RISK MANAGEMENT OF MUSCULOSKELETAL DISORDERS AND ERGONOMIC RISK FACTORS IN BAKERY MANUFACTURING INDUSTRY

SITI NOR HIDAYAH BINTI NORDIN

Thesis submitted in fulfillment of the requirements
for the award of the degree of Bachelor of Occupational Safety and Health

Faculty of Engineering Technology

UNIVERSITI MALAYSIA PAHANG

JANUARY 2017

UNIVERSITI MALAYSIA PAHANG

DECLARATION OF THESIS AND COPYRIGHT

Author's Full Name : SITI NOR HIDAYAH BINTI NORDIN

Date of Birth : 08 NOVEMBER 1994

Title : RISK MANAGEMENT OF MUSCULOSKELETAL DISORDERS AND ERGONOMIC RISK FACTORS IN BAKERY MANUFACTURING

Academic Session : 2016/2017

I declare that this thesis is classified as:

☐ CONFIDENTIAL	(Contains confidential information under the Official Secret Act 1997)*
☐ RESTRICTED	(Contains restricted information as specified by the organization where research was done)*
☑ OPEN ACCESS	I agree that my thesis to be published as online open access (Full Text)

I acknowledge that Universiti Malaysia Pahang reserves the following rights:

1. The Thesis is the Property of Universiti Malaysia Pahang
2. The Library of Universiti Malaysia Pahang has the right to make copies of the thesis for the purpose of research only.
3. The Library has the right to make copies of the thesis for academic exchange.

Certified by:

(Student's Signature)

941108-11-5294

New IC/Passport Number

Date: 16 / 1 / 2017

(Supervisor's Signature)

Name of Supervisor

Date:

NOTE : * If the thesis is CONFIDENTIAL or RESTRICTED, please attach a thesis declaration letter.

SUPERVISOR'S DECLARATION

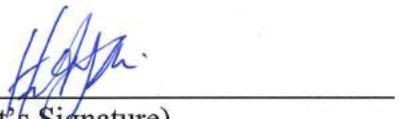
I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of Occupational Safety and Health.

_____

(Supervisor's Signature)
Full Name :DR.NORAZURA BINTI ISMAIL
Position :LECTURER
Date : 15 JANUARY 2016

STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.



(Student's Signature)
Full Name : SITI NOR HIDAYAH BINTI NORDIN
ID Number : PA13039
Date :15 JANUARY 2016

ACKNOWLEDGEMENT

I would like to ALLAH S.W.T for everything along completing the thesis. Every difficulty can be managed properly with the strength given by Him. Without Him, thesis cannot be completed in the meantime. I am also thanks to my supervisor, Dr. Norazura binti Ismail for giving me this opportunity to conduct the thesis and supervise me in writing. I am also appreciate all the guidance, and feedback given from her.

Next, I would like to thank my parents and family for every support in overcoming numerous obstacles during completion of this project. Thousand thanks also given to my friends who always help me by giving any opinion regarding my thesis and correct the way I'm doing my work. Lastly, thanks for bakery respondent for their willingness to take part in this study. Without them, I will not be able to collect information that required in this study.

ABSTRAK

Satu kajian tentang pengurusan risiko di industri bakeri dijalankan untuk mengenal pasti faktor-faktor risiko ergonomik dalam proses-proses kerja, kelaziman MSDs di kalangan pekerja, hubungan antara sakit MSDs dengan factor risiko ergonomik. Seramai 44 pekerja bakeri telah mengambil bahagian dalam kajian ini. Kajian ini menggunakan pendekatan soal jawab untuk mengenalpasti kelaziman MSDs. Analisis postur badan dilakukan bagi menggenalpasti tahap risiko postur badan. Senarai semak digunakan untuk mengenalpasti factor-faktor yang boleh membawa kepada masalah ergonomic dalam proses kerja. Kajian ini menunjukkan risiko paling tinggi terletak pada proses kerja menghiris dan membungkus produk dengan peratus (leher = 38.1%), (bahu = 28.6%), (pergelangan tangan / tangan = 45.0%), (belakang atas = 47.1%) dan (paha = 42.9%) disebabkan beberapa factor seperti mengangkat objek melebihi paras bahu, mengangkat objek >30 cm dan pergerakan berulang. Proses membakar dan menghias mempunyai kelaziman sakit badan yang paling rendah dengan (pergelangan tangan/tangan=25.0%), (siku=35.0%) dan (leher=28.6%).Umur, jantina dan tempoh pekerjaan mempunyai kesan yang paling tinggi ke atas kelaziman untuk sakit MSDs di semua kawasan badan dengan $p < 0.05$. Keputusan dari kajian ini menunjukkan bahagian atas badan menyebabkan tanda-tanda awal MSDs. Oleh itu, bakeri perlu menjalankan intervesi program dengan menyediakan pemegang yang sesuai, teknik berdiri dan duduk dengan betul dan kerja bergilir-gilir.

ABSTRACT

A cross-sectional study of risk management at bakery industry was conducted to identify the ergonomic risk factors in the work processes, the prevalence of MSDs among workers and its relationship with the ergonomic risk factors. A total of 44 bakery workers took part in the study. Methodology used in this study involving questionnaire to analyze prevalence of MSDs. Postural analysis was done to determine risk level of posture. While checklist used to determine the associated ergonomic risk factors. This study shows the higher prevalence occurred in slicing and wrapping last product (neck= 38.1%), (wrist/hand=45.0%), (shoulders=28.6 %), (upper back=47.1%) and (hips/thigh =42.9%) due to combination of lifting object above shoulder level, lifting object >30 cm horizontally and repetitive motion. Baking and decoration had the lowest prevalence of body pain (wrist/hand=25.0%), (elbow=35.0%) and neck (28.6%). Respondents' age, gender and duration of employment significantly influenced the prevalence of MSD at all body region. This study shows the workers were experiencing mostly the upper limb as compared to lower limb. Therefore, bakery should take into account by providing proper handhold, educate correct siting and standing techniques and also implement job rotation.

TABLE OF CONTENT

CHAPTER 2 LITERATURE REVIEW

CHAPTER 3 METHODOLOGY

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

x^2	Chi Square for Independent Test
p-value	Test for significant of study

LIST OF ABBREVIATIONS

OSHA	Occupational Safety and Health
SPSS	Statistical Package Science Software
MSDS	Musculoskeletal Disorder
SOCSO	Social Security Organization
REBA	Rapid Entire Body Assessment
SME	Small-Medium enterprise
CTD	Cumulative Trauma Disorder
WHO	World Health organization
SNQ	Standardized Nordic Questionnaire
IEA	International Ergonomic Association
WSHC	Workplace Safety and Health Council

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This chapter provides the general ideas on the matter which were being studied including problem statement, objectives of study, hypothesis, research questions, significance of study, scope of study, expected results, conceptual framework and definition of variables.

1.2 BACKGROUND OF STUDY

Small and Medium Enterprise (SME) was one of the important industry in Malaysia that mostly the work process was done manually. According to SME Corporation Malaysia (2016), SMEs defined as firms with sales turnover not exceeding RM50 million with less than 150 workers or number of full-time employees not exceeding 200. Bakery manufacturing industry is categorized as one of the SME that use mostly manual work in their work processes such as baking the bread, mixing the flour, and packaging the product to be delivered to customer. In SME, ergonomics related problems are one of the main issues that have not been fully concerned (Marquez et al. 2006).

According to United States Legal Definition (2016), ergonomics can be defined as the process of changing the work environment including equipment, furniture and pace of work to fit the physical requirements and limitations of employees rather than forcing workers to adapt to jobs that can cause debilitating effect on their physical well-being. Human contribution as manual work resource was still dominant in current

manufacturing activities. Manual use of equipment rather than use machineries most preferred due to low cost and high flexibility to manage simple work. However, manual work lead to ergonomic problem higher than by using automatic equipment because it was involving human factor (Md. Deros et al. 2010).

A study done among production line workers in printing industry showed that there was high prevalence of musculoskeletal disorder with a high proportion experiencing symptoms in the lower back, shoulders, knees, and neck which having the same scope of work as in bakery manufacturing (Marques et al. 2012). Musculoskeletal disorders (MSDs) were one of the ergonomic problems that existed in the workplace. MSDs mainly affected workers who were exposed to extreme work pressure or work in unsystematically workplace designation. There were several factors which give influence to the increase of MSDs risk such as repetitive motion, awkward posture, and standing for a long period of time (Qutubuddin et al. 2013). Workers were at risk of musculoskeletal disorder problems when they exposed to working environment that require them to perform similar tasks repetitively, exerted higher forces to work and being in the same posture in long period of times such as firefighters, bakery workers, factories workers and office workers. These factors determine which work area that exposed to MSDs problems respectively. MSDs mostly affect human body regions including lower extremities and upper extremities.

1.3 PROBLEM STATEMENT

Based on research done by Mehrizi et al., (2014), there was high prevalence of Cumulative Trauma Disorder (CTD) among averagely 30 years old bakers in Iran. There were 298 subjects were experiencing CTD in neck, shoulder, wrist, hand and lumbar. The latest estimates from the Labour Force Survey (2015) show that in Great Britain, elevated rates of musculoskeletal disorders were seen in occupations across the above industries such as health and caring occupations, skilled agricultural and construction trades and postal workers. The total number of musculoskeletal disorder cases in 2014 and 2015 was 553,000 out of a total of 1,243,000 for all work related illnesses, 44% of the total (Labour Force Survey, 2015).

According to Social Security Organization (SOCSO), occupational musculoskeletal disease statistic showed increasing number of cases reported which was 448 cases in 2012, 517 cases in 2013 and 675 cases in 2014. The effects of musculoskeletal disorder due to ergonomic problems range from simple discomfort to life threatening such as permanent disability (Marquez et al. 2006). Generally, the safety compliance level of Small Medium Enterprise still not satisfactory due to lack of awareness in safety management system (Rabiul, 2002). The increased recognition of musculoskeletal disorder hazard to workers, especially in bakery manufacturing had been stimulated concern among government, employers and workers (Alexopoulos et al. 2009).

1.4 OBJECTIVES

1.4.1 General Objective

To assess the ergonomic risk associated with musculoskeletal disorders in order to propose the appropriate ergonomic intervention programme for the selected bakery.

1.4.2 Specific Objective

1.4.2.1 To determine the prevalence of musculoskeletal disorders symptoms among workers in bakery industry.

1.4.2.2 To investigate the association between ergonomic risk factors and musculoskeletal disorders symptoms among bakery workers.

1.4.2.3 To propose appropriate ergonomic intervention program in relation to ergonomic problem identified in the selected bakery.

1.5 RESEARCH QUESTION

1.5.1 What is the prevalence of musculoskeletal disorders among workers in bakery industry?

1.5.2 What are the risk factors associated with musculoskeletal disorders symptoms among workers in bakery workers?

1.5.3 What is the appropriate control measure related to ergonomic problem identified among bakery workers?

1.6 RESEARCH HYPOTHESIS

H_0: There is no significant association between ergonomic risk factors with musculoskeletal disorder symptoms among workers in bakery industry.

H_1: There is significant association between ergonomic risk factors with musculoskeletal disorder symptoms among workers in bakery industry.

1.7 SCOPE OF STUDY

The study was focusing on the bakery workers who were working in production line that consists of different work processes namely mixing, dividing and shaping dough, baking various types of bread and decorating, slicing and wrapping finished products. The respondent of this study randomly selected from a bakery located in Besut. Ergonomic risk factors such as awkward posture, repetitive motion and prolonged standing observed among the workers which can lead to musculoskeletal disorder while handling the job task. All respondents involved in data collection activities using several methods including Industrial Ergonomics Screening Checklist, Standardize Nordic Questionnaire (SNQ) and Rapid Entire Body Assessment (REBA). Lastly, the appropriate ergonomic intervention was proposed based on the ergonomic risk assessment for each work process using Worker Safety and Health Guidelines.

1.8 EXPECTED RESULT

Ergonomic risk factors associated with musculoskeletal disorders among workers in the selected bakery industry can be identified including awkward posture, repetitive motion and prolonged standing. Besides, the prevalence of musculoskeletal disorders also can be determined among workers such as discomfort or pain in the shoulders, neck, upper and lower back, range of motion loss and tingling particularly in the hands and finger. Thus, appropriate ergonomic intervention proposed to reduce ergonomic problems among bakery workers for short term and long term application.

1.9 SIGNIFICANCE OF STUDY

The ergonomic risk factors associated with musculoskeletal disorders among bakery workers investigated in several work stations. This study was conducted to determine the prevalence of musculoskeletal disorder symptoms among worker and provide comprehensive data on ergonomic problems associated with musculoskeletal disorders in each work process. This study also help to determine which work processes are at risk so that an appropriate ergonomic intervention programme can be proposed based on the assessment conducted.

1.10 CONCEPTUAL FRAMEWORK

Figure 1.1 shows the risk factors associated with musculoskeletal disorders among the bakery workers in several work process namely mixing, dividing and shaping dough, baking various types of bread and decorating, slicing and wrapping finished products. Most of the workers performed their work manually. Thus, they were exposed to ergonomic risk factors such as awkward posture, repetitive motion and prolonged standing.

Meanwhile, individual factors such as age, duration of working in daily day, and duration of work experience also lead to MSDs problems which affected various areas

of the body such as neck, shoulders, upper back, elbows, lower back, wrists or hands, hips or thighs, knees, ankles and feet.

These effects observed for short term and long term duration through various approach including ergonomic screening checklist, Nordic Questionnaire and Rapid Entire Body Assessment. From this observation, further assessment done to propose appropriate intervention programme in order to reduce the ergonomic risk associated with MSDs problems in bakery industry.

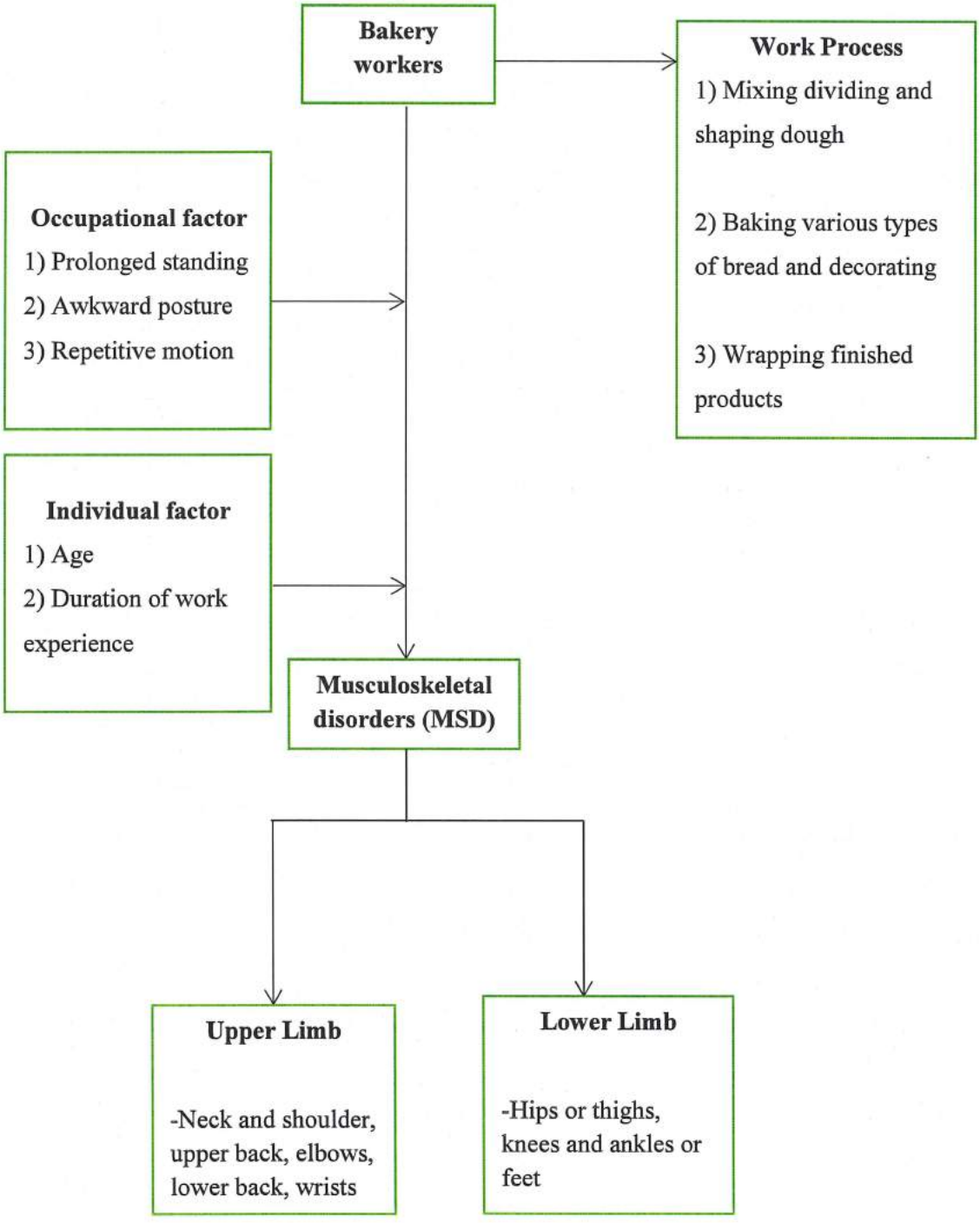


Figure 1.1: Risk factors associated with musculoskeletal disorders among bakery workers

1.11 CONCEPTUAL AND OPERATIONAL DEFINITION

1.11.1 Bakery Worker

Conceptual Definition: Job task done by manual work is mainly by operators on the production lines, operators supervising the production flow, and material handling (Willquist & Törner, 2003).

Operational Definition: Work performed in different work process such as mixing, dividing and shaping dough, baking various types of bread and decorating, slicing and wrapping finished products (Khatkar, n.d.).

1.11.2 Occupational Factor

Conceptual Definition: Chemical, physical, biological or other agent that may cause harm to an exposed person in the workplace and is potentially modifiable (Majid et al., 2004).

Operational Definition: Activities such as manual material handling (MMH) including heavy load lifting, lowering, carrying, pulling and pushing lead to awkward postures, repetitive motion and prolonged standing (Nejad et al., 2013).

1.11.3 Individual Factor

Conceptual Definition: A personal factor is any attribute, characteristic or exposure of an individual that increases the likelihood of developing a disease or injury (WHO, 2014).

Operational Definition: Personal characteristics which can be a risk factor such as age, working hour and duration of work experience (Alexopoulos et al., 2009).

1.11.4 Musculoskeletal Disorders (MSDs)

Conceptual Definition: Public health issue productivity injuries and disorders due to working condition that affect the human body's movement or musculoskeletal system (Mohammadi & Ghanbary, 2014).

Operational Definition: Ache, pain or discomfort in at least one of the anatomical sites which are neck, shoulders, elbows, wrists/hands, upper back, lower back, hips or thighs, knees, and ankles or feet (Anon n.d.).

1.11.5 Upper Limb

Conceptual Definition: Part of body region mainly focused on upper part of body that enables to grip, write, lift and throw among many other movements (Mehrizi et al., 2014).

Operational Definition: Specific body region from neck, shoulder, upper back, elbows, lower back, wrists and hand (Gholami et al., 2014).

1.11.6 Lower Limb

Conceptual Definition: lower extremity refers to the part of the body from the hip to the toes that give body strength to do movement in walking and standing (Makrides et al., 2011).

Operational Definition: Body region at lower part of body taken into measurements which are hips or thighs, knees and ankles or feet (Nejad et al., 2013).

1.11.7 Industrial Ergonomics Screening Checklist

Conceptual Definition: screening tool identify risk factors for work activities with ergonomic concerns and risk-reduction solutions (Marques et al., 2012)

Operational Definition: to evaluate ergonomic risks factors including awkward postures, highly repetitive motions, high hand force, repeated impacts, lifting, and hand-arm vibration (Mehrizi et al. 2014).

1.11.8 Standardized Nordic Questionnaire (SNQ)

Conceptual Definition: An instrument used to obtain information on the musculoskeletal disorder risk (Md. Deros et al., 2010)

Operational Definition: questionnaires consist of structured, forced, binary or multiple choice variants and can be used as self-administered questionnaires or in interviews in order the identify musculoskeletal disorder symptoms (Kuorinka et al., 1987)

1.11.9 Rapid Entire Body Assessment

Conceptual Definition: A quick and easy observational postural analysis tool for whole body activities in static and dynamic condition that giving musculoskeletal risk action level (Ansari et al., 2013)

Operational Definition: analysis tool that provides a scoring system for muscle activity caused by static, dynamic, rapid changing or unstable postures (Qutubuddin et al., 2013)

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The purpose of this chapter is to provide a review of past literature on ergonomic problem and musculoskeletal disorder that may affect body region which include risk factor of MSDs, effects of the risk and suggested controls of ergonomic problem in the past studies.

2.2 ERGONOMICS

Ergonomics can be defined as a discipline in its own right, as the theoretical and fundamental understanding of human behaviour and performance in purposeful interacting socio-technical systems, and the application of that understanding to design of an industrial workstation (Satish et al., 2013). More specifically, ergonomics is the science of designing the job to fit the worker, rather than physically forcing the worker's body to fit the job. Adapting tasks, work stations, tools, and equipment to fit the worker can help reduce physical stress on a worker's body and eliminate many potentially serious, disabling Work-Related Musculoskeletal Disorders (MSDs). Ergonomics draws on a number of scientific disciplines, including physiology, biomechanics, psychology, anthropometry, industrial hygiene, and kinesiology (Occupational Safety and Health Administration (OSHA), 2014). The International Ergonomics Association (IEA, 2013) defines ergonomic as the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design

in order to optimize human well-being and overall system performance. Ergonomics is the science of fitting workplace conditions and job demands to the capabilities of the working population (National Institute for Occupational Safety and Health (NIOSH), 2013).

The main goal of ergonomics is to reduce stress and eliminate injuries and disorders associated with the overuse of muscles, bad posture, and repeated tasks. This is accomplished by designing tasks, work spaces, controls, displays, tools, lighting, and equipment to fit the employee's physical capabilities and limitations. The ergonomics is the key importance in design of work place and series of production for well working environment (Alexopoulos et al., 2009).

2.3 ERGONOMICS IN BAKERY INDUSTRY

A baking industry is characterized with a variety of different products sold that daily find their place on the market. Their quality of product will estimate all possible generations of consumers. From the long-term point of view, stable quality of production, is not easy to preserve (Marić et al., 2009). In the baking manufacturing industry, the work process IS characterised by a mix of semi-automated machine and manual work. The semi-automated work mostly takes place in refinement of products and at packaging areas. However, there is a certain times where these production chains are sometimes performed manually, to some extent, depending on products characteristics or requirements on packages. Manual work is performed mainly by operators controlling product quality on the production lines, operators supervising the production flow, and material handling (Willquist & Törner, 2003). Some of the common problems of the small scale and unorganized sector industries are improper workplace design, ill-structured jobs, mismatch between workers abilities and job demands, adverse environment, poor human–machine system design, poor working postures and inappropriate management programs (Qutubuddin et al., 2013).

2.3.1 Work Process in Bakery Manufacturing

Bakery products not only serve as ready to eat convenient food, but also help in increasing the utilization of surplus wheat production in the country. The growth of bakery industry could be much greater if some of the problems faced by them are solved. The major problems mostly are non-availability of quality raw materials, lack of knowledge of raw materials for specific product applications, poor understanding of process equipment and process technology (Barreto et al., 2009). Bakery products becoming popular even in places where rice has been the staple food. The contributing factors for the popularity of bakery products due to increased demand for ready to eat convenient product, availability at reasonable cost, greater nutritional quality, availability of varieties with different textural and taste profiles and better taste (Rabiul 2002). Bread is the product obtained by several work processes mixing, fermentation, forming and baking of dough (Marić et al., 2009). Work performed in different work process such as mixing, dividing and shaping dough, baking various types of bread and decorating, slicing and wrapping finished products (Marques et al. 2012).

2.3.1.1 Mixing, Dividing and Shaping Dough

Within the bakery, there are several processes undertaken from mixing ingredients brought together into dough and proving dough is allowed to proof over time. Mixing refers to homogenization of formula ingredients, whereas kneading is the development of the dough or gluten network by mechanical means (Alexopoulos et al. 2009). Mixers mostly used to develop dough vary widely in size and intensity of mixing action. Many mixing machines are available those still work similar to hand mixing. The mixing devices includes hand tools or trays which are used for preparing, shaping and processing edible dough, for the mixing and kneading of dough (Barreto et al., 2009). Baked goods are produced from either doughs or batters which are a mixture of flour and water made by mixing, beating, kneading or folding. The processing method depends on the ingredients being used and the product being made. The final dough mixing done by hand to an enhanced quality (Service & Division, 1947).

2.3.1.2 Baking and Decorates Bread

Baking the dough mostly done in a hot oven meanwhile cooling done in order to allow the hot product to cool to ambient temperature (Wash, 1993). After being processed in the dough kneading machine, the dough goes to several different processes before either on baking sheets which used for traditional bread rolls or baking trays that is used for thin dough bread. Topping or stuffing will be added in this moment (Barreto et al., 2009). Study showed that during baking, risk level of bread baker and baking tasks in every four bakeries as well as counter hand task in Sangak and Baguette bakeries and counter hand/seller agent in Sangak bakery were in red zone or danger zone (Mehrizi et al., 2014).

2.3.1.3 Slicing and Wrapping Finished Products

There were high accident risk in the process of cutting the dough, especially the imminent risk of accident in the kneading machine in the moment scraping the inside for wrapping the dough (Wash, 1993). Slicing is an expensive process with a low profit margin Slicing should only be done by large-scale bakers with automatic equipment. Bread should always be allowed to cool down before they were wrapped(Service & Division, 1947). During refilled wrapping plastics into the machines Lifting above head level will occurred. These activities are categorized in high category where contribution to back pain is high (Md. Deros et al., 2010). Meanwhile, manual shrink wrapping forces a worker into an awkward posture (Website Department of Occupational Safety and Health Malaysia, n.d.)

2.4 MUSCULOSKELETAL DISORDER (MSDs)

Musculoskeletal disorders (MSDs) are a major cause of occupational injury in the developed and industrially developing countries (Nejad et al., 2013). Musculoskeletal disorders also can be defined as injuries and disorders of the soft tissues made of muscles, tendons, ligaments, joints, and cartilage, and nervous system. They can affect nearly all tissues, including the nerves and tendon sheaths, and most

frequently involve the arms and back (Occupational Safety and Health Administration, 2014). Occupational safety and health professionals also called these disorders a variety of names, including cumulative trauma disorders, repeated trauma, repetitive stress injuries, and occupational overexertion syndrome. According to National Institute of Occupational and Safety Health (2013), Cumulative trauma disorder (CTD) means one or more signs such as pain, creeping and rigidity, and movement restriction in one of four joint zones of upper limb which are neck, shoulder, elbow, forearm and wrist and lumbar that last more than one week or repeat at least one time at month in last year providing there is not any acute and previous injuries for related joint.

2.4.1 Symptoms of Musculoskeletal Disorders

The term of musculoskeletal symptoms can be defined as ache, pain or discomfort in at least one of the anatomical sites which are neck, shoulders, elbows, wrists or hands, upper back, lower back, hips or thighs, knees, and ankles or feet (Mahdavi et al., 2014). Prevalence of musculoskeletal symptoms in printing production line workers showed that 79.6% workers associated with the MSDs cases. In printing production line workers, the highest prevalence rates of reported symptoms in all body regions determined it mostly associated in the knees lower back and wrists or hands (Of et al., 2014). The findings from Malaysian Food Manufacturing also showed that the highest prevalence being lifting activities, 45% for Upper Back Pain and 84% for Lower Back Pain (Md. Deros et al., 2010). Findings related to the prevalence of MSDs in porcelain manufacturing industry show that each limb in the past 12 months showed that the highest prevalence related to low back (77.0%) and then wrist and hand (65.0%), knee (60.0%), shoulder (49.0%), neck (45.0%), thigh (17.5%), leg (30.0%) and elbow (9.0%), respectively (Gholami et al., 2014).

2.4.2 Effects of Musculoskeletal Disorders (MSDs)

Musculoskeletal disorders (MSDs) are a major part of occupational diseases and one of the main causes of disability (Abedini et al. 2013). Study by Nejad et al., (2013)

showed that the most commonly affected regions were the knees, lower back and wrists or hands. The questionnaire showed that the most commonly affected regions among the subjects were the knees with 39%, lower back with 35.6% and wrists or hands with 29.5% In the food-processing industry, employees remain in static postures on assembly lines, sorting stations, and inspection stations. Employees may stand or sit for long periods of time, placing strain on the legs and back. Circulation is reduced, blood pools, and localized fatigue increases the longer the employees must stand. Muscles and tendons become more susceptible to strain as they become fatigued from prolonged standing (Marquez et al., 2006).

2.4.2.1 Lower Limb

The lower back was the commonest problems among bakery respondents and almost half of them had low back pain in pain, discomfort and injuries among standing workstation employees due to standing work (Of et al., 2014). Obviously, if worsening trend in lower limbs were detected, this would indicate a risk (Department of Occupational Safety and Health, 2014). Figure 2.1 below shows the anatomy of lower limb (Centres for Disease Control and Prevention, 2013).

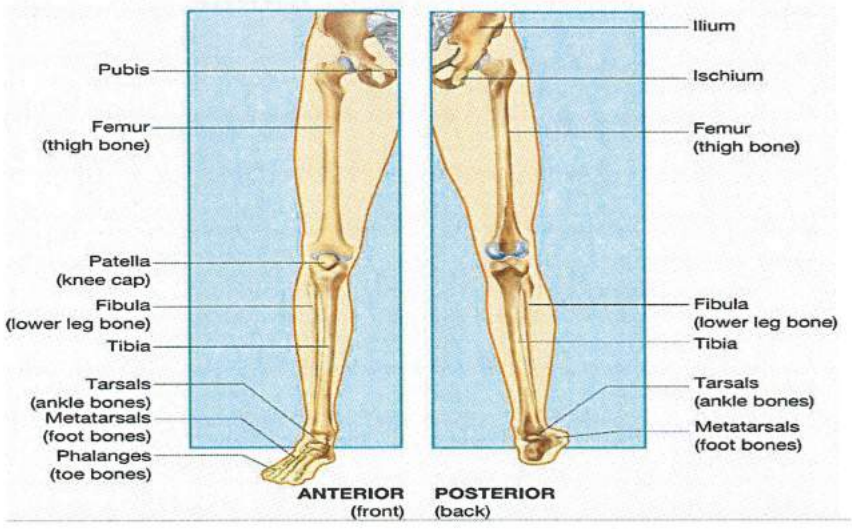


Figure 2.1: Anatomy of Lower Limb

Source: Centres for Disease Control and Prevention (2013)

2.4.2.2 Upper Limb

Around 53% of the bakery workers were working at pre-packaging activities exposed to high risk levels of MSDs (Alexopoulos et al. 2009). It was found that, if the workers continued to work in the same posture they suffer from the MSDs related to neck, trunk and wrist in the near future. Some of the workers in the turning jobs were bending their trunk to unacceptable limit and most of them had upper arm under high strain. The workers were suggested to keep their trunk straight while working which after analysed, it shown that significant proportion of the workers are working in uncomfortable and painful postures found (Ansari & Sheikh, 2014). Women worker felt severe to very severe pain in fingers, wrists, upper and lower arm which is due to more strain because while shelling cashew nut they used one wooden mallet to hit the cashew shell to break and also while peeling by using small and heavy knife throughout the day (Saikia & Borah. 2015).

In the present study for hairdresser, 58.7% of the hairdressers experienced pain in their lower back, 52.3% in their neck, 41.3% in their knees, 20.3% in their ankle, 28.5% in their dominant right wrist and hand, 5.2% in their left wrist and hand, and 15.1% in both their wrists and hands (Mahdavi et al., 2014). The lower back were the area with the highest prevalence of musculoskeletal symptoms (48.0%), followed by shoulder (44.4%), knee (32.8%), neck (29.6%) %), upper back (28.8%), wrist/hand (20.8%), ankle/feet (19.6%), hip/thigh (10.4%), and elbow (9.6%) in respondents. The most commonly affected regions were lower back, shoulders, knees, and neck. Mostly in some of the site of the upper body section the extremity of pain is more and cause of rigorous trouble to worker in the outlook which they do not understand and sense now (Ansari et al., 2013). Figure 2.2 below showed anatomy of upper limb (Centres for Disease Control and Prevention, 2013).

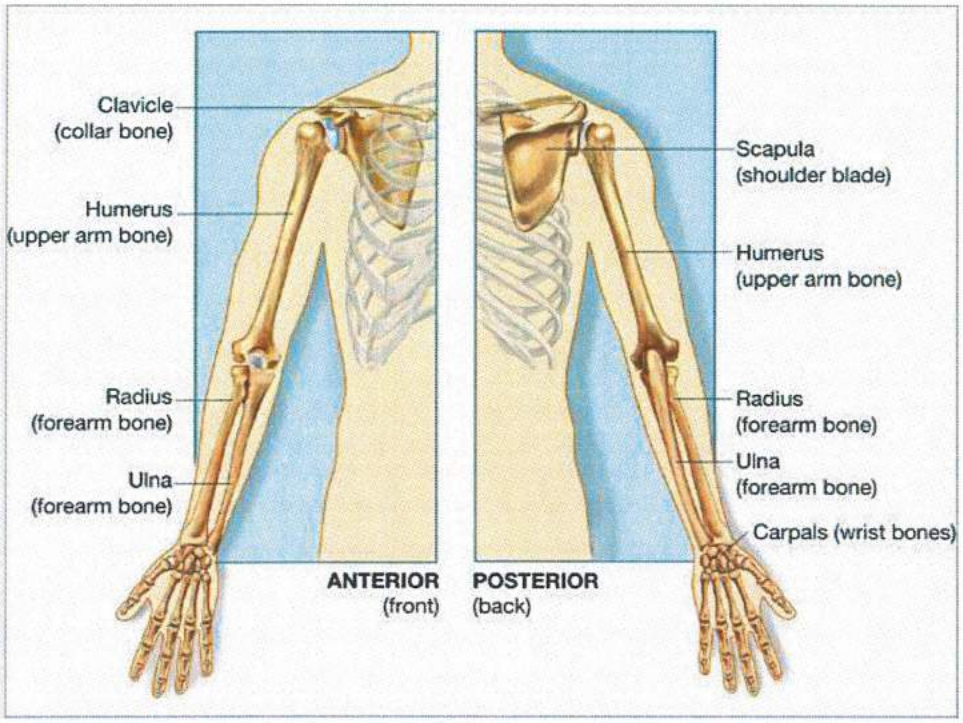


Figure 2.2: Anatomy of Upper Limb

Source: Centres for Disease Control and Prevention (2013)

2.5 ERGONOMIC RISK FACTOR

Heavy lifting, force exertion, repetitive motion, awkward and static working postures, vibration, contact stress, pinch grips and environmental factors are recognized as the main factors associated with work-related musculoskeletal disorders in the furniture industry (Nejad et al., 2013). These hazards and injuries resulting from incidence include being caught-in or struck by machinery, falling from a height, ergonomic hazards resulting from lifting of heavy loads, reaching for objects, repetitive work, and poor work posture, twisting or reaching, and breathing in fine particles of saw dust while working for increase productivity (Qutubuddin et al., 2013).

According to Occupational Safety and Health Administration (2014), conditions that are likely to cause MSDs problems include exerting excessive force, excessive repetition of movements that can irritate tendons and increase pressure on nerves, awkward postures, or unsupported positions that stretch physical limits, static postures,

or positions that a worker must hold for long periods of time which can restrict blood flow and damage muscles and motion. Uncomfortable working posture, standing for a long period of time, unsuitable tools and equipment such as unsuitable chairs, clipper, razors, blow-dryer, and scissors, and working with a shoulder or shoulders raised, bending forward or sideways, bending the head forward or sideways, and twisting the neck can led to high risk score in hairdressers (Mahdavi et al., 2014).

Moreover, the most important causes of the high prevalence of MSDs in the rivet and packaging units may be undesirable postures of the neck, shoulder, wrist, and hand and applying excessive force and using non-ergonomically designed tools (Mohammadi & Ghanbary, 2014). In the manufacturing process where workers are working in standing posture lack of knowledge regarding ergonomics is studied and analysed in industry in which work is carried out. Musculoskeletal disorders are found and it shows that there is need to modify the existing body postures (Ansari et al., 2013). Main causes of musculoskeletal disorders injuries are repetitive movements, work stress, poor body condition or static body posture as well as continuous bending and spinning (Gholami et al., 2014). The most important occupational hazards in the study involved heavy loads, repetitiveness, high temperatures, high rate of work, stressful deadlines, and noise (Alexopoulos et al., 2009).

2.5.1 Individual Factor

Individual factors, such as level of physical fitness, weight, diet, habits, and lifestyle, may affect the development of musculoskeletal disorders. In addition, some medical conditions may predispose individuals to musculoskeletal disorders (ANON, 1971). Individual characteristics and work history included age, gender, level of education, duration of employment, and job title held (Alexopoulos et al., 2009). The results of analysis show that weight and Body Mass Index was significantly associated with musculoskeletal symptoms on lower back (Nejad et al. 2013). The rather high prevalence of Cumulative Trauma Disorder (CTD) in studied population that was young with age average of 30 years and had a few job background and results of performed risk assessment can be taken account of serious warning and if it is not considered, it

will probably impose enormous costs on government and society in future (Mehrizi et al., 2014). From other analysis, it was found that gender factor have significant relationships with Upper Back Pain (UBP) for postures pushing loads, holding loads, rotating during lifting, standing statically for 10 minutes, reaching and lifting loads above head level (Md. Deros et al., 2010).

Besides, the survey from Ansari & Sheikh (2014) found that male were more likely to say that their back discomfort or pain is work-related, while female tend to believe that their back discomfort or pain originates in the home. The results of study among hairdresser showed a significant correlation between Body Mass Index (BMI) and MSDs in the elbow, hip, and thigh. The finding of this study also revealed a significant correlation between age and MSDs in the knee, shoulder, and neck (Mahdavi et al., 2014).The prevalence of MSDs and risk level increased with increase of work experience and age (Mohammadi & Ghanbary, 2014).

2.5.2 Occupational Factor

Physical activities such as manual material handling (MMH) include heavy load lifting, lowering, carrying, pulling and pushing, awkward postures and poor working conditions are very common (Nejad et al., 2013). Awkward posture, lifting, forceful movement and manual work at rapid rate contribute to musculoskeletal disorder (Ansari & Sheikh, 2014). Musculoskeletal disorder could be attributable to awkward working posture due to manual material handling, bending forward to move the finishing paper product to pallet, and standing in a workstation for long hours without an adequate rest, which were common at almost all workstations and work tasks observed in the company. The workers might feel exhausted for the prolonged standing position. The most commonly affected regions were lower back, shoulders, knees, and neck. The lower back was the commonest problems among respondents and almost half of them had low back pain (Of et al., 2014).

2.5.2.1 Awkward Posture

Awkward working posture occur due to manual material handling, bending forward to move things, and standing in a workstation for long hours without an adequate rest commonly happen at almost all workstations and work tasks.. Workers could not leave the workstation unless the task is finished since the work process is continuous (Of et al., 2014). Awkward and extreme force exertion and repetitive postures can increase the risk of MSDs (Mohammadi & Ghanbary, 2014). Posture affects the muscle groups in use during a work activity. Awkward postures make work tasks more physically demanding. They increase the exertion required from smaller muscle groups and prevent stronger, larger muscle groups from working at maximum efficiencies. The increased exertion from the weaker, smaller muscle groups impairs blood flow and increases the rate of fatigue (Reinhold et al., 2008).

2.5.2.2 Prolonged Standing

The workers might feel exhausted for the prolonged standing position when the task requires standing and awkward posture most of the time and this could be another possible explanation for the higher rate of musculoskeletal symptoms on knees (Marquez et al., 2006). Findings from previous studies by Andersen et al. (2007) revealed that lifting, repetitive task, pulling, and standing were associated with any regional pain among general working population lead to musculoskeletal disorder effect. Machining in the industry is done on standing posture as the fixture used for machining is placed on the ground. Continuously worker has to stand on that posture and has to perform machining. It is observed and found that due to continuous standing posture worker get fatigued frequently and musculoskeletal problems are identified in them. The workers are doing work mainly in standing and forward bending postures they are found out with the more problems of MSDs as compared to those who are doing the same work in kneeling posture (Ansari et al., 2013).

2.5.2.3 Repetitive Motion

Previous study found that there were significant relationships between repetitive works and back pain problems and lifting load above head level and back pain problems (Md. Deros et al., 2010). Musculoskeletal disorder problems, tendons, peripheral nerves, joints, bones, ligaments, and blood vessels disorders are the result of repetitive motion (Mohammadi & Ghanbary, 2014). In repetitive work the same types of motions are performed over and over again using the same muscles, tendons, or joints. The repetition rate may be affected by the pace of work and the amount of variety of job tasks (Marquez et al., 2006). The main stress factors workers reported were monotonous work, high work intensity, repetitive movements, noisy environment and unpleasant or insufficient relationships between workers (Reinhold et al., 2008).

2.6 ERGONOMIC RISK ASSESSMENT

Risk assessment evaluates hazards by measuring or assessing the probability and the severity of the associated adverse effects (Alexopoulos et al., 2009). Risk assessment of prevalence of Musculoskeletal Disorders (MSDs) showed that people are exposed to a high risk (Gholami et al., 2014). Ergonomic risk assessment is done to analyse the risk level of lifting loads and manual material handling (Reinhold et al., 2008). Risk assessments of work activities completed in order to identify potential ergonomic risk factors and appropriate control measures to avoid or reduce poor ergonomic conditions in the workplace (Practice & Workplace, n.d.).

2.6.1 Industrial Ergonomic Screening Checklist

To assess ergonomic working conditions in the furniture workshops, a comprehensive ergonomics checklist was developed. The checklist was structured to identify ergonomic problems that might exist in furniture workshops. The checklist integrated the available knowledge on this issue and provided a systematic ergonomics assessment tool for furniture workshops. It could also be used to provide a list of priorities for improving working conditions (Nejad et al., 2013).

2.6.2 Standardize Nordic Questionnaire

The Malay version of Standardized Nordic Questionnaire (SNQ) was an instrument used to obtain information on the MSD risk. The questionnaire consists of two parts and a diagram showing clearly of nine anatomical sites to assist the subjects for the assessment of musculoskeletal symptoms. First part was on the socio-demographic and working experience and the second part is on the musculoskeletal symptoms and related anatomical sites (Md. Deros et al., 2010). The SNQ is used to qualitatively evaluate MSDs of the neck, shoulders, back, elbow, wrist, hand, thigh, knee, and foot. This questionnaire is very useful for assessing musculoskeletal problems in epidemiological studies (Mohammadi & Ghanbary, 2014). The Malay version of Standardized Nordic Questionnaire (SNQ) is an instrument used to obtain information on the symptoms of MSDs with more detail information on human body (Kourinka et al., 1987).

2.6.3 Rapid Entire Body Assessment (REBA)

Rapid Entire Body Assessment (REBA) was developed by Hignett, and McAtamney (2000), to provide a quick and easy observational postural analysis tool for whole body activities in static and dynamic condition that giving musculoskeletal risk action level (Ansari et al., 2013). The development of REBA is aimed to divide the body into segments to be coded individually with reference to movement planes. It provides a scoring system for muscle activity caused by static, dynamic, rapid changing or unstable postures. This method was specifically developed to be useful for assessing MSD risks or working postures. It also can be used to assess a variety of tasks, in any setting, where the whole body is being used, the posture is static, dynamic, rapidly changing, or unstable, or animate or inanimate loads are being handled either frequently or infrequently (Ansari et al., 2013).

2.7 CONTROL MEASURES OF ERGONOMIC PROBLEMS

Some study recommends the immediate implementation of ergonomics interventions with proper knowledge among workers and health education on common postural change, implementation and monitoring of laws among industries are recommended to take down morbidity due to musculoskeletal disorders (Ansari & Sheikh, 2014). The best suggestion is the ergonomic control methods as most important part in every ergonomic program and the effect of them in reducing work related musculoskeletal disorders was proved till now. Redesign in whole bread baking systemic recommended as the first and best remedy for reducing and even eliminating musculoskeletal disorder.

On the other hand, it is better to say, best remedy is replacing the mechanical bread instead of traditional bread to eliminate the process of musculoskeletal disorders creation (Mehrizi et al., 2014). Existing ergonomic interventions in manufacturing industry also be continued to reduce MSDs risk which are trainings and education, personal protective equipment and mechanical assistance (Md. Deros et al., 2010).The result of the present study showed that the prevalence of MSDs among the staff of household appliances production companies is high and ergonomic interventions such as workstation redesign, reduced working hours, cycle of rest-work development are necessary (Mohammadi & Ghanbary, 2014). According to findings of the current study and observation of working conditions of the study population, it is proposed that required ergonomic solutions such as improved work methods, workstation, postures and inappropriate and undesirable physical positions as well as other ergonomic risk factors and management measures such as rest pause and work rest recovery cycle will be performed to remove or reduce these disorders as much as possible (Gholami et al., 2014).

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter gives detail explanation on materials and methods used in data collection. This chapter covers on study area, study design, population and sampling, sampling strategy, instrument and data collection methods and data analysis.

3.2 STUDY AREA

The study area of this research focused in a production line of a bakery industry which located in Besut, Terengganu. This industry consists of three different work processes namely mixing, dividing and shaping dough, baking various types of bread and decorating, slicing and wrapping finished products. At that area, workers were exposed to ergonomic risk factors including awkward posture, repetitive movement and standing for a long time as most the work involved manual material handling.

3.3 STUDY DESIGN

This study was a cross-sectional study to determine the relationship between working posture of worker and prevalence of musculoskeletal disorder symptoms and propose effective ergonomic control in bakery industry. A self- assessment conducted to evaluate the workers using Industrial Ergonomics Screening Checklist, Standardize Nordic Questionnaire, Rapid Entire Body Assessment and Rapid Upper Limb Assessment. Job description details identified before workers were evaluated.

In this study, in other to collect the data, some steps also be considered. Worker's job details identified before Standardize Nordic Questionnaire distributed. For the first step, walkthrough observation around the bakery manufacturing done before risk assessment conducted to workers in order to determine ergonomic risk factors by using Industrial Ergonomics Screening Checklist. After that, Standardize Nordic Questionnaire (SNQ) asked directly to the respondents to determine the prevalence of MSDs. After all questionnaires had been answered, the questionnaire analysed in data analysis. Next, assessment on Rapid Entire Body Assessment (REBA) worksheet conducted to determine specific area of musculoskeletal disorders symptoms among workers in bakery industry. After the level of risk is determined, control measures to reduce the risk proposed to the top-management in order for being implemented in the manufacturing.

3.4 STUDY SAMPLE

The sample population were among workers of bakery manufacturing. Workers who were working at specific work process selected as respondents of this study to see whether they were exposed to musculoskeletal disorder occurred or not. In order to ensure every single work process consists of same and equal chance being selected as study respondent, the samples of population chosen randomly.

The number of individuals to include in a research study, the sample size of the study, is an important consideration in the design of many clinical studies (Eng 2003). Krejcie & Morgan (1970) is a strategy that has no calculation and the required sample size can be directly obtain from the table to determine the sample size (refer Table 3.1)

Table 3.1: Table for determining the sample size from given a population

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	346
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	354
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	191	1200	291	6000	361
45	40	170	118	400	196	1300	297	7000	364
50	44	180	123	420	201	1400	302	8000	367
55	48	190	127	440	205	1500	306	9000	368
60	52	200	132	460	210	1600	310	10000	370
65	56	210	136	480	214	1700	313	15000	375
70	59	220	140	500	217	1800	317	20000	377
75	63	230	144	550	226	1900	320	30000	379
80	66	240	148	600	234	2000	322	40000	380
95	70	250	152	650	242	2200	327	50000	381
90	73	260	155	700	248	2400	331	75000	382
95	76	270	159	750	254	2600	335	100000	384

Note: "N" is population size

"S" is sample size

For this study, the required sample size obtained by entering Table 3.3.1 at N = 50. The sample size representative of the workers in this study was 44. Table 3.3.1 was applicable to any defined population.

3.5 DATA COLLECTION PROCESS

The brain storming of the study area was the first step in sampling strategy. There are three different work process were selected in production line of bakery manufacturing industry. After confirm the study area, preliminary assessment were conducted by using checklist. It was to determined physical ergonomics risk factors in the work area. The workers who have worked with the bakery manufacturing for at least one year were selected as study respondents. The respondents will be asked to answer the checklist by using interview method. After that, questionnaires asked directly to the workers which consist of personal information and MSDs symptoms.

During observation of the bakery workers, the pictures of their working postures and video of the working processes recorded for further analysis. Negative ergonomic postures will be observed such as frequency, duration and the force used while applying the postures. Once all of these postures are observed, a posture targeting method which was Rapid Entire Body Assessment worksheets used to assess the working posture. And then, final score will be applied to each are of the body to determine the risk. At the end, all the collected data analysed by Statistical Package Science Software Version 22 and with significant value ($p<0.05$). Figure 3.1 below show the step for data collection process applied in this study.

Figure 3.1: Data Collection Process

3.6 RESEARCH INSTRUMENTATION

3.6.1 Industrial Ergonomic Screening Checklist

A checklist was only one part of an ergonomic analysis, and works best as a preliminary tool for observing a job and characterizing the levels of risk factors present in the job. Industrial Ergonomic Screening Checklist adopted from SLAC National Acceleration Laboratory (2016). The checklist identified any workers that exposed to the hazard from lifting activities, awkward posture and forceful hand movements. All the categories of hazards exposure will be inspected at working area for each work process of workers. This area included at mixing, dividing and shaping dough, baking various types of bread and decorating, slicing and wrapping finished products. Appendix B shows the checklist used in this study.

3.6.2 Standardize Nordic Musculoskeletal Disorder Questionnaire (SNMQ)

The Standardize Nordic Questionnaire is a closed-ended questionnaire used to identify prevalence of Musculoskeletal Disorder symptoms frequency of pain that occur towards workers. The questionnaire used to determine musculoskeletal disorders frequency of pain and intensity of pain. The questionnaire asked about experience of musculoskeletal disorders problems in nine body areas which are neck, shoulder, elbows, wrists or hands, upper back, lower back, hips or thighs, knees and ankles or feet. Respondent has been asked if they have any musculoskeletal trouble in the last months and last 7 days which might been prevented them to conduct their normal activity for those who had trouble and intensity of musculoskeletal troubles like aches, pains, discomfort and numbness for every respondents. In this assessment, the questionnaires distributed to all the respondents who working in area that exposed to ergonomic risk in bakery manufacturing industry. Appendix C shown questionnaire used in this study.

3.6.3 Rapid Entire Body Assessment (REBA)

Rapid Entire Body Assessment (REBA) was a method to provide a quick and easy observational postural analysis tool for whole body activities in static and dynamic condition that giving musculoskeletal risk action level. The development of Rapid Entire Body Assessment aimed to divide the body into segments to be coded individually with reference to movement planes. It provides a scoring system for muscle activity caused by static, dynamic, rapid changing or unstable postures.

In this research, REBA will be done based on video-recording of workers above five minutes for every work process. The most difficult postures and work tasks chosen in this study. Then, score for each of the following body regions include wrists, forearms, elbows, shoulders, neck, trunk, back, legs and knees assigned. After the data for each region is collected and scored, tables on the form are then used to compile the risk factor variables, generating a single score that represents the level of MSD risk which determined required certain action. Appendix D shows the Rapid Entire Body Assessment worksheet used in this study.

3.6.4 Workplace Safety and Health Guidelines

Workplace Safety and Health Guidelines published by the Workplace Safety and Health Council complied with Legislation and Act that covers every workplace and every stakeholder, including employers, employees, self-employed persons, occupiers, principals, manufacturers and suppliers. This set of guidelines outlines how to develop an in-house ergonomics programme for a company or organisation to manage ergonomics problems and work-related MSDs at the workplace. Employees and employers can also obtain information on good ergonomics practices and the prevention of work-related injury or illness. In particular, through using this guidelines, workplace, equipment, task or job design can be better matched to the capabilities of the working population, including pregnant employees, older workers or those with functional limitations.

Based on assessment done by using International Ergonomic Screening Checklist, Nordic Musculoskeletal Questionnaire and Rapid Entire Body Assessment, the factors and criteria that will be taken in appropriate control measures includes awkward posture, repetitive motion and prolonged standing. The control measures later will be proposed to top-management of the bakery which several factors will be taken into account includes number of workers and simple measures that can be implemented for short-period of time.

3.7 DATA ANALYSIS

Data analysis was the process of evaluating data using analytical and logical reasoning to examine each component of the data provided. All the data that will be collected will be analysed using software known as Statistical Package Social Science (SPSS) 22. This software used to perform statistical analysis on the questionnaires in percentages, mode, frequency and mean of data that obtain from analysis. Beside, by using this software, it also enables to get the reliability of the questionnaire and significant of association between ergonomics risk factors and posture score of respondent.

3.8 QUALITY ASSURANCE AND CONTROL

The reliability test of the questionnaire was initially done before conducting the actual research. The Cronbach's Alpha value of the reliability test for this study was 0.77. Thus, this questionnaire is reliable to be used. The technique of interview for the questionnaire must be adopted and every respondent interviewed by the researcher verbally to avoid misunderstanding of questions and to prevent interviewer bias.

3.9 RESEARCH ETHICS

In conducting the research for this study, study ethic need to be considered. Due to use of human subject in this study, the workers informed first before study conducted. This study explained both in verbally and in written form to the subject prior to testing so as to ensure that all details is clarified and within the capabilities of the individual. In addition, all the respondent and industry details are confidential. All the results and details will be kept as secret and will be used for education purpose only. Besides, all information used in the research was genuine and not plagiarized from others.

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

This chapter presents the result finding and the result of statistical analysis conducted on the finding data. For the result, the topic that will be discussed are reliability analysis of the measurement, followed by descriptive statistics, assessment on Musculoskeletal Disorders (MSDs) among the workers, and lastly association between MSDs and the ergonomic problem among the workers. Descriptive statistics were used to identify the sample based on the background information of the workers.

4.2 BACKGROUND OF RESPONDENT

The total number of respondents for this study is 44 respondents, which consisted of 14 workers for mixing, dividing and shaping dough, 15 workers for baking and decorates bread and 15 workers for slicing and wrapping finished product. A total of 44 (100%) questionnaires were returned from a total of 44 distributed. Out of the total respondents, 34 (77.3%) were females. The average age of participants was 21.41 years (standard deviation (SD): 1.82 years). The majority of bakery workers for 8 hours per week and had an average working experience of 1.61 years (SD: 1.48 years). The majority of bakery workers were working at baking and decorate section (34.1%) and slicing and wrapping section (34.1%) while 31.2% were working at mixing, dividing

and shaping dough respectively. Detailed descriptive statistics for demographic and work-related characteristics of female and male workers are shown in Table 4.1 below.

Table 4.1: Demographic characteristics

Work Section		**Mixing, dividing and shaping dough**	**Baking and decorate**	**Slicing and wrapping finished product**
		Mean (SD)	**Mean (SD)**	**Mean (SD)**
Age (years)		21.11 (1.72)	21.72 (1.93)	21.42 (1.81)
Working duration (hours)		1.81 (1.44)	1.4 (1.52)	1.56 (1.47)
Gender	Male Freq (%)	1 (7.1%)	5 (33.3)	4 (26.7)
	Female Freq (%)	13 (92.9)	10 (66.7)	11 (73.30)

N=44 ; Freq: frequency; SD: Standard deviation

4.3 PREVALENCE OF MUSCULOSKELETAL DISORDERS' COMPLAINT

Table 4.2 shows the 12-month self-reported complaint related to musculoskeletal disorders (MSDs) at any of the body sites among workers. The highest reported were at neck (47.7%) and shoulder (47.7%). Meanwhile, the least reported MSD was at knees (20.5%) and ankles or feet (11.4%).

Table 4.2: Prevalence of musculoskeletal disorder symptoms among bakery workers

Specific Body Parts	Frequency	Percentage (%)
Neck	21	47.7
Shoulder	21	47.7
Elbow	20	45.5
Wrist/ Hand	20	45.5
Upper Back	17	38.6
Lower Back	16	36.4
Hip/Thigh	14	31.8
Knees	9	20.5
Ankles/ Feet	5	11.4

N=44

The result found similar with the previous study done by Deros et al. (2014) which stated that the highest prevalence of musculoskeletal symptoms for bakery workers at neck was 65.9%. From another study, the reported prevalence was 68.0%, 73.6%, 79.0%, 80.5%, and 93.0% in neck, shoulder, elbow, wrist/hand and upper back (Abedini et al. 2013). The prevalence rate in this study slightly difference of those reported in previous studies. Not easy to make a direct comparison with different occupations since exposures were likely to vary among tasks. The prevalence was high at neck among the studied population as compared to previous study (65.9%) which conducted in similar business-oriented industry in printing industry (Of et al. 2014).

Meanwhile, Table 4.3 shows chi-square analysis for prevalence of MSDs according type of work. Chi-square test for goodness-of-fit was performed to identify the prevalence of musculoskeletal symptom among bakery workers in three different work station based on Table 4.3. The entire body regions were having significant prevalence of MSD with p-value below 0.05. Prevalence of MSD at hip or thigh with type of work task were strongly positively correlated (r: 6.970, p= 0.031). Meanwhile, upper limb body region moderately positively correlated with work process. The highest prevalence recorded at work task involving slicing and wrapping finished at ankles/feet

(60.0%) and upper back (47.1%). Manual working tasks require extensive use of hand and feet in the form of gripping, awkward posture, lifting, frequent bending, and repetitive motion. Table 4.3 also shows that almost 50.0% of respondents for mixing, dividing and shaping are suffering pain from hips or thigh, meanwhile 38.1 % of the respondents performing baking and decorates activities are suffering from shoulder pain.

The prevalence rate of MSD in this study was comparable to findings done by Palmer (2011) indicated that majority of the workers who performed pre packing activities found the work place too high and congested while performing there activities with majority of the respondents expressed discomfort in performing pre-packaging (66.6%) activity and packaging activity (60%) due to improper workstation. A cross-sectional study was carried out in bakery manufacturing located in Iran by (Of et al. 2014) stated that the most common musculoskeletal symptoms were from the neck (48.0%), shoulders (44.4%), knees (32.8%), and lower back (29.6%). In another study by Mehrizi et al., (2014) indicated that MSD prevalence was high reported in back, knees and hand/wrist.

Table 4.3: Chi-square analysis for prevalence of MSDs according type of work

Variable	N	Mixing, dividing and shaping dough	Baking and decorate	Slicing and wrapping finished product	x^2 statistic	*P*-Value
		Freq (%)	Freq (%)	Freq (%)	(df)	
Neck						
No	23	7 (30.4)	9 (39.1)	7 (30.4)	0.577	0.749
Yes	21	7 (33.3)	6 (28.6)	8 (38.1)	(2)	
Shoulder						
No	23	7 (30.4)	7 (30.4)	9 (39.1)	0.577	0.749
Yes	21	7 (33.3)	8 (38.1)	6 (28.6)	(2)	
Elbow						
No	24	9 (37.5)	8 (33.3)	7 (29.2)	0.920	0.631
Yes	20	5 (25.0)	7 (35.0)	8 (40.0)	(2)	
Wrist/Hand						
No	24	8 (33.3)	10 (41.7)	6 (25.0)	2.180	0.336
Yes	20	7 (35.0)	5 (25.0)	9 (45.0)	(2)	
Upper Back						
No	27	9 (33.3)	11 (40.7)	7 (25.9)	1.681	0.432
Yes	17	5 (29.4)	4 (23.5)	8 (47.1)	(2)	
Lower back						
No	28	7 (25.0)	12 (42.9)	9 (30.0)	2.946	0.229
Yes	16	7 (43.8)	3 (18.8)	6 (42.9)	(2)	
Hips/Thigh						
No	30	7 (23.3)	14 (46.7)	9 (30.0)	6.970	0.031
Yes	14	7 (50.0)	1 (7.1)	6 (42.9)	(2)	
Knees						
No	35	10 (28.6)	12 (34.3)	13 (37.1)	1.036	0.596
Yes	9	4 (44.4)	3 (33.3)	2 (22.2)	(2)	
Ankles/Feet						
No	38	12 (31.6)	13 (34.2)	13 (34.2)	1.687	0.430
Yes	6	2 (33.3)	2 (33.3)	3 (50.0)	(2)	

*Significance at $p<0.05$ (Chi Square test) N=44

4.4 IMPACT OF MUSCULOSKELETAL DISORDERS (MSDS)

Table 4.4 shows the frequency of the workers that having problem for last seven day of their work. Most of the affected body region was neck with mixing, dividing and shaping (16.7%), baking and decorate (33.3%) and slicing and wrapping finished product (50.0%). The least affected body regions were knees and ankles/feet with 33.3% for each work process.

This study showed that workers were having acute effect from their work. Some of the workers who reported MSD in this study were being unable to work for several days because of pain at slicing and wrapping finished product work process especially at neck (50.0%), wrist/hand (75.0%) and shoulder (50.0%) region. This is in line with previous researched by Norris (2000) which stated that prevalence of seven days mostly happen at shoulder (35%) and upper back (20%) compared to other body region. Md. Deros et al. (2010) stated that packaging activity recorded highest acute prevalence of musculoskeletal disorders symptoms among workers in food manufacturing.

Table 4.4: Frequency of workers that having problem for last 7 days (%)

Variable	N	Mixing, dividing and shaping dough	Baking and decorate	Slicing and wrapping finished product	X2 statistic	*P*-Value
		Freq (%)	Freq (%)	Freq (%)	(df)	
Neck						
No	9	4 (44.4)	1 (11.1)	4 (44.4)	14.091	
Yes	12	2 (16.7)	4 (33.3)	6 (50.0)	(2)	0.001*
Shoulder						
No	13	5 (38.5)	4 (30.8)	4 (30.8)		
Yes	8	2 (16.7)	2 (33.3)	3 (50.0)	0.290 (2)	0.865
Elbow						
No	13	5 (31.3)	6 (37.5)	3 (37.5)		
Yes	7	2 (28.6)	2 (28.6)	3 (42.9)	0.290 (2)	0.865
Wrist/Hand						
No	15	6 (40.0)	4 (26.7	7 (46.7)		
Yes	4	1 (25.0)	1 (25.0)	3 (75.0)	3.153 (2)	0.207
Upper Back						
No	14	4 (28.6)	3 (21.4)	7 (50.0)		
Yes	3	1 (33.3)	1 (33.3)	1 (33.3)	0.003 (2)	0.998
Lower back						
No	11	5 (45.5)	2 (18.2)	4 (36.4)	0.505 (2)	0.777
Yes	5	2 (40.0)	1 (20.0)	2 (40.0)		
Hips/Thigh						
No	12	6 (50.0)	1 (8.3)	5 (41.7)		
Yes	3	1 (33.3)	1 (33.3)	1 (33.3)	0.003 (2)	0.998
Knees						
No	5	3 (60.0)	2 (40.0)	1 (20.0)		
Yes	3	1 (33.3)	1 (33.3)	1 (33.3)	0.003 (2)	0.998
Ankles/Feet						
No	3	1 (33.3)	1 (33.3)	1 (33.3)		
Yes	3	1 (33.3)	1 (33.3)	1 (33.3)	0.003 (2)	0.998

*significant at p-value <0.05

4.4 POSTURAL ANALYSIS

The Rapid Entire Body Assessment is a posture- based analysis technique used for the evaluation of the risk of Musculoskeletal Disorders (MSDs) in various tasks, in particular for assessment of working postures in health care and other services in the workplace. Table 4.5 below shows Rapid Entire Body Assessment score and indications. These indications used to determine risk level based on work postures of the working while performing their task.

Table 4.5: Rapid Entire Body Assessment (REBA) scores and indications

Score	Action
1	Negligible Risk
2-3	Low Risk. Change may be needed.
4-7	Medium Risk. Further Investigate. Change Soon.
8-10	High Risk. Investigate and Implement Change.
11-15	Very High Risk. Implement Change.

Table 4.6 shows the posture score for each of highest Rapid Entire Body Assessment for each work section studied. Mixing, dividing and shaping dough and slicing and wrapping finished product indicated score with action level 4 based on indicator from Table 4.5. The work processes really were in high risk and immediately further investigation with needed changes on the worker. Meanwhile, baking and decorate only need action level 3 which stated that the risk level is medium and also needed further investigation.

Table 4.6: Posture Score according work task

Posture Score	Work Process		
	Mixing, Dividing and Shaping	**Baking and Decorate**	**Slicing and Wrapping Finished product**
Posture Score A (Trunk, Neck, Leg)	7	4	7
Posture Score B (Upper Arm, Lower Arm, Wrists)	5	5	6
REBA Score	9	6	9

Results of a similar study conducted by Mahdavi et al., (2014) showed that about 45% of the postures related to worked in baker work section classified as medium level using REBA. Furthermore, the results of the study by Ansari & Sheikh, (2014) showed that about 42% of the postures related to pre-packaging activity were classified as high level of risk. Gholami et al., (2014) stated that for packaging and decorating activities, about 10.91% of workers are at high risk postures account for 26.36% of workers.

4.6 MUSCULOSKELETAL DISORDERS RISK FACTOR

Logistic Regression analysis revealed a number of associations between MSD and individual risk factor and occupational factors. Logistic Regression tests were conducted to initially examine which independent variables had any statistical associations with different body regions at a significance level of <0.05. Independent variables that were significantly associated with musculoskeletal disorders of different body sites are shown in Table 4.7 and Table 4.8. Table 4.7 show the risk factor associated with body region at upper limb and Table 4.8 show the risk factor associated with body region at lower limb.

This study provides evidence that the most important occupational hazards in the bakery industry involve repeating same movement with associated body region at wrist/hand (OR: 0.432, CI: 0.012-12.435); upper back (OR: 0.134, CI: 0.001-13.234) and knees (OR: 0.057, CI: 0.004-0.749). It also showed that female gender is more associated to have prevalence of MSD at all parts of body region with the most likely is at lower back (OR:2.737, CI: 0.148-15.07). Older age group also recorded highest prevalence compared to lower age group. The prevalence of symptom most likely at upper back part with (OR: 1.436, CI: 0.207-9.953). Study also showed that the more experienced the worker, the more likely for prevalence of MSD to happen especially at wrist/hand with (OR: 0.519, CI: 0.051-5.326). This result revealed that prevalence of MSD associated with significant risk factor most likely to happen at upper limb region compared to lower limb region.

Previous research by Md. Deros et al., (2010) showed that female workers experienced more back pain as compared to their male co-workers. In addition, workers abilities to perform tasks may vary because of differences in age, physical condition, strength, gender, stature, and other individual factors as stated by Mehrizi et al., (2014). The results are in agreement with study from Alexopoulos et al., (2009) with older age having mote chance to likely develop prevalence of MSD respectively, when compared to those who were younger. Study conducted in manufacturing company by Willquist & Törner, (2003) stated that workers with more working experience were 1.17 times more likely to develop lower limb pain (OR: 1.17, 95% CI: 1.09-1.26)

Another study done by Palmer (2011), the most evaluated risk factor was repeating same movement due to almost all body region indicated that the risk factor was most contributable activity for having prevalence of MSD at certain upper extremities. In addition, Alexopoulos et.al, (2009) stated that repetitive motion and standing for a long period of time are the greatest causes of MRMSDs in bakery manufacturing. This is in line with study done by Barreto et al., (2009) which stated that musculoskeletal disorders are the result of repetitive motion, unsuitable posture and over exertion forces.

Table 4.7: Factors (categorical variables) associated with type of work (upper limb)

Body Region	Significant Risk Factor	OR	95% Confidence Interval	P-value
	Age			
	21-25 year old	0.792	0.115-5.452	0.013*
	26-30 year old	0.543	0.023-8.432	
	Gender			
Neck	Male	0.431	0.011-8.542	0.012*
	Female	0.482	0.012-12.98	0.034*
	Job Experience			
	1-2 year	0.213	0.012-7.324	0.021*
	2-3 year	0.422	0.085-8.992	0.040*
	Risk factor			
	Lifting object above shoulder level	0.296	0.034-2.577	0.270
	Lifting object>30 cm horizontally	0.918	0.177-4.722	0.914
	Age			
	21-25 year old	1.984	0.116-33.94	0.036*
Shoulder	26-30 year old	0.853	0.136-5.348	0.035*
	Gender			
	Male			
	Female	1.211	0.011-12.209	0.023*
		1.944	0.023-29.873	0.037*
	Risk factor			
	Lifting object above shoulder level	0.742	0.106-5.201	0.764
	Neck or back is bent>30°	1.123	0.234-5.384	0.885
	Age			
	21-25 year old	1.792	0.114-33.874	0.021*
Elbows	26-30 year old	0.510	0.326-5.418	0.044*

*significant at p-value<0.05; OR= Odd Ratio

Table 4.7: Continued

Body Region	Significant Risk Factor	OR	95% Confidence Interval	P-value
	Gender			
	Male	1.221	0.011-7.321	0.012*
	Female	1.452	0.013-9.173	0.010*
Elbow	**Risk Factor**			
	Lifting objects with hand>30cm	0.367	0.126-5.201	0.578
	Bent wrists	1.312	0.434-5.324	0.092
	Age			
	21-25 year old	0.486	0.018-13.09	0.019*
	26-30 year old	0.189	0.02-1.674	0.034*
	Gender			
	Male	0.213	0.012-6.543	0.021*
	Female	0.348	0.017-7.349	0.048*
Wrist/hand				
	Job Experience			
	1-2 year	0.331	0.023-0.432	0.027*
	2-3 year	0.519	0.051-5.326	0.038*
	Risk factor			
	Repeating same movement	0.432	0.012-12.435	0.014*
	Age			
	21-25 year old	1.174	0.038-35.867	0.027*
	26-30 year old	1.436	0.207-9.953	0.014*
	Gender			
	Male	3.212	0.218-16.651	0.024*
	Female	8.310	0.337-24.642	0.032*
Upper Back	**Job Experience**			
	1-2 year	0.123	0.012-1.234	0.012*
	2-3 year	0.177	0.019-1.638	0.127
	Risk Factor			
	Lifting object above shoulder level	0.613	0.102-3.695	0.593
	Repeating same movement	0.134	0.001-13.234	0.075*

*significant at p-value<0.05 ; OR= Odd ratio

Table 4.8: Factors (categorical variables) associated with type of work (lower limb)

Body Region	Significant Risk Factor	OR	95% Confidence Interval	P-value
Lower Back	**Age**			
	21-25 year old	0.609	0.023-16.256	0.017*
	26-30 year old	0.911	0.140-5.946	0.023*
	Gender			
	Male	1.234	0.123-3.213	0.012*
	Female	2.737	0.148-5.070	0.044*
	Risk Factor			
	Repeating same movement	0.406	0.077-2.155	0.290
	Work around hazard	0.312	0.134-20.986	0.234
Hips/Thigh	**Age**			
	21-25 year old	0.618	0.019-10.72	0.046*
	26-30 year old	0.370	0.068-2.729	0.039*
	Gender			
	Male	0.213	0.012-3.456	0.023*
	Female	0.476	0.017-6.686	0.028*
	Risk Factor			
	Squatting or kneeling	0.238	0.037-2.266	0.290
	Repeating same movement	0.142	0.047-1.555	0.269
Knees	**Age**			
	21-25 year old	0.238	0.007-8.541	0.012*
	26-30 year old	0.151	0.005-4.790	0.013*
	Gender			
	Male	0.346	0.213-0.212	0.011*
	Female	1.093	0.168-7.093	0.036*
	Risk Factor			
	Neck or back is bent>30°	0.149	0.010-2.226	0.167
	Repeating same movement	0.057	0.004-0.749	0.029
Ankles/feet	**Age**			
	21-25 year old	0.042	0.000-0.856	0.016*
	26-30 year old	0.040	0.001-0.822	0.021*
	Gender			
	Male	0.023	0.001-1.234	0.023*
	Female	0.083	0.001-1.483	0.017*
	Risk Factor			
	Work around hazard	0.435	1.005-3.491	0.437

*significant at p-value<0.05; OR= Odd Ratio

4.7 ERGONOMIC INTERVENTION IN WORKPLACE

The results of this study can be an appropriate basis for planning and implementing interventional ergonomics programs in the work- place and improving workers' health in work process of the bakery. The results of this study can be an appropriate basis for planning and implementing interventional ergonomics programs in the work- place and improving workers' health.

The result based on Table 4.3 shows for mixing, dividing and shaping showed that the most commonly affected regions among the subjects were the neck (33.3 %), shoulder (50.0%), lower back (43.8%) and hips/ thigh (50.0%). The results also revealed that repetitive motion has most significant correlation with the prevalence of MSD based on Table 4.7 and Table 4.8 below. This indicates poor condition in these area necessitate adequate ergonomic intervention. Thus, one of intervention programme should be done is by providing handholds for better grip or good holding points for handles, hand grips, indents or any other features to improve the grip of the employee on the load. Carrying loads is much easier and quicker if they can be grasped easily and firmly (Mehrizi et al. 2014). With good grips, there is less chance of body exertion area to reduce MSD symptom at body region affected. The workplace must make a rule to order boxes, trays and containers that have handholds or grip (Tajvar et al. 2009). Putting handhold at correct angle allow workers carry box or container in straight position (Ansari & Sheikh 2014). Figure 4.1 below shows trays with proper handholds for better grip.

Figure 4.1: Trays with proper handholds for better grip

Source: Workplace Safety and Health Guidelines (2016)

Meanwhile, the highest prevalence of MSD for baking and decorate work process based on Table 4.3 is at shoulder (38.6%). This is due to the worker mostly doing their job by bending and static postures. When the body is in the same position or posture for a long period of time, excessive stress is placed on particular parts of the body. Intervention program that should be applied for this problem is correct seating and standing techniques. Workers should be provided with footrest bars as shown in Figure 4.2 below for employees who sit when they work so that they can alter their posture when necessary. The perfect footrest can mean the difference between a nice environment and discomfort in their chair (Barreto et al. 2009). The right one will support lower body and keep workers feeling fresh and spray throughout the day (Mirmohammadi et al. 2015).

Besides that, provide anti-fatigue mats or sit or stand stools for employees to stand or sit on and allow employees to sit and rest at regular intervals. Anti-fatigue mats (Figure 4.3) are often used to decrease foot and lower limb disorders for workers who stand in one position for long period. Figure 4.4 below show the example of combination anti-fatigue mats and footrest that can be applied to the workers in bakery. Providing footrest gain positive responses regarding the effectiveness of the

intervention and the rest believed that footrest help in tackling their back pain problems (David. 2005). According to scientific literature study conducted by National Institute Occupational Safety and Health (2016), there is sufficient scientific evidence that anti-fatigue mat actually effective in reducing the risk of back injury. Hence, the institute does recommend the use of anti-fatigue to prevent injuries among workers who have never been injured.

Figure 4.2: Anti-fatigue mats

Source: Workplace Safety and Health Guidelines (2016)

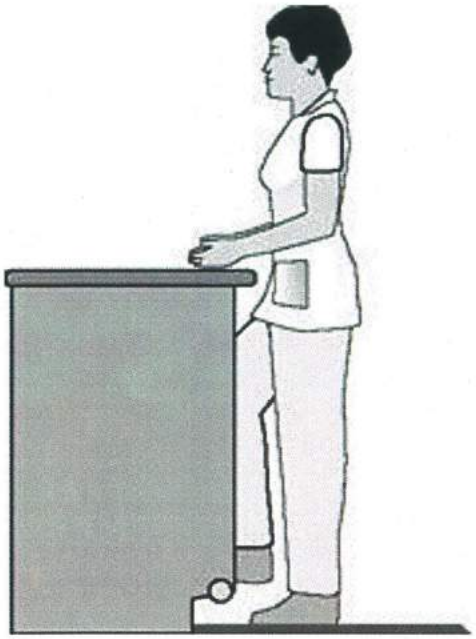


Figure 4.3: Example of Footrest

Source: Workplace Safety and Health Guidelines (2016)

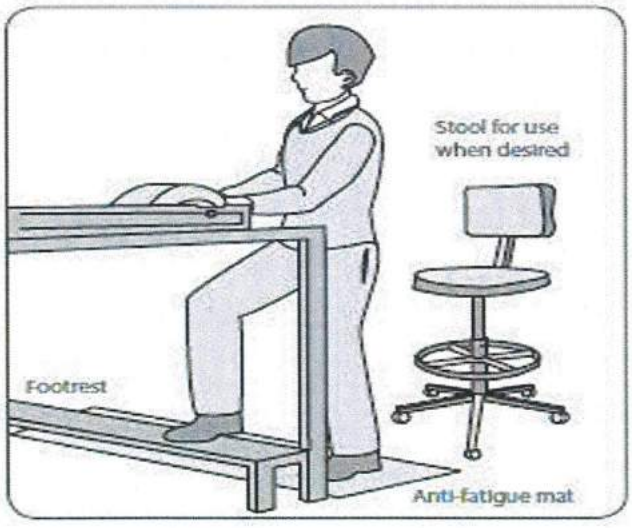


Figure 4.4: A stool, footrest and anti-fatigue mat for a standing workstation

Source: Workplace Safety and Health Guidelines (2016)

Lastly, prevalence of MSD on neck (38.1%), elbow (28.6%), wrist/hand (45.0%) and upper back (47.1%) based on Table 4.3 were the highest for slicing and wrapping work task. The results also revealed that repetitive motion has most significant correlation with the prevalence of MSD based on Table 4.7 and Table 4.8 below. Thus, intervention programme that will propose is job rotation. Job rotation can mean that a worker can performs two or more different tasks in different parts of the day (Economics 2013). For example, if the bakery workers always do the job of mixing and shaping the dough, he or she should change their daily task by changing to decorate or baking the cake and bread. The switching must be two to four hour intervals (Gholami et al. 2014). The important consideration is to ensure that the different tasks do not present the same ergonomic stressors to the same parts of the body (Mehrizi et al. 2014).

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

This chapter concluded on this study that has been made and some recommendation for further research.

5.2 CONCLUSION

Bakery workers at mixing, dividing and shaping dough, baking and decoration, and slicing and wrapping finished product are mainly experienced pain at upper region compared to lower region. This can be related with the way the workers do their work with awkward postures and their body movement. Risk factors such as age, gender, job experience and repetitive movement were significantly associated with the prevalence of musculoskeletal disorders complaint. Therefore, an ergonomic intervention programme has been proposed according to the type of work process and job activities. It includes providing proper handholds, footrest, anti-fatigue mat and practicing job rotation among the workers in order to reduce the prevalence of MSD complaints.

5.3 LIMITATION OF STUDY

The limitation occurred during assess ergonomic risk factors is that the assessment is done through observation. For this study, there is limited respondent due to small city which data that have been collected may not be enough to conclude all of bakery

workers having same type of problem while performing their task. Next, the study also focused on self-relied data. The analysis done based on worker's perception and their

ability to remember each of important information related to this study. For this study, some of the photos and videos are restricted except only at certain workplace. Videos and photos will be great help for the evaluator to evaluate the workers.

5.4 RECOMMEDATIONS

There are several recommendations that can be used for this study. The ergonomic intervention programme proposed in Section 4.7 can be implemented at the bakery industry in order to reduce the risk of ergonomic problem. It should be done according to the type of work process and job task done by workers. It includes providing proper handholds, footrest, anti-fatigue mat and practicing job rotation among the workers in order to reduce the prevalence of MSD complaints.

REFERENCES

Abedini, R., Choobineh, A., Soltanzadeh, A., Gholami, M., Amiri, F., & Hashyani, A. A. (2013). Ergonomic Risk Assessment of Lifting Activities ; a Case Study in a Rubber Industry.

Alexopoulos, E. C., Kavadi, Z., Bakoyannis, G., & Papantonopoulos, S. (2009). Subjective risk assessment and perception in the Greek and English bakery industries. *Journal of Environmental and Public Health, 2009*. http://doi.org/10.1155/2009/891754

ANON. (1971). Ergonomics in action- 3. *Applied Ergonomics*, *2*(1), 44–55. http://doi.org/10.1016/0003-6870(71)90010-X

Anon, CDC - The National Institute for Occupational Safety and Health (NIOSH). Available at: https://www.cdc.gov/niosh/ [Accessed January 15, 2017a].

Anon, Centers for Disease Control and Prevention. Available at: https://www.cdc.gov/ [Accessed January 15, 2017b].

Anon, International Screening Ergonomic Checklist. Available at: https://www6.slac.stanford.edu/ [Accessed January 15, 2017c].

Anon, Labour Force Survey (LFS) - Office for National Statistics. Available at: https://www.ons.gov.uk/surveys/informationforhouseholdsandindividuals/householdandindividualsurveys/labourforcesurveylfs [Accessed January 15, 2017d].

Anon, Laman Web Rasmi Pertubuhan Keselamatan Sosial. Available at: http://www.perkeso.gov.my/my/.

Anon, Legal Definitions Legal Terms Dictionary | USLegal, Inc. Available at: https://definitions.uslegal.com/ [Accessed January 15, 2017f].

Anon, Occupational Safety and Health Administration - Home | Occupational Safety and Health Administration. Available at: https://www.osha.gov/.

Anon, SME Corporation Malaysia - SME Definition. Available at: http://www.smecorp.gov.my/index.php/en/policies/2015-12-21-09-09-49/sme-definition [Accessed January 15, 2017h].

Ansari, N. a., & Sheikh, D. M. J. (2014). Evaluation of work Posture by RULA and REBA: A

Case Study. *IOSR Journal of Mechanical and Civil Engineering*, *11*(4), 18–23. http://doi.org/10.9790/1684-11431823

Ansari, N. A., Shende, P. N., Sheikh, M. J., & Vaidya, R. D. (2013). Study and Justification of Body Postures of Workers Working In SSI by Using Reba. *International Journal of Engineering and Advanced Technology (IJEAT)*, *2*(3), 505–509.

B.S.Khatkar. (n.d.). Bread Industry and Processes. Retrieved from http://www.ddegjust.ac.in/studymaterial/pgdbst/pgdbst-05.pdf

Barreto, F., Rocha, D. A., & Ufrn, G. (2009). Analysis of Ergonomic Demands in the Bread Making Section of a Bakery in Natal / Rn : a Case Study.

Council, H. & Safety, W., 2014. Workplace Safety and Health Guidelines Improving Ergonomics in the Workplace. , (January).

David, G. (2005). Ergonomic methods for assessing exposure to risk factors for work-related musculoskeletal disorders. *Occupational Medicine*. Retrieved from http://occmed.oxfordjournals.org/content/55/3/190.short

Dosh. (2002). *Guidelines on Occupational Safety and Health for Standing At Work*.

Economics, E. I. S. (2013). Ergonomics is economics 5, (September).

Eng, J. (2003). Sample size estimation: how many individuals should be studied? *Radiology*, *227*(2), 309–313. http://doi.org/10.1148/radiol.2272012051

Gholami, A., Soltanzadeh, A., Abedini, R., & Sahranavard, M. (2014). Ergonomics assessment of musculoskeletal disorders risk by rapid upper limb assessment (RULA) technique in a porcelain manufacturing factory. *Journal of Research & Health*, *4*(1), 608– 612.

Hignett, S., & McAtamney, L. (2000). Rapid Entire Body Assessment (REBA). *Applied Ergonomics*, *31*(2), 201–205. http://doi.org/10.1016/S0003-6870(99)00039-3

Krejcie, R. V & Morgan, D.W., 1970. Determining Sample Size for Research Activities Robert. *Educational and Psychological Measurement*, 38(1), pp.607–610.

Kuorinka, I., Jonsson, B., Kilbom, A., Vinterberg, H., Biering-S??rensen, F., Andersson, G., & J??rgensen, K. (1987). Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Applied Ergonomics*, *18*(3), 233–237. http://doi.org/10.1016/0003-6870(87)90010-X

Mahdavi, S., Rashidi, R., & Dehghani, T. (2014). Evaluation of the risk of musculoskeletal disorders using Rapid Entire Body Assessment among hairdressers in, *2*(3).

Majid, E., Lopez, A. D., Rodgers, A., & Murray, C. J. L. (2004). Comparative Quantification of Health Risks: Sexual and reproductive health. *Comparative Quantification of Health Risks: Sexual and Reproductive Health*, 1651–1800.

Makrides, L., Smith, S., Allt, J., Farquharson, J., Szpilfogel, C., Curwin, S., … Edington, D. (2011). The Healthy LifeWorks Project. *Journal of Occupational and Environmental Medicine*, *53*(7), 799–805. http://doi.org/10.1097/JOM.0b013e318222af67

Marić, A., Arsovski, S., & Mastilović, J. (2009). Contribution to the improvement of products quality in baking industry. *International Journal for Quality Research*, *3*(3), 1–8. Retrieved from http://www.ijqr.net/journal/v3-n3/01.pdf

Marques, N. R. P., Oliveira Matias, J. C. De, Reis Baptista Teixeira, R. Dos, & Ribeiro Proença Brojo, F. M. (2012). Implementation of Hazard Analysis Critical Control Points (HACCP) in a SME: Case Study of a Bakery. *Polish Journal of Food and Nutrition Sciences*, *62*(4), 215–227. http://doi.org/10.2478/v10222-012-0057-5

Marquez, M. . c, Cancelo, A. . c c, Ramírez, C. . c c, & Colmenares, A. . c c. (2006). Assessment of ergonomics risk factors in a SME plastic injection case of study: Europol C.A. *9th Annual Applied Ergonomics Conference 2006, Conference Proceedings*, *2006*. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-34047163570&partnerID=40&md5=9e3a2c510c3bc17897340e5b45c659db

Md. Deros, B., Daruis, D. D. I., Ismail, A. R., & Rahim, A. R. A. (2010). Work posture and back pain evaluation in a Malaysian food manufacturing company. *American Journal of Applied Sciences*, *7*(4), 473–479. http://doi.org/10.3844/ajassp.2010.473.479

Mehrizi, M. M., Ebrahemzadih, M., & Tajvar, A. (2014). Survey of Prevalence and Risk Factors Associated with Upper Extremity Musculoskeletal Disorders by Repetitive Job Activities Methods in Baker of Iran, (December), 3030–3036.

Mirmohammadi, S., Yazdani, J., & Etemadinejad, S. (2015). A cross-sectional study on work-related musculoskeletal disorders and associated risk factors among hospital health cares. *Procedia Manufacturing*, *3*(Ahfe), 4528–4534. http://doi.org/10.1016/j.promfg.2015.07.468

Mohammadi, Z., & Ghanbary, A. (2014). Evaluation of musculoskeletal disorders through loading postural upper body assessment method in household appliances production companies in Tehran , Iran , in 2014, *3*(3), 140–144.

Nejad, N. H., Choobineh, A., Rahimifard, H., Haidari, H. R., & Tabatabaei, S. H. R. (2013). Musculoskeletal risk assessment in small furniture manufacturing workshops. *International Journal of Occupational Safety and Ergonomics*, *19*(2), 275–284. http://doi.org/10.1080/10803548.2013.11076985

Of, P., Symptoms, M., Production, A., Workers, L., Printing, I. N. A., & Company, M. (2014). Prevalence of Musculoskeletal Symptoms Among Production Line Workers in a Printing. *International Journal of Public Health and Clinical Sciences*, *1*(1), 109–117.

Palmer, K. T. (2011). Carpal tunnel syndrome: The role of occupational factors. *Best Practice & Research Clinical Rheumatology*, *25*(1), 15–29. http://doi.org/10.1016/j.berh.2011.01.014

Practice, G., & Workplace, I. (n.d.). Good Practice in the Irish Workplace.

Preventing and managing discomfort , pain and injury. (n.d.).

Qutubuddin, S. M., Hebbal, S. S., & Kumar, A. C. S. (2013). An ergonomic study of work related musculoskeletal disorder risks in Indian Saw Mills. *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)*, *7*(5), 7–13.

Rabiul, M. (2002). *Occupational Health , Safety and Ergonomic Issues in Small and Medium-Sized Enterprises in a Developing Country*.

Reinhold, K., Tint^1, P., Tuulik, V., & Saarik, S. (2008). Innovations at Workplace: Improvement of Ergonomics. *Naujoviu Jvedimas Darbo Vietose: Pasiekimai Ergonomikoje.*, *60*(5), 85–94. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=36170471&site=ehost-live

Saikia, P., & Borah, R. (2015). Postural and musculoskeletal disorder risk assessment in bakery industry using Rula method, *6*(2), 106–112. http://doi.org/10.15740/HAS/ARJSS/6.2/106-112

Satish, S., Karandikar, V., & Sane, S. M. (2013). Industrial Work Station design : An Ergonomic Approach to Number Punching Machine, 1463–1466.

Service, L. T., & Division, R. D. (1947). Food and Agriculture Organization of the United Nations. *International Organization*, *1*(02), 350. http://doi.org/10.1017/S0020818300006160

Stevenson, J., 2014. Ecological Assessments with Algae: A Review and Synthesis. *Journal of Phycology*, 50, pp.437–461.

Tajvar, A., Hasheminejad, N., & Ghashghavi, H. (2009). Evaluation of risk factors causing work - related musculoskeletal disorders (WMSDS) in kerman bakery workers by OCRA Index method

Wash, E. (1993). Shaping and Baking Dinner Rolls, (December), 15–17.

Website Department of Occupational Safety and Health Malaysia - Main. (n.d.). Retrieved from http://www.dosh.gov.my/index.php/en/

WHO | Risk factors. (2014). *WHO*.

Willquist, P., & Törner, M. (2003). Identifying and analysing hazards in manufacturing industry - A review of selected methods and development of a framework for method applicability. *International Journal of Industrial Ergonomics*, *32*(3), 165–180. http://doi.org/10.1016/S0169-8141(03)00061-1

APPENDIX A

GANTT CHART

Activities		JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC
Propose research title		W2											
Reviewing the literature			W1	W1	W1	W1	W1	W1	W1	W1	W3		
Finalising method					W2	W1	W4						
Data collection	Checklist							W4					
	Questionnaire							W4					
	Worksheet Assessment								W2				
Data Analysis									W3	W4	W1		
Preparation of Report											W3	W4	
Report Submission													w1
Final Presentation													w2

APPENDIX B

INDUSTRIAL ERGONOMIC SCREENING CHECKLIST

Industrial Ergonomic Screening Checklist

Direction: Analyze the task and mark the check boxes for any risk factors. List the ergonomic control measures that mitigate the identified risk factors.

Task			
Location		**Department**	
Evaluated by		**Date**	

1. Lifting		
Risk Factor	**Risk Factor Observed**	**Risk Control Measures** (e.g., mechanical assists, making load smaller, additional help, lifting technique, postural awareness, microbreaks, work rotation)
Lifting between 50 and 70 lbs.	☐	
Lifting objects above shoulder level or below the knees	☐	
Lifting objects with the hands > 12 inches horizontally from the body	☐	
Frequent lifts Low-frequency: < 2 hours/day or > 2 hours/day with < 12	☐	

lifts/hour Moderate-frequency: > 2 hours/day and < 30 lifts/hour High-frequency: > 2 hours/day and < 360 lifts/hour		
2. Awkward Postures		
Risk Factor	**Check If Observed**	**Risk Control Measures** (e.g., mechanical assists, adjustable workstations, tools with alternate handles, stands, larger grips, postural awareness, microbreaks)
Overhead work - hands above the head, elbows above the shoulders. Cumulative duration > 2 hours/day.	☐	
Neck or back is bent > 30°, little ability to vary posture. Cumulative duration > 2 hours/day.	☐	
Squatting or kneeling. Cumulative duration > 2 hours/day.	☐	
Bent wrists. Cumulative duration > 2 hours/day.	☐	
3. Forceful Hand Movements		

Risk Factor	**Check If Observed**	**Risk Control Measures** (e.g., mechanical assists, tools with alternate handles, stands, larger grips, clamps, making load smaller)
Pinching to hold unsupported objects ≥ 2 lbs/hand (using pinch force equivalent to holding half a ream of paper). Cumulative duration > 2 hours/day.	☐	
Gripping ≥ 10 lbs/hand to hold unsupported objects (using gripping force equivalent to squeezing car jumper cables). Cumulative duration > 2 hours/day.	☐	
4. Other (Body Movements, Vibration, Slip/Trip/Fall)		
Risk Factor	**Check If Observed**	**Risk Control Measures** (e.g., automated processes, gloves/grip handles, barriers, proper tool maintenance, microbreaks, work rotation, proper housekeeping)
Repeating the same movement with little or no variation (≥ 5 times/min). Cumulative duration > 2 hours/day.	☐	

Work involving sudden movements (e.g., starting a chainsaw)	☐	
Vibration from high-vibration tools (e.g., chain saws, jackhammers, impact wrenches) > 30 minutes/day OR from moderate-vibration tools (e.g., saws, sanders) > 2 hours/day.	☐	
Work around potential slip/trip/fall hazards (e.g., loading docks, stairs, wet/greasy surfaces)	☐	

Source: SLAC National Acceleration Laboratory (2016)

APPENDIX C

STANDARDIZED NORDIC QUESTIONNAIRE

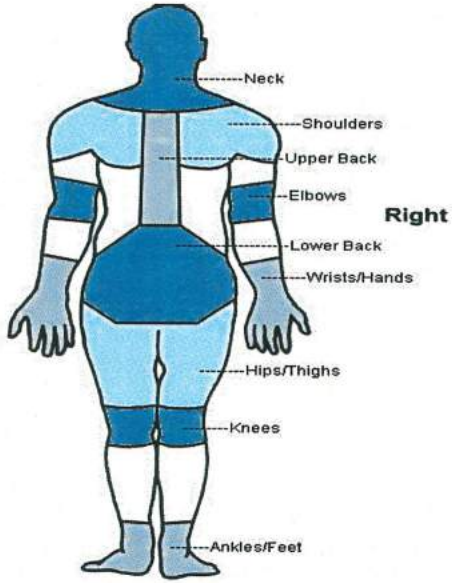
Musculoskeletal Discomfort Form (Based on the Nordic Questionnaire (Kourinka et al. 1987)) **Employee ID:**_____

Job/Position: _____ Gender: M F Age: _____

How long have you been doing this job? ___years ___ months How many hours do you work each week? _____

To be answered by everyone	**To be answered by those who have had trouble**	
Have you at any time during **the last 12 months** had trouble (ache, pain, discomfort, numbness) in:	Have you at any time during the **last 12 months been prevented from doing your normal work** (at home or away from home) because of the trouble?	Have you had trouble at any time during **the last 7 days?**
Neck ☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes
Shoulders ☐ No ☐ Yes, right shoulder ☐ Yes, left shoulder ☐ Yes, both shoulders	☐ No ☐ Yes	☐ No ☐ Yes

Left **Right**



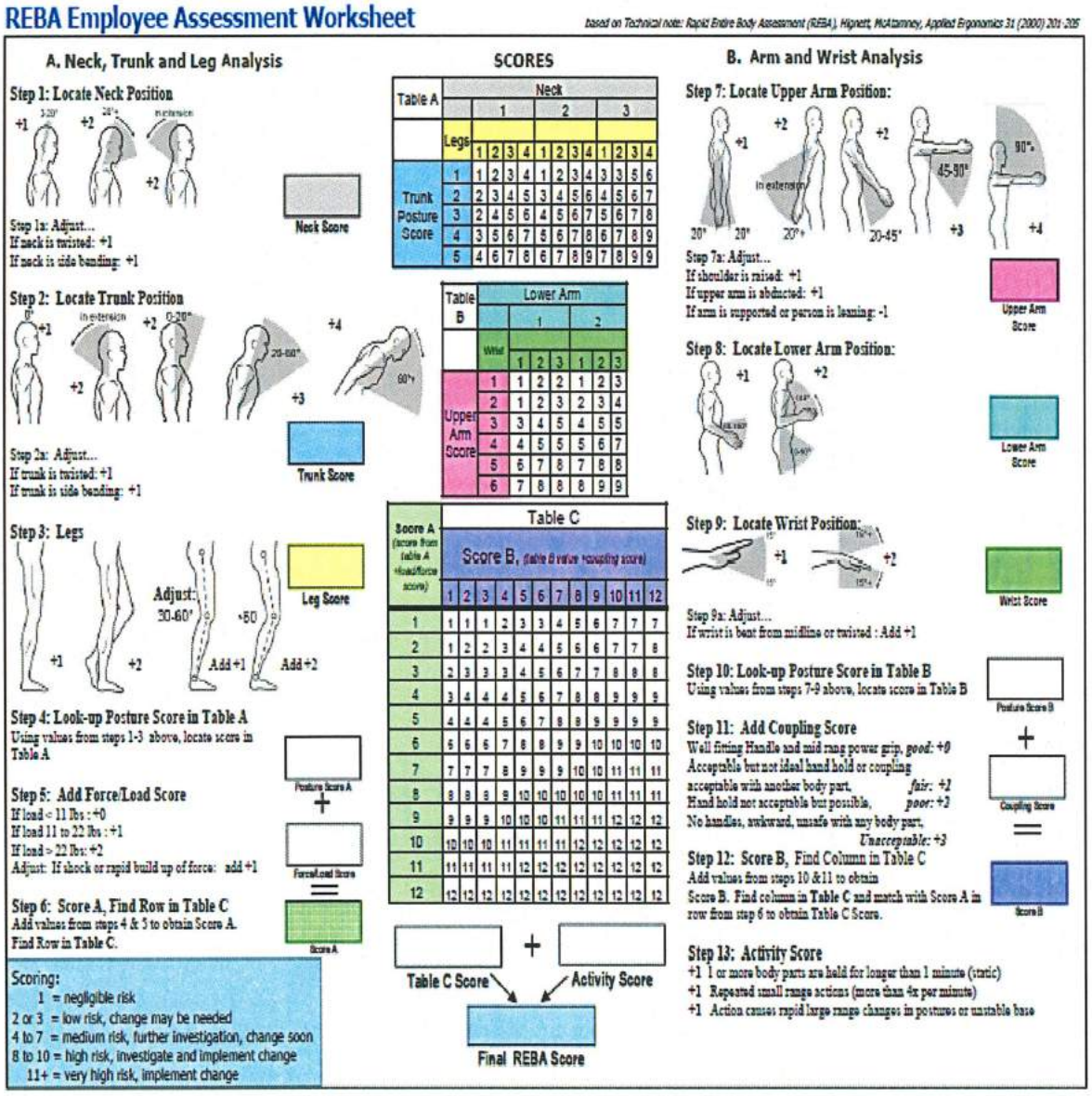
Back View

Elbows ☐ No	☐ Yes, right elbow ☐ Yes, left elbow ☐ Yes, both elbows	☐ No	☐ Yes	☐ No	☐ Yes
Wrists/Hands ☐ No	☐ Yes, right wrist/hand ☐ Yes, left wrist/hand ☐ Yes, both wrists/hands	☐ No	☐ Yes	☐ No	☐ Yes
Upper Back ☐ No	☐ Yes	☐ No	☐ Yes	☐ No	☐ Yes
Lower Back (small of back) ☐ No	☐ Yes	☐ No	☐ Yes	☐ No	☐ Yes
One or Both Hips/Thighs ☐ No	☐ Yes	☐ No	☐ Yes	☐ No	☐ Yes
One or Both Knees ☐ No	☐ Yes	☐ No	☐ Yes	☐ No	☐ Yes
One or Both Ankles/Feet ☐ No	☐ Yes	☐ No	☐ Yes	☐ No	☐ Yes

(Adopted From Kourinka et .Al. 1987)

APPENDIX D

RAPID ENTIRE BODY ASSESSMENT



(Adopted From Hignett & McAtamney 2000)

APPENDIX E

LIST OF RELATED FIGURES

a) Mixing, dividing and shaping

b) Baking

c) Slicing

d) Wrapping

e) Interview Session