. s.l. : CreateSpace, 2008.
- [33] Yale. Extreme Temperatures. s.l. : Yale University, 2016.
- [34] Taylor, K. and Green, N. Psychosocial risk factors: what are they and why are they important? s.l. : Wellnomics, 2015.

- [35] Ergonomics principles and utilizing it as a remedy for probable work related injuries in construction projects. Shoubi, M., Barough, A. and Rasouljavaheri, A. 1, 2013, International Journal of Advances in Engineering & Technology, Vol. 6, pp. 232-245.
- [36] Cohen, A. Elements Of Ergonomics Programs: A Primer Based On Workplace Evaluations Of Musculoskeletal Disorders. s.l. : Diane Pub Co, 1997.
- [37] Ergonomic Principles and utilizing it as a remedy for probable worke related injuryI in construction project. Shoubi, M. V., Barough, A. S. and Rasouljavaheri, A. 2013, International Journal of Advances in Engineering & Technology.
- [38] Oregon OSHA. Oregon OSHA. [Online] 2016. <http://www.cbs.state.or.us/osha/pdf/ergo/ergoadvantages.pdf>.
- [39] Rajyalaksmi, G. Ergonomics in workplace. 2013.
- [40] Electronics, EMI Ltd. Ergonomics-costs and benefits. UK : National Institutes of Health, 2003.
- [41] Tamara, M. AN EROGONOMIC JOB ANALYSIS OF A WORK PROCESS WITHIN A GLOVEBOX. s.l. : New Jersey Institute of Technology, MSc thesis, 2006.
- [42] Bhattacharya, A. and McGlothlin, J., [ed.]. Occupational Ergonomics: Theory and Applications. 2nd. s.l. : Taylor & Francis Group, 2011.
- [43] Middlesworth, M. 5 Proven Benefits of Ergonomics in the Workplace. s.l. : Ergonomics Plus, 2015.
- [44] Nunes, Isabel Lopes. Ergonomics and Usability – key factors in Knowledge Society. Portugal : New University Lisbon/Faculty Sciences Technology, 2006.
- [45] Ergonomics the study of work. US : U.S. Department of Labor / Occupational Safety and Health Administration, 2000.
- [46] Middlesworth, Mark. Ergonomics plus. Ergonomics plus. [Online] 2016. <http://ergo-plus.com/ergonomic-risk-factors/>.