UNIVERSITI PUTRA MALAYSIA

IMPLEMENTATION OF KIKEN YOCHI INTERVENTION APPROACH TO REDUCE MUSCULOSKELETAL SYMPTOMS AMONG MALE WORKERS OF PINEAPPLE FARM PLANTATIONS IN JOHOR, MALAYSIA

NOOR AFIFAH BINTI YA'ACOB

FPSK(M) 2017 53

IMPLEMENTATION OF KIKEN YOCHI INTERVENTION APPROACH TO REDUCE MUSCULOSKELETAL SYMPTOMS AMONG MALE WORKERS OF PINEAPPLE FARM PLANTATIONS IN JOHOR, MALAYSIA

By

NOOR AFIFAH BINTI YA'ACOB

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Master of Science

June 2017

COPYRIGHT

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the Degree of Master of Science

IMPLEMENTATION OF KIKEN YOCHI INTERVENTION APPROACH TO REDUCE MUSCULOSKELETAL SYMPTOMS AMONG MALE WORKERS OF PINEAPPLE FARM PLANTATIONS IN JOHOR, MALAYSIA

By

NOOR AFIFAH BINTI YA'ACOB

June 2017

Chairman : Emilia Zainal Abibdin, PhD
Faculty : Medicine and Health Science

Background: Work tasks in pineapple plantations in Malaysia are characterized by non-ergonomic work posture, awkward movement and repetitive tasks that put a lot of strain on the body, heavy weight lifting and manual handling of work tools. Heavy work tasks contributes to the reporting of musculoskeletal symptoms (MSS) of workers. Thus, *Kiken Yochi* training was selected as training programmes in reducing MSS. *Kiken* (hazard) *Yochi* (prediction) training is a Japanese activity used to motivate members to recognize and predict hazards that develops sensitivity to unsafe conditions or hazardous situations. **Objective:** The aim of this study was to assess effects of work improvement module using a *Kiken Yochi* participatory approach in reducing MSS among male migrant pineapple farm plantation workers in Pontian, Johor. **Methodology:** A total of 45 male migrant workers that consisted of 27 workers for the intervention group and 18 workers for the control group from two pineapple plantations in Pontian, Johor were recruited by simple random sampling method in this experimental type study. This study consisted of three phases. Before the first phase of this study started, hazard identification, risk assessment and risk control (HIRARC) was conducted using a video recording which were based on the methods established by the Department of Occupational Safety and Health (DOSH) (Malaysia). In the first phase of the study, workers completed a self-administered questionnaire in Bahasa Malaysia which asks items on MSS. MSS were assessed using a questionnaire adapted from the standardized Nordic questionnaire (SNQ). Then ergonomic risks were assessed using rapid upper limb assessment (RULA) and lastly MSS education training were implemented to both groups of workers. The MSS education training provided information on proper lifting techniques and education on body mechanics and ergonomics to reduce MSS among workers. *Kiken Yochi* Training was given to the intervention group only. In the second phase of the study, post- intervention questionnaire was distributed among all workers 2 months after the first phase of the study was conducted. **Results:** The highest distribution of MSS for the past 12 months

during pre-intervention phase among intervention group are knee (59%, n=16), lower back (59%, n=16) and shoulder (56%, n=15) while among control group are lower back (67%, n=12), shoulder (50%, n=9) and knee (44%, n=8). Based on the HIRARC outcome, there are three work tasks categorized as high risk, namely cultivation, manual weeding and harvesting. While for ergonomic risk assessment, the highest risk were cultivation and harvesting where 22 of workers were categorized as having very high risk of MSS level (grand score of more than 7+). Approximately 8 of workers had very high risk for MSS while performing manual weeding. Post-intervention, statistical analysis using non-parametric McNemar test found significant decrease of prevelance of ankle/feet disorders but the prevalence of lower back symptoms showed an increase within the intervention group. **Conclusion**: Implementation of the *Kiken-Yochi* participatory approach training among male migrant pineapple workers at Pontian, Johor was not linked with the general reduction of MSS except for the selected regions of the body. It is suggested that work methods incorporating modifications on the existing manual tools are needed before a successful ergonomic training can be effectively implemented. Proactive measures and actions needs to be taken by the authority in improving the safety and health of workers in the pineapple plantation sector.

Keywords: Rapid Upper Limb Assessment, Farmers, Agriculture, Ergonomics, HIRARC

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Sarjana Sains

PELAKSANAAN PENDEKATAN CAMPUR TANGAN KIKEN YOCHI BAGI MENGURANGKAN GEJALA PENYAKIT OTOT DALAM KALANGAN PEKERJA ASING LELAKI LADANG NANAS DI PONTIAN, JOHOR.

Oleh

NOOR AFIFAH BINTI YA'ACOB

Jun 2017

Pengerusi : Emilia Zainal Abibdin, PhD
Fakulti : Perubatan dan Sains Kesihatan

Latar Belakang: Bidang kerja di ladang nanas di Malaysia bercirikan postur kerja yang tidak ergonomik, pergerakan yang janggal dan tugas berulang-ulang yang menyebabkan tekanan pada badan, mengangkat berat dan pengendalian alat kerja yang manual. Oleh itu, latihan *Kiken Yochi* telah dipilih sebagai program latihan bagi mengurangkan MSS. Latihan *Kiken* (bahaya) *Yochi* (jangkaan) ialah aktiviti orang Jepun yang digunakan untuk memotivasikan ahli bagi mengenalpasti dan menjangkakan bahaya yang mengembangkan sensitivity kepada persekitaran yang tidak selamat atau situasi yang bahaya. **Objektif:** Tujuan kajian ini adalah untuk menilai kesan modul penambahbaikan kerja menggunakan pendekatan penyertaan Kiken Yochi dalam mengurangkan MSS dalam kalangan pekerja asing lelaki di ladang nanas Pontian, Johor. **Metodologi:** Seramai 45 pekerja asing lelaki yang terdiri daripada 27 pekerja untuk kumpulan intervensi dan 18 pekerja untuk kumpulan kawalan dari dua ladang nanas di Pontian, Johor telah diambil dengan menggunakan kaedah persampelan rawak mudah dalam kajian jenis eksperimen ini. Kajian ini terdiri daripada tiga fasa. Sebelum fasa pertama dijalankan, *Hazard Identification, Risk Assessment and Risk Control* (HIRARC) telah dijalankan menggunakan rakaman video yang dibuat berdasarkan kaedah yang ditetapkan oleh Jabatan Keselamatan dan Kesihatan Pekerjaan (JKKP) (Malaysia). Pada fasa pertama kajian, pekerja telah melengkapkan soal selidik tentang MSS dalam Bahasa Malaysia. Gejala otot skeletal telah dinilai menggunakan soalan yang diadaptasi daripada boring soal selidik *Standardized Nordic Questionnaire* (SNQ). Manakala penilaian risiko ergonomik telah diukur melalui *Rapid Upper Limab Assessment* (RULA) dan akhir sekali pendidikan gejala otot skeletal telah dilaksanakan untuk kedua-dua kumpulan pekerja. Pendidikan gejala otot skeletal yang diberikan berkenaan teknik mengangkat yang betul dan mengenai mekanik badan dan ergonomik untuk mengurangkan gejala otot skeletal dalam kalangan pekerja. Latihan Kiken Yochi telah diberikan kepada kumpulan intervensi sahaja. Dalam fasa kedua kajian, pasca campur tangan soal

selidik telah diedarkan di kalangan semua pekerja 2 bulan selepas fasa pertama kajian ini dijalankan. **Hasil Kajian:** Taburan tertinggi MSS bagi tempoh 12 bulan lalu semasa fasa intervensi antara kumpulan intervensi ialah lutut (59%, n = 16), belakang (59%, n = 16) dan bahu (56%, n = 15) manakala taburan MSS antara kumpulan kawalan adalah belakang rendah (67%, n = 12), bahu (50%, n = 9) dan lutut (44%, n = 8). Berdasarkan keputusan HIRARC, terdapat tiga tugas kerja yang dikategorikan sebagai berisiko tinggi, iaitu penanaman, merumput manual dan menuai. Manakala bagi penilaian risiko ergonomik, risiko paling tinggi adalah penanaman dan penuaian di mana 22 pekerja telah dikategorikan sebagai mempunyai risiko tahap gejala otot skeletal yang sangat tinggi (jumlah skor lebih daripada 7+). Kira-kira 8 pekerja mempunyai risiko yang sangat tinggi untuk gejala otot skeletal semasa melakukan merumput secara manual. Post-intervensi, analisis statistik menggunakan ujian McNemar bukan parametrik mendapati penurunan ketara untuk gangguan buku lali / kaki tetapi prevalens gejala belakang rendah menunjukkan peningkatan dalam kumpulan intervensi. **Kesimpulan:** Pelaksanaan pendekatan penyertaan *Kiken-Yochi* dalam kalangan pekerja asing lelaki di ladang nanas Pontian, Johor tiada kaitan dengan pengurangan gejala otot skeletal kecuali bagi anggota badan yang terpilih. Adalah dicadangkan bahawa kaedah kerja menggabungkan pengubahsuaian kepada alat manual yang sedia ada yang diperlukan sebelum latihan ergonomik yang berjaya dapat dilaksanakan dengan berkesan. Langkah-langkah proaktif dan tindakan perlu diambil oleh pihak berkuasa dalam meningkatkan keselamatan dan kesihatan pekerja dalam sektor perladangan nanas.

Kata kunci: Rapid Upper Limb Assessment, Peladang, Pertanian, Ergonomik, HIRARC

ACKNOWLEDGEMENTS

In the name of Allah, the Most Gracious and the Most Merciful

Alhamdulillah, all praises to Allah for the strengths and His blessing in completing this thesis. Special appreciation goes to my dedicated supervisor, Dr Emilia Zainal Abidin, for her supervision and never ending support. Her meaningful words and invaluable help of constructive comments and suggestions throughout the research and thesis works have contributed a lot to the success of this research. Not forgotten, my appreciation to my co-supervisors Dr Irniza Rasdi, Associate Proffesor Dr Anita Abd Rahman, Dr Suriani Ismail for their support and knowledge pertaining to this research.

I would like to express my deepest gratitude to my beloved and supportive family for their endless prayers and encouragement. My acknowlwedgement also goes to all office staffs of Department of Occupational and Environmental Health, Faculty of Medicicne and Health Sciences, Universiti Putra Malaysia for their co-operations.

My sincere thanks to all managers and workers of pineapple farm plantations who involved in this study for their involvement, co-operation and toleration through data collection phase. Last but not least, sincere thanks to all my lovely friends for their moral support during my study.

Thank you.

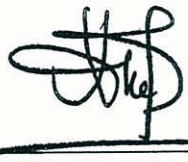
I certify that a Thesis Examination Committee has met on 9 June 2017 to conduct the final examination of Noor Afifah binti Ya'acob on her thesis entitled "Implementation of Kiken Yochi Intervention Approach to Reduce Musculoskeletal Symptoms among Male Workers of Pineapple Farm Plantations in Johor, Malaysia" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

Members of the Thesis Examination Committee were as follows:

Haliza binti Abdul Rahman, PhD
Associate Professor
Faculty of Medicine and Health Sciences
Universiti Putra Malaysia
(Chairman)

Karmegam a/l Karuppiah, PhD
Senior Lecturer
Faculty of Medicine and Health Sciences
Universiti Putra Malaysia
(Internal Examiner)

Noor Hassim Ismail, PhD
Professor
Universiti Kebangsaan Malaysia
Malaysia
(External Examiner)



NOR AINI AB. SHUKOR, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 28 September 2017

This thesis was submitted to the Senate of the Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The member of the Supervisory Committee were as follows:

Emilia Zainal Abibdin, PhD
Senior Lecterur
Faculty of Medicine and Health Sciences
Universiti Putra Malaysia
(Chairman)

Irniza Rasdi, PhD
Senior Lecterur
Faculty of Medicine and Health Sciences
Universiti Putra Malaysia
(Member)

Anita Abd Rahman, M. CommH (OH)
Associate Professor
Faculty of Medicine and Health Sciences
Universiti Putra Malaysia
(Member)

Suriani Ismail, M. CommH (OH)
Medical Lecturer
Faculty of Medicine and Health Sciences
Universiti Putra Malaysia
(Member)

_____
ROBIAH BINTI YUNUS, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date :

Declaration by graduate student

I hereby confirm that:

- this thesis is my original work;
- quotations, illustrations and citations have been duly referenced;
- this thesis has not been submitted previously or concurrently for any other degree at any institutions;
- intellectual property from the thesis and copyright of thesis are fully-owned by Universiti Putra Malaysia, as according to the Universiti Putra Malaysia (Research) Rules 2012;
- written permission must be obtained from supervisor and the office of Deputy Vice-Chancellor (Research and innovation) before thesis is published (in the form of written, printed or in electronic form) including books, journals, modules, proceedings, popular writings, seminar papers, manuscripts, posters, reports, lecture notes, learning modules or any other materials as stated in the Universiti Putra Malaysia (Research) Rules 2012;
- there is no plagiarism or data falsification/fabrication in the thesis, and scholarly integrity is upheld as according to the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) and the Universiti Putra Malaysia (Research) Rules 2012. The thesis has undergone plagiarism detection software

Signature: _____ Date: _____

Name and Matric No.: Noor Afifah Binti Ya'acob, GS41038

Declaration by Members of Supervisory Committee

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) were adhered to.

Signature: _____
Name of Chairman of Supervisory Committee: Dr. Emilia Zainal Abibdin

Signature: _____
Name of Member of Supervisory Committee: Dr. Irniza Rasdi

Signature: _____
Name of Member of Supervisory Committee: Associate Professor Dr. Anita Abd Rahman

Signature: _____
Name of Member of Supervisory Committee: Dr. Suriani Ismail

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

BMI	Body Mass Index
CI	Confidence Interval
DOSH	Department of Occupational Safety and Health
GDP	Gross Domestic Product
HIRARC	Hazard Identification, Risk Assessment and Risk Control
ILO	International Labor Organization
KYT	Kiken Yochi Training
MPIB	Malaysia Pineapple Industry Board
MSD	Musculoskeletal Disease
MSS	Musculoskeletal Symptoms
NADOPOD	Notification of Accident, Dangerous Occurrence, Occupational Poisoning and Occupational Disease
NIOSH	National Institute Occupational Safety and Health
NKEA	National Key Economic Area
OR	Odd Ratio
PE	Participatory Ergonomic
RULA	Rapid Upper Limb Assessment
SD	Standard Deviation
SNQ	Standardized Nordic Questionnaire
SOCSO	Social Security Organization
WRMSD	Work Related Musculoskeletal Disorder

CHAPTER 1

INTRODUCTION

1.1 Background

The economic activity in the agricultural sector propels the significant number of employments to fulfil the demands of the workforce worldwide. In 2014, it is estimated that the percent of employment in agriculture range between 30 to 49% in Asian countries such as Thailand, Vietnam, Indonesia, Philipines and Sri Lanka (World Bank, 2016). In Malaysia, the agricultural sector remains as an important sector for economy after services and manufacturing sectors employing an estimated 12.2% of employment in year 2014 (UNdata, 2016). Recent estimates showed that agricultural sector has contributed a gross domestic product (GDP) of 8.43% that is equal to RM 22.6 million (Department of Statistic Malaysia, 2015) to Malaysia. As reported by Department of Agriculture in 2008, the number of labor force in the agricultural industries has increased from 1.2 million to approximately 1.4 million workers (Tamrin & Aumran, 2014).

Nevertheless, agriculture is well known as one of the most hazardous occupational sectors worldwide (Fathallah, 2010). This is due to labor intensive practices such as manual handling of heavy materials and loads (Walker-Bone and Palmer, 2002; Gupta & Tarique, 2013), awkward and difficult work postures (Da Costa and Vieira, 2010; Gupta & Tarique, 2013), long and irregular working hours (Raanaas and Anderson, 2008; Earle-Richardson *et al*., 2010), exposure to extreme weather conditions (Earle-Richardson *et al*., 2010) and whole body vibration (Davis & Kotowski 2007; Walker-Bone and Palmer, 2002; Gupta & Tarique, 2013) apart from animal and insect bites (Rocha *et al*., 2014). These occupational hazards in the agricultural sector has been linked with musculoskeletal diseases (MSDs), physical stress (Essen & Curdy, 1998), respiratory disease, noise induced hearing loss, pesticide-related illnesses, and increased reporting of cancer cases (Arcury and Quandt, 2003; Arcury *et al*., 2002; Earle-Richardson *et al.,* 2003; Kirkhorn and Schenker, 2002; McCurdy et al., 2003; Rautiainen and Reynolds, 2002).

In Malaysia, the main commodity for agricultural sector is the palm oil industry. Besides the palm oil sector, cocoa, rubber and paddy plantations are also important in Malaysia. Other than these plantations, Malaysia are involved in tropical fruits plantations which contributes significantly to the Gross Domestic Product (GDP) of the nation. Pineapple is one of the selected tropical fruits which has been promoted by the Malaysian government and has been included as one of the five fruits stated in the National Key Economic Area (NKEA) (Department of Agriculture (DOA), 2012). In 2015, canned pineapple from Malaysia has been exported to Japan, Pakistan and the United States of America (USA) while for fresh pineapples, Malaysia has exported large quantities of the product to Singapore, Iran and Egypt (Malaysian Pineapple Industry Board (MPIB), 2016). In 2015, Malaysia had 14,700 hectares of pineapple

plantation area producing approximately 427,680 metric ton of pineapple per year which valued at RM577.4 million (MPIB, 2016).

The pineapple industry in Malaysia is the oldest agro-based export-oriented industry which was introduced by the Portoguese in the sixteenth century (MPIB, 2012). The pineapple industry plays an important role in the socio-economic activity of the rural population in this country although it is relatively smaller compared to palm oil and rubber industries. This industry provided jobs to almost 5,200 smallholding farmers in Malaysia in 1994 (MPIB, 2001). In 2009, the Malaysia pineapple industry currently employes an estimated number of 8, 000 workers (MPIB, 2010).

The Malaysian pineapple farming is unique because nearly 90% of the crop is planted on peat soil. Peat soil is characterized by its soft and unstable base of land (Rani *et al*., 2016). The primary area for pineapple production in Malaysia is Johor, a state in the southern peninsular of Malaysia. Three main districts in Johor that have planted pineapples are Pontian with 3,686 hectares, Kluang with 2,950 hectares and Muar with 1,286 hectares respectively (DOA, 2009). In addition, pineapple plantations has now advanced to Selangor, Pahang and Perak and also to Sabah and Sarawak.

In terms of occupational health effects from labor internsive practices, musculoskeletal disorder (MSD) is a common disease among those working in the agriculture sector (Holmberg *et al*., 2003). In general, MSD can affect the neck, back, shoulders, elbows, forearms, wrists and hands (Abas et al., 2008). Musculoskeletal symptoms (MSS) consists of signs such as pain, swelling in the joints, stiffness, numbness, tingling, clumsiness, loss of coordination, loss of strength, skin discoloration and difficulty moving in activities either at work or during leisure time (Pheasant et al., 2006). MSD is a chronic cumulative disorder, due to ergonomic reasons related to repeated exposure to heavy loads, repetitive movements, and awkward body postures over a period of time, forceful exertion, static muscular work, mechanical pressure and other relevant factors. These factors are also called work-related musculoskeletal disorders (WMSDs) (Aptel *et al*., 2002).

Complaints regarding WMSDs among agriculture workers are highest compared to other sectors of occupation. Agriculture is ranked as top three most hazardous sectors in world for both in developing and developed countries (DeRoo & Rautiainen, 2000). This is due to the fact that work in agricultural sector is strenuous and has been linked with high physical strain associated with farming tasks (Xiang *et al*., 1999). The tasks that agricultural workers have faced in their daily routine consist of among others lifting and carrying heavy loads over 23 kg, constant and repeated full body bending and twisting and performing highly repetitive hands work (Meyers *et al*., 2002).

The extent of the MSD problem among those working in agricultural sector is large. A survey was conducted among farmers at the Southeast of Kansas, USA in 2005 (Rosecrance *et al*., 2006) revealed nearly 60% of the workers experienced MSS.

According to Meyers *et al*. (2002), the rate of lost-time injuries occurred among field crop farmers are 5.8 injuries per 200,000 hours. Due to the fact that MSS can result in lifelong pain and permanent disability when not addressed (Singh & Arora, 2010), the impact of MSS problems is far-reaching and is above the scope of the individual. As a result, it is not only affects the psychosocial status of individuals but impacts on their families and those under their care (Woolf & Pfleger, 2003). Workers who are involved in labor intensive practices such as manual loading and those who work for a long period of time are at greater risk for MSS.

Consequently, MSD cause a huge burden to the industrial sector in terms of economic aspects. MSD can cost the farming industry lost productivity and human costs to the farmers (Chapman & Meyers, 2001). According to the Washington State Department of Labor and Industries, USA the direct cost for MSDs especially in the neck, back and upper extremity among workers who worked in the agriculture, forestry, fishing, and hunting industries is estimated to be more than United States Dollar (USD) 136 million between 1995 and 2007. While Demers and Rosenstock (1991) stated that insurance claims for agricultural workers were 50% higher compared to non-agricultural workers in Washington, USA. In 2011, the Bureau of Labor Statistics reported more than 1,500 farm workers experienced lost work time for a median of seven days due to MSDs (Lee *et al.,* 2014). A 23% to 34% of farmers or farm residents were reported to undergo medical visits due to back pain in the USA (Rosecrance *et al.,* 2006, Greenlee *et al*., 2005).

Since MSD can cause a huge burden in all aspects, it has been often been suggested that MSD can be reduced by employing an intervention approach in the work training. There have been many reports of intervention involving participatory approachs in reducing MSD and participatory ergonomic approaches interventions are one of the known avenues (Denis *et al.,* 2007). Ergonomic improvement in the workplace condition play an important role in occupational health practices (Kogi, 2010) since it can generally improve both productivity at work and workers' quality of life (ILO, 2012; Niu & Kogi, 2012). These improvements have direct effects on manager and employee relationship, mutual support among co-workers, and workplace culture for better quality of work life. The participatory intervention has been successfully used in several studies to reduce physical work demands and to prevent MSDs (Vink *et al*., 2006). Participatory approaches have been frequently reported to be more effective than common training, or didactic training (Yu, Yu & Li, 2011).

Participatory approaches such as *Kiken Yochi* Training and *Kiken Yochi Katsudou* are methods which have originated from Japan (Ito *et al*., 2014) since year 1974 (Na & Yi, 2011). *Kiken* in Japanese means hazard while *yochi* means prediction. The purpose of *Kiken Yochi* Training is to enhance first-line employees' ability to anticipate potential hazards in their workplace, discover hazards which they could cause themselves and work accordance with safety operating procedures. There are four-round steps in *Kiken Yochi* Training which consist of discussion, evaluation, planning, and implementation. This approach use an illustrations to represent abnormal or unplanned state of a

workplace. Through the discussion about how to improve abnormal or unplanned, workers learn to anticipate potential hazard in the work procedure and workplace.

Kiken Yochi has been frequently used in the manufacturing industries. With recent time, this method has evolved to include the calling out and verbal affirmation of the description of the hazard by practicing pointing activities in all of the important hazards in the workplace. This method is hugely popular in Japan, being implemented in Tokuyama Corporation (chemical product), zeon corporation (world leading products), NGK Spark Plug Co. Ltd. (provides information on job opportunities) and Hitachi Chemical co. Ltd. (chemical manufacturer).

1.2 Problem Statements

Activities performed in pineapple plantations entails tasks that are strenuous relative to other types of work in the agricultural sector as almost all of the activities are performed manually *(*Rani *et al.,* 2016). Pineapples are a short crop-rotation crop in which the life cycle for pineapple from planting to maturity is 14 to 16 months depending on the variety and the physical environment. Pineapple growing involves five main steps that start from land preparation, cultivating, weeding control, flowering induction (hormone growth) and ends with harvesting (Rani *et al*., 2016). Work in pineapple plantation involve heavy weight lifting and repetitive and monotonous tasks that put a lot of strain on the body such as constant bending (Tamrin & Aumran, 2014). To make matters worse, since pineapples grow low from the ground averaging to a height of one meter tall and 0.5 meter width, the workers need to work in an awkward posture such as stooping and constant bending while tasks are performed due to manual work for 6 to 8 hours per day (Rani *et al*., 2016). In addition, due to the soft peat soil, work tasks that require maneuvering manual loads becomes difficult (Tamrin & Aumran, 2014). From a previous study, it was found that MSS is common among pineapple workers who worked manually that many perceived them as no more than normal and inevitable consequences of plantation labour (Rani *et al.* 2016).

Recent data have found that pineapple workers complaints lower backache while bending for a prolonged time to perform the tasks (Tamrin & Aumran, 2014). Another local study found that MSS reported at the lower back area were linked with heavy lifting of pineapple fruits on the back which occurs during harvesting process and also excessive bending during the cultivation of shoots and manual weeding process (Rani *et al*., 2016). When MSD data from the Social Security Organization (SOCSO) (2014) was observed, it was found that increasing trend of reported cases in Malaysia is evident, from 517 cases in 2013 to 675 cases in 2014.

Figure 1.1 : Work Process linked with Musculoskeletal Problems at Lower Back Area

Reiterating an earlier point, MSD causes a huge burden to the manual working sector in terms of economic aspects. On a local scale, Malaysia has reported the increasing trend of workers' compensation for permanent and temporary benefits from 310 million in 2008 to 500 million in 2012 (SOCSO, 2012) for all the sectors.

All these evidences of MSS cases have shown the need for participatory approach such as in order to reduce MSS to be conducted. There are a lot of successful participatory approach programs based on simple and low-cost practical solution concept in disseminating ergonomically sound workplace improvement applicable and adaptable for different local situation and work environment (Niu, 2010). The programs such as Work Improvements in Small Enterprises (WISE), Work Improvement in Neighbourhood Development (WIND) and Ergonomics Checkpoints in Agriculture has been created specifically for the rural and agricultural setting. In Malaysia, a study done by Ng *et al.* (2014) described the implementation of Participatory-Action Oriented Training (PAOT) among harvesters at oil palm plantation (OPP) to the south of Peninsular Malaysia. The result revealed that the PAOT approach were ineffective in preventing MSD among harvesters in intervention group. The difference between PAOT and finger-point-and-call is finger-point-and-call is for ensuring safety and avoiding mistakes when working (Katsuya, 2009) while PAOT is and practical low-cost improvement measures that support self-help improvement actions (Kogi *et al*., 1989).

There are a lot of articles regarding studies which has been carried out on intervention approach in preventing MSS among agricultural workers (Jafry and O'Neill, 2000; Holmes *et al*., 2008; Singh and Arora, 2010). However, *Kiken Yochi* intervention approach never been applied and practiced by agricultural workers in the world including Malaysia. Japan and Thailand has done this intervention approach among their industrial workers but not for their agricultural workers. Poosanthanasarn *et al*. (2005a) had implemented *Kiken Yochi* Training among the auto-part factory workers. *Kiken Yochi* Training was used together with ergonomic intervention program (EIP) in reducing muscular discomfort. Muscular discomfort was measured by electromyography (EMG). The means for low back muscular activity of an applied ergonomics intervention program (AEIP) group had significantly reduced low back muscular discomfort compared from those of the non-AEIP group.

Most of the trainings on safe work practices among agricultural workers in Malaysia has been done at OPP and there is so far no training which has been done at pineapple plantation. The issue of safety and health of workers in the pineapple plantation are being less highlighted compared to other plantations and industries. To conduct effective training incorporating participatory approaches, there is the need for work tasks to have a thorough hazard identification, risk assessment and risk control (HIRARC) program. With the identification of significant risks, focus on the important aspect of training in participatory approaches can be identified. Data on HIRARC findings on pineapple plantations is limited.

Furthermore, in Malaysia, about 26% of foreign workers are employed in the agricultural sector (Central Bank, 2013). The training of foreign workers needs to be tailored to their laguange of understanding. It is the duty of all employer under the section 15 of of the Occupational Safety and Health Act 1994 to ensure the safety, health and welfare of all employees. As such, there is a need for trainings to be delivered in the form which facilities the understandings of the workers. The current statistics showed that there is a lack of awereness on safety and health among workers in the agricultural sectors as well as their top managements (Tamrin & Aumran, 2014).

All these evidences have shown the need for a study focusing on the impact of participatory approach such as *Kiken Yochi* Training among pineapple farm plantations workers in order to reduce MSS to be conducted.

1.3 Research Justification

MSS are major concern for farmers and health care professionals due to the negative impact on the health and productivity of workers. These impacts are measurable in terms of health and safety costs, injury and illness rate, lost work time, treatment duration, and workers' compensation costs. It is expected that by reducing the incidence of MSS, a reduction in total costs, an increasing in productivity, and improvement in employees' quality of life will be achieved.

The outcomes of this study will deliver broad understanding of the ergonomic hazards of the workers engaged in pineapple plantations. This research is expected to provide guidance in identifying steps that could be taken to improve the working methods of workers in their routine daily work. Besides, this study would benefit not only the pineapple plantation workers but other stakeholders, including DOSH, MPIB, and the DOA in improving the safety and health of workers.

In addition, this study functions as a source of a baseline data, as well as a measurement towards identifying the direction of plantation owners in Malaysia in addressing occupational health and safety problems. As a result, injuries due to ergonomic hazard can be reduced if the hazards can be identified earlier and appropriate and effective intervention methods are implemented.

Beside, this study will be able to identify, assess and determine risks related to ergonomic hazards at the selected pineapple plantations. By understanding the existence of risk and hazards that may harm workers, proper control measures can be taken before the predicted mishap happens. Thus, the application of HIRARC in this study aimed to improving the work environment in the pineapple plantation. Plus, it will enable employers to plan, introduce and monitor preventive measures to ensure that the risks are adequately controlled at all time.

This will be the first study in Malaysia conducted using *Kiken Yochi* intervention method in reducing MSS among pineapple workers. *Finger-pointing* method as practice testing in *Kiken Yochi* make it different from other participatory approaches that has been practiced before. Study done by Carpenter in (2009) proved that direct effects of practice testing is can enhance retention by triggering elaborative retrieval processes compared to restudy or rereading among students. It is because the practice test increase the likelihood that the related information was activated and encoded along with the target during learning. Hunt (2006), also suggests that practice testing may enhance how well students mentally organize information and how well they process idiosyncratic aspects of individual items, which together can support better retention. This method also can be applied among workers at pineapple farm where when they applied *Kiken Yochi* in their daily work, it can prevent and decrease the MSS by remembering the right body postures during working.

1.4 Research Questions

1. What are the hazards and its subsequent risks associated with work activities among pineapple workers at pineapple farm plantations?
2. What are the ergonomic risk factors associated with body postures of pineapple workers while performing work tasks at pineapple farm plantations?
3. What are the ergonomic work postures which needs to be improved to reduce MSS among pineapple farm plantation workers?
4. What are the effects of MSS among pineapple farm plantation workers after KYT is given?

1.5 Research Objectives

1.5.1 General objective

To assess the effects of work improvement module using a participatory approach of *Kiken Yochi* in reducing MSS among male migrant pineapple farm plantation workers in Pontian, Johor.

1.5.2 Specific objectives

1) To determine hazards and assess the risks within work activities among pineapple farm plantation workers.
2) To analyse body postures of pineapple workers during work at pineapple farm plantations
3) To construct and implement work improvement module to intervention (*Kiken Yochi* Training) and control groups (MSS educational training) of pineapple farm plantation workers.
4) To measure pre and post-intervention MSS among intervention and control groups of pineapple farm plantation workers.

1.6 Research Hypothesis

1) There will be a significant difference between MSS among control and intervention groups of pineapple farm plantation workers before and after the intervention.

1.7 Conceptual Framework

Among other agricultural workers, pineapple farm plantation workers are the target group of this study. The work tasks involved in pineapple plantations are land preparation, cultivating, weeding control, hormoning (flowering) and harvesting.

From the review of the literature, one of the ergonomic hazards in pineapple plantation are working in awkward posture for long period of time. Working in awkward posture may contribute to the development of MSDs. The risk factors for developing of MSDs can be divided into two categories which are occupational and non-occupational factors. Occupational factors consist of working tenure, specific work task done by workers. While for the non-occupational factors involve of age, body mass index (BMI) and smoking status.

The musculoskeletal symptoms (MSS) in the nine different body parts is divided into neck, shoulder, upper back, elbow, low back, wrist/hand, hip/thigh, knee and feet./ankle. MSS can be measured by the standardized Nordic questionnaire (SNQ). SNQ asked about muscle ache, discomfort and pain of the workers for past 12 months and 7 days.

In order to reduce MSS, an intervention approach utilizing participaptory approach will need to be given to the workers. When workers who are given ergonomic participatory approach intervention are compared to workers who are given training using conventional methods, it is suggested that the former group will experience less MSS upon its practice compared to the latter when assessed within a suitable frame of time. Figure 1.1 shows the conceptual framework of the study.

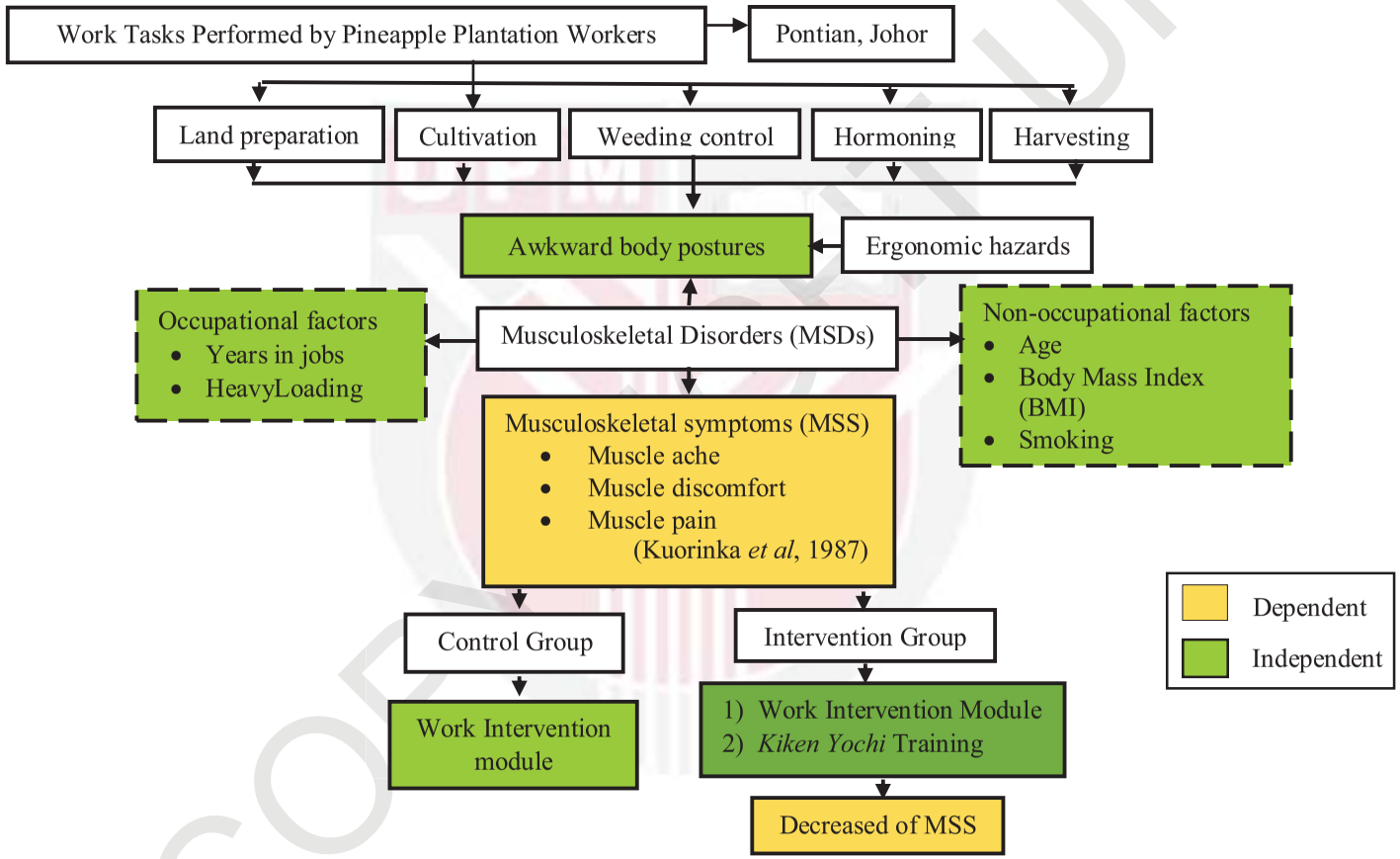


Figure 1.2 : Conceptual framework of the study

REFERENCES

Abas, A. B. L., Said, A. R. B. M., Mohammed, M. A. B. A., & Sathiakumar, N. (2008). Occupational disease among non-governmental employees in Malaysia: 2002-2006. *International journal of occupational and environmental health*, *14*(4), 263-271.

Albers, J. T., Li, Y., Lemasters, G., Sprague, S., Stinson, R., & Bhattacharya, A. (1997). An ergonomic education and evaluation program for apprentice carpenters. *American journal of industrial medicine*, *32*(6), 641-647.

Andersen, J. H., Haahr, J. P., & Frost, P. (2007). Risk factors for more severe regional musculoskeletal symptoms: A two-year prospective study of a general working population. *Arthritis & Rheumatism*, *56*(4), 1355-1364.

Andersson G., J. E. Bell, S. L. John, P. D. Michael, B Furman. (2008). The burden of Musculoskeletal Diseases in the United States: prevalence, societal and economic cost: Rosemont, IL: *American Academy of Orthopaedic Surgeons* 1-10.

Aptel, M., Aublet-Cuvelier, A., & Cnockaert, J. C. (2002). Work-related musculoskeletal disorders of the upper limb. *Joint Bone Spine*, *69*(6), 546-555.

Arcury, T. A., Quandt, S. A., & Russell, G. B. (2002). Pesticide safety among farmworkers: perceived risk and perceived control as factors reflecting environmental justice. *Environmental Health Perspectives*, *110*(Suppl 2), 233.

Arcury, T. A., & Quandt, S. A. (2003). Pesticides at work and at home: exposure of migrant farmworkers. *The Lancet*, *362*(9400), 2021.

Batino, J. M. (1997). Work improvement in small enterprises (WISE) project in the Philippines. In *Proceedings of the Fifth Southeast Asian Ergonomics Society Conference on Human Factors Vision—Care for the Future. IEA Press, Louisville*.

Buchholz, B., Paquet, V., Punnett, L., Lee, D., & Moir, S. (1996). PATH: a work sampling-based approach to ergonomic job analysis for construction and other non-repetitive work. *Applied ergonomics*, *27*(3), 177-187.

Burdorf, A., & Van Der Beek, A. (1999). Exposure assessment strategies for work-related risk factors for musculoskeletal disorders. *Scandinavian journal of work, environment & health*, 25-30.

Better Health Channel. (2014). *Passive smoking.* Retrieved 26th May, 2014, from http://www.betterhealth.vic.gov.au/bhcv2/bhcarticles.nsf/pages/Passive_smoking

C. H. De Zwart, M.H. W. Frings-Dresen, J. C. Van Duivenbooden, B. (1999). Senior workers in the Dutch construction industry: a search for age-related work and health issues. *Experimental aging research*, *25*(4), 385-391.

Canadian centre for Occupational Health and Safety (CCOHS). (2014). Work-related Musculoskeletal Disorders (WMSDs) - Risk Factors. Retrieved from http://www.ccohs.ca/oshanswers/ergonomics/risk.html

Cassou, B., Derriennic, F., Monfort, C., Norton, J., & Touranchet, A. (2002). Chronic neck and shoulder pain, age, and working conditions: longitudinal results from a large random sample in France. *Occupational and Environmental Medicine*, *59*(8), 537-544.

Central Bank. Economic Developments in 2013, pp 18.

Chaffin, D.B. and Andersson, G.B.J. (1984). Occupational Biomechanics. John Wiley & Sons, New York. Coffman, J.D., 1975. Diseases of the peripheral veins. In: P.B. Beeson and W. McDermott (Eds.), Textbook of Medicine Vol. II, 14th edition. W.B. Saunders Co., Philadelphia, pp. 1083-1084.

Chan, Y. K. (1995, February). Performance and stability of pineapple hybrids in GXE trials in Malaysia. In *II International Pineapple Symposium 425* (pp. 201-212).

Chapman, L., & Meyers, J. (2001). Ergonomics and musculoskeletal injuries in agriculture: recognizing and preventing the industry's most widespread health and safety problem. In *Agricultural safety and health conference proceedings* (pp. 2-3).

Chen, Q., & Jin, R. (2012). Safety4Site Commitment to Enhance Jobsite Safety Management and Performance. *Journal of Construction Engineering and Management, 138*(4), 509–519. http://doi.org/10.1061/(ASCE)CO.1943-7862.0000453

Choobineh, A., Sani, G. P., Rohani, M. S., Pour, M. G., & Neghab, M. (2009). Perceived demands and musculoskeletal symptoms among employees of an Iranian petrochemical industry. *International Journal of Industrial Ergonomics*, *39*(5), 766-770.

Crawford, J.O. (2007). The Nordic Musculoskeletal Questionnaire. *Occupational Medicine, 57,* 300-301.

Da Costa, B. R., & Vieira, E. R. (2010). Risk factors for work-related musculoskeletal disorders: a systematic review of recent longitudinal studies. *American journal of industrial medicine*, *53*(3), 285-323.

Daltroy, L. H., Iversen, M. D., Larson, M. G., Ryan, J., Zwerling, C., Fossel, A. H., & Liang, M. H. (1993). Teaching and social support: effects on knowledge, attitudes, and behaviors to prevent low back injuries in industry. *Health Education & Behavior*, *20*(1), 43-62.

David, G. C. (2005). Ergonomic methods for assessing exposure to risk factors for work-related musculoskeletal disorders. *Occupational medicine*, *55*(3), 190-199.

Davis, K. G., & Kotowski, S. E. (2007). Understanding the ergonomic risk for musculoskeletal disorders in the United States agricultural sector.*American Journal of Industrial Medicine*, *50*(7), 501-511.

Dawson, A.P., Steele, E.J., Hodges, P.W., Stewart, S. (2009). Development and test-retest reliability of an extended version of the Nordic Musculoskeletal Questionnaire (NMQ-E): A screening instrument for musuloskeletal pain. *The Journal of Pain, 10(*5), 517-525.

Demers, P., & Rosenstock, L. (1991). Occupational injuries and illnesses among Washington State agricultural workers. *American journal of public health*, *81*(12), 1656-1658.

Dennis, M. L., Foss, M. A., & Scott, C. K. (2007). An eight-year perspective on the relationship between the duration of abstinence and other aspects of recovery. *Evaluation Review*, *31*(6), 585-612.

Department of Agriculture. (2012). *Draf Pelan Strategik Jabatan Pertanian (2011-2015),* pp. 93.

Department of Agriculture. (2015). *Booklet statistic tanaman (sub-sektor tanaman makanan),* pp. 99

Department of Occupational Safety and Health (DOSH) Malaysia (2008). *Guidelines for Hazard Identification, Risk Assessment and Risk Control.* Department of Occupational Safety and Health, Ministry of Human Resources Malaysia, pp. 5-16.

Department of Safety and Health. (2005).*Guidelines on Occupational Safety and Health (Notification of Accident, Dangerous Occurance, occupational Poisoning and Occupational Disease) Regulations 2004* (NADOPOD).

Department of Statistics Malaysia (2012). *Selected Indicators for Agriculture, Crops and Livestock, Malaysia, 2006-2010*, pp. 2-3.

Department of Statistics Malaysia (2015). *Gross Domestic Product Third Quarter of 2016. Key contributors to the economy. Services, manufacturing & construction.*

DeRoo, L. A., & Rautiainen, R. H. (2000). A systematic review of farm safety interventions. *American journal of preventive medicine*, *18*(4), 51-62.

Devereux, J. J., Buckle, P. W., & Vlachonikolis, I. G. (1999). Interactions between physical and psychosocial risk factors at work increase the risk of back disorders: an epidemiological approach. *Occupational and Environmental Medicine*, *56*(5), 343-353.

Dhande, K. K. (2013). Practical Approach towards Issue on Ergonomic Training With Respect to Productivity Improvement. *Journal of Ergonomics*, *2013*.

Earle-Richardson, G., Jenkins, P. L., Slingerland, D. T., Mason, C., Miles, M., & May, J. J. (2003). Occupational injury and illness among migrant and seasonal farmworkers in New York State and Pennsylvania, 1997–1999: pilot study of a new surveillance method. *American journal of industrial medicine*, *44*(1), 37-45.

Erden, V., Basaranoglu, G., Erkalp, K., Yangin, Z., Delatioglu, H., Teker, M.G., et al. (2010). The effect of nicotine treatment on propofol injection pain. *Medical Journal of Trakya University*, 27(1), 18-22.

Essen, V. S., & Curdy, M. S. (1998). Health and safety risks in production agriculture. *Western Journal Of Medicine, 169*(4), 214.

Evanoff, B. A., Bohr, P. C., & Wolf, L. D. (1999). Effects of a participatory ergonomics team among hospital orderlies. *American journal of industrial medicine*, *35*(4), 358-365.

Fathallah, F. A. (2010). Musculoskeletal disorders in labor-intensive agriculture. *Applied ergonomics*, *41*(6), 738-743.

Faucett, J., Garry, M., Nadler, D., & Ettare, D. (2002). A test of two training interventions to prevent work-related musculoskeletal disorders of the upper extremity. *Applied Ergonomics*, *33*(4), 337-347.

Fountain, L.J. (2003). Examining RULA's postural scoring system with selected physiological and psychophysiological measures. *International Journal of occupational Safety and Ergonomics, 9*(4), 383-392.

Franklin, J., Ingvarsson, T., Englund, M., & Lohmander, L. S. (2009). Sex differences in the association between body mass index and total hip or knee joint replacement resulting from osteoarthritis. *Annals of the rheumatic diseases*, *68*(4), 536-540.

Ghasemkhani, M., Mahmudi, E., & Jabbari, H. (2008). Musculoskeletal symptoms in workers. *International Journal of Occupational Safety and Ergonomics*, *14*(4), 455-462.

Gomez, M. I., Hwang, S., Stark, A. D., May, J. J., Hallman, E. M., & Pantea, C. I. (2003). An analysis of self–reported joint pain among New York farmers. *Journal of agricultural safety and health*, *9*(2), 143.

Goto, T., Munechika, M., & Kajihara, C. (2015). A study on the measurement method of effect for healthcare-safety-education. *Total Quality Science*, *1*(1), 41-51

Greenlee, R. T., Zentner, J., Kieke, B., Elliott, J., & Marlenga, B. (2005). Farm health surveillance in the Marshfield Epidemiologic Study Area: a pilot study. *Journal of agricultural safety and health*, *11*(2), 211-218.

Guo, H. R., Chang, Y. C., Yeh, W. Y., Chen, C. W., & Guo, Y. L. (2004). Prevalence of musculoskeletal disorder among workers in Taiwan: a nationwide study. *Journal of occupational health*, *46*(1), 26-36.

Gupta, G. (2013). Prevalence of Musculoskeletal Disorders in Farmers of Kanpur-Rural, India. *Journal of Community Medicine & Health Education*, *2013*.

Heinrich, H. W. Industrial Accident Prevention, second edition, McGraw Hill, New York. 1941.

Henchoz, Y., & So, A. K. L. (2008). Exercise and nonspecific low back pain: a literature review. *Joint Bone Spine*, *75*(5), 533-539.

Heneweer, H., Vanhees, L., & Picavet, H. S. J. (2009). Physical activity and low back pain: a U-shaped relation. *Pain*, *143*(1), 21-25.

Hidaka, A., & Miyake, A. (2015). Selection of Suitable Safety Activities and Experience of Safety Condition Establishment. *Open Journal of Safety Science and Technology*, *5*(01), 1.

Hignett, S., & McAtamney, L. (2000). Rapid entire body assessment (REBA). *Applied ergonomics*, *31*(2), 201-205.

Holmberg, S., Thelin, A., Stiernström, E. L., & Svärdsudd, K. (2003). The impact of physical work exposure on musculoskeletal symptoms among farmers and rural non-farmers. A population-based study. *Annals of Agricultural and Environmental Medicine, 10*(2), 179-184.

Holmberg, S., Thelin, A., Stiernstrom, E., & Svardsudd, K. (2005). Low back pain comorbidity among male farmers and rural referents: a population-based study. *Annals of Agricultural and Environmental Medicine*, *12*(2), 261-268.

Holmes, W., Lam, P. Y., Elkind, P., & Pitts, K. (2008). The effect of body mechanics education on the work performance of fruit warehouse workers. *Work*, *31*(4), 461-471.

Hopsu, L., & Louhevaara, V. (1991). The influence of educational training and ergonomic job redesign intervention on the cleaners' work: a follow up study. In *Designing for Everyone: Proceedings of the 11th Congress of the International Ergonomics Association, Paris* (pp. 534-6).

Hyoudou Y., Hosokawa K. (2012). Iryouanzen ni ikasu KYT. *Tokyo Medical Friend CO*. (in Japanese).

Ilmarinen, J. (2002). Physical requirements associated with the work of aging workers in the European Union. *Experimental aging research*, *28*(1), 7-23.

Institute of Public Health. (2008). Ministry *of Health Malaysia: Smoking*. National Health and Morbidity Survey Volume 17. 2008, Kuala Lumpur: Institute of Publish Health

International Labour Organiazation (ILO). (2012). Recording and notification of occupational accidents and diseases. *An ILO code of practice. Geneva. Interntional Labour Office.*

International Labour Organiazation (ILO). (2013). *Social Security Organization Malaysia: Report to the Social Security Organization on the ninth actuarial valuation*. International Labour Organization

Ito, K., Taguchi, H., & Fujinami, K. (2014). Posing Questions during Experimental Operations for Safety Training in University Chemistry Experiments. *International Journal of Multimedia and Ubiquitous Engineering*, *9*(3), 51-62.

Jafry, T., & O'Neill, D. H. (2000). The application of ergonomics in rural development: a review. *Applied ergonomics*, *31*(3), 263-268.

Ji, H. J. (2014). A Study on Safety Culture Construction for Coal Mine. *Applied Mechanics and Materials*, *644*, 5949-5952.

Japan International Centre for Occupational Safety and Health, (JICOSH) (2008). Concept of "Zero-accident Total Participation Campaign". Retrieved from http://www.jniosh.go.jp/icpro/jicosh-old/english/zero-sai/eng/

Japan International Centre for Occupational Safety and Health, (JICOSH) (2013). *Concept of zero-accident total participation campaign*. Retrieved on from http://www.jniosh.go.jp/icpro/jicoshold/english/index.htm.

Juul-Kristensen, B., & Jensen, C. (2005). Self-reported workplace related ergonomic conditions as prognostic factors for musculoskeletal symptoms: the "BIT" follow up study on office workers. *Occupational and environmental medicine*, *62*(3), 188-194.

Karhu, O., Kansi, P., & Kuorinka, I. (1977). Correcting working postures in industry: a practical method for analysis. *Applied ergonomics*, *8*(4), 199-201.

Puntumetakul, U., Puntumetakul, R., Swangnetr, M., & Boucaut, R. (2015). Prevalence and risk factor analysis of lower extremity abnormal alignment characteristics among rice farmers. *Patient preference and adherence*, *9*, 785.

Kar, S.K., Dhara, P.C. (2007). An evaluation of musculoskeletal disorder and socioeconomic status of farmers in West Bengal, India. *Nepal Medical College Journal, 9*(4), 245-249.

Karwowski, W. & Marras, W.S. (2003). *Principles and applications in engineering series Occupational ergonomics engineering and administrative controls*. CRC Press. United States of America.

Katsuya, E. (1999). Self-motivated accident prevention activities at enterprises in Japan.

Kawakami, T. (2006). Networking grassroots efforts to improve safety and health in informal economy workplaces in Asia. *Industrial health*, *44*(1), 42-47.

Kawakami, T., Batino, J. M., & Khai, T. T. (1999). Ergonomic strategies for improving working conditions in some developing countries in Asia. *Industrial Health*, *37*(2), 187-198.

Kawakami, T., Kogi, K., Toyama, N., & Yoshikawa, T. (2004). Participatory Approaches to Improving Safety and Health under Trade Union Initiative-Experiences of POSITIVE Training Program in Asia-. *Industrial health*, *42*(2), 196-206.

Khai, T., Kawakami, T., Kogi, K., & Son, N. (1996). Ergonomic checkpoints for agricultural working and living conditions. *Toyota Foundation, Tokyo*.

Kheerajit, C., & Flor, A. G. (2013). Participatory Development Communication for Natural Resources Management in Ratchaburi Province, Thailand. *Procedia-Social and Behavioral Sciences*, *103*, 703-709.

Kilbom, A. (2000). Repetitive work of the upper extremity: Part I–Guidelines for the practitioner. *Ergonomics Guidelines and Problem Solving*, *1*, 145.

Kirkhorn, S. R., & Schenker, M. B. (2002). Current Health Effects of Agricultural Work: Respiratory Disease, Cancer, Reproductive Effects, Musculoskeletal Injuries, and Pesticide–Related Illnesses. *Journal of Agricultural Safety and Health*, *8*(2), 199.

Kirkhorn, S. R., Earle-Richardson, G., & Banks, R. J. (2010). Ergonomic risks and musculoskeletal disorders in production agriculture: recommendations for effective research to practice. *Journal of agromedicine*, *15*(3), 281-299.

Kishi, C., Nakano, Y., Bhuiyan, M. S., Kawanaka, H., & Oguri, K. (2014, October). Verification of the effect on "Finger Pointing and Calling" method from observation of brain activity related driver's attention. In *17th International IEEE Conference on Intelligent Transportation Systems (ITSC)* (pp. 1896-1897). IEEE.

Knapik, J. J., Reynolds, K. L., & Harman, E. (2004). Soldier load carriage: historical, physiological, biomechanical, and medical aspects. *Military medicine*, *169*(1), 45-56.

Kogi, K. (2006). Advances in participatory occupational health aimed at good practices in small enterprises and the informal sector. *Industrial Health*, *44*(1), 31-34.

Kogi, K. (2008). Facilitating participatory steps for planning and implementing low-cost improvements in small workplaces. *Applied ergonomics*, *39*(4), 475-481.

Kogi, K. (2010). Integrating occupational hygiene and health: the effectiveness in improving small-scale workplaces. *ARCHIVE of ISSUES, 1*(2).

Kogi, K., Phoon, W. O., & Thurman, J. E. (1989). *Low-cost ways of improving working conditions: 100 examples from Asia*. International Labour Office.

Kumar, R., Chaikumarn, M., & Lundberg, J. (2005). Participatory ergonomics and an evaluation of a low-cost improvement effect on cleaners' working posture. *International Journal of Occupational Safety and Ergonomics*, *11*(2), 203-210.

Kuorinka, I., Jonsson, B., Kilbom, A., Vinterberg, H., Biering-Sørensen, F., Andersson, G., & Jørgensen, K. (1987). Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Applied ergonomics*, *18*(3), 233-237.

Lee, S. J., Tak, S., Alterman, T., & Calvert, G. M. (2014). Prevalence of musculoskeletal symptoms among agricultural workers in the United States: an analysis of the National Health Interview Survey, 2004–2008. *Journal of Agromedicine*, *19*(3), 268-280.

Lim, H. K., Ghazali, S. M., Kee, C. C., Lim, K. K., Chan, Y. Y., Teh, H. C., ... & Salleh, S. (2013). Epidemiology of smoking among Malaysian adult males: prevalence and associated factors. *BMC Public Health*, *13*(1), 8.

Lindsay, A. & Ewert, A. (1999). Learning at the edge. *Journal of Experiential Education*. 22(1), 12-19.

Lipton, S., & Lynch, J. (1994). *Handbook of health hazard control in the chemical process industry*. Wiley-Interscience.

Luangwilai T., Norkaew S., Siriwong W. (2014) Factors associated with musculoskeletal disorders among rice farmers: cross sectional study in

Tarnlalord sub-district, Phimai district, Nakhonratchasima province, Thailand. *J Health Res. 28*(Suppl.): S85-91.

Luttmann, A., Jager, M., Griefahn, B., Caffier, G., Liebers, F. & Steinberg, U. (2003). *Preventing Musculoskeletal Disorder in the Workplace.* India: World Health Organization

Lwanga, S. K., & Lemeshow, S. (1991). *Sample size determination in health studies: a practical manual*. World Health Organization.

Malaysia Pineapple Industry Board. (2001). *History*. Retrieved from http://www.mpib.gov.my/en/web/guest/sejarah

Malaysian Pineapple Industrial Board, (2012). Perangkaan Industri Nanas Malaysia 2012, pp. 18.

Malaysia Pineapple Industry Board. (2016). *Asal usul nanas*. Retrieved from http://www.mpib.gov.my/web/guest/asal-usul-nanas

Malaysia Pineapple Industry Board. (2016). *Laporan Eksport Industri Nanas Malaysia 2015*. Retrieved from http://www.mpib.gov.my/documents/10124/618618/LAPORAN-EKSPORT-INDUSTRI-NANAS-MALAYSIA-2015.pdf

Malaysia Pineapple Industry Board. (2016). *Keluasan Tanaman Nanas 2015*. Retrieved from http://www.mpib.gov.my/documents/10124/618618/KELUASAN-TANAMAN-NANAS-2015.pdf

Manothum, A., & Rukijkanpanich, J. (2010). A participatory approach to health promotion for informal sector workers in Thailand. *Journal of injury and violence research*, *2*(2), 111.

McAtamney, L., & Corlett, E. N. (1993). RULA: a survey method for the investigation of work-related upper limb disorders. *Applied ergonomics, 24*(2), 91-99.

McCurdy, S. A., Samuels, S. J., Carroll, D. J., Beaumont, J. J., & Morrin, L. A. (2003). Agricultural injury in California migrant Hispanic farm workers.*American journal of industrial medicine*, *44*(3), 225-235.

Meksawi, S., Tangtrakulwanich, B., & Chongsuvivatwong, V. (2012). Musculoskeletal problems and ergonomic risk assessment in rubber tappers: A community-based study in southern Thailand. *International Journal of Industrial Ergonomics*, *42*(1), 129-135.

Meyers, J. M., Miles, J. A., Tejeda, D. G., Faucett, J., Janowitz, I., Weber, E., & Garcia, L. (2002). Priority risk factors for back injury in agricultural field work: Vineyard ergonomics. *Journal of Agromedicine*, *8*(1), 39-54.

Mobasheri, A., & Mendes, A.F. (2013). Physiology and pathophysiology of musculoskeletal aging: current research trends and future priorities. *Front Physiol. 4*:1–2.

Moore, J. S., & Garg, A. (1998). The effectiveness of participatory ergonomics in the red meat packing industry evaluation of a corporation. *International Journal of Industrial Ergonomics*, *21*(1), 47-58.

Morton, J. F., & Dowling, C. F. (1987). *Fruits of warm climates*. Miami, FL; Winterville, N.C.

Murai, Y., Sato, M., Yamaguchi, H., Shimada, M., Mano, N., Goto, J., & Hishinuma, T. (2009). Introducing hazard prediction training'KYT'to undergraduate pharmacy education on patient safety. Yakugaku zasshi: *Journal of the Pharmaceutical Society of Japan, 129*(11), 1367-1373

Na, C., & Yi, M. A. O. (2011). Specific Statistics and Control Method Study on Unsafe Behavior in Chinese Coal Mines. *c*, 2222-2229

Naidoo, S., Kromhout, H., London, L., Naidoo, R. N., & Burdorf, A. (2009). Musculoskeletal pain in women working in small-scale agriculture in South Africa. *American journal of industrial medicine*, *52*(3), 202-209.

National Agricultural Research Institute (NARI). (1999). *Pineapple production practices*. Mon Repos, East Coast Demerara.

Ng, Y. G., Tamrin, S. B. M., Yik, W. M., Yusoff, I. S. M., & Mori, I. (2014). The prevalence of musculoskeletal disorder and association with productivity loss: a preliminary study among labour intensive manual harvesting activities in oil palm plantation. *Industrial health*, *52*(1), 78-85.

NIOSH (2001), *Guide to Evaluating the Effectiveness of Strategies for Preventing Work Injuries*, (Cincinnati, Ohio: U.S. Department of Health and Human Services), Publication No. 2001-119.

Niu, S. (2010). Ergonomics and occupational safety and health: An ILO perspective. *Applied ergonomics*, *41*(6), 744-753.

Nishigaki, S., Vavrin, J., Kano, N., Haga, T., Kunz, J. C., & Law, K. (1994). Humanware, human error, and hiyari-hat: A template of unsafe symptoms. *Journal of construction engineering and management*, *120*(2), 421-442.

Niu, S., & Kogi, K. (2012). Ergonomic checkpoints in agriculture. *Geneva (Switzerland): International Labour Office*, 234.

Okihiro, G. Y. (2009). *Pineapple culture: a history of the tropical and temperate zones.* Berkeley, University of California Press.

Pal, A., De, S., Sengupta, P., Maity, P., & Dhara, P. C. (2015). Evaluation of work related musculoskeletal disorder and postural stress among female potato cultivators in West Bengal, India. *Ergonomics SA: Journal of the Ergonomics Society of South Africa*, *27*(1), 46-64.

Palmer, K. T., Syddall, H., Cooper, C., & Coggon, D. (2003). Smoking and musculoskeletal disorders: findings from a British national survey. *Annals of the rheumatic diseases*, *62*(1), 33-36.

Park, H., Sprince, N. L., Whitten, P. S., Burmeister, L. F., & Zwerling, C. (2001). Risk factors for back pain among male farmers: analysis of Iowa Farm Family Health and Hazard Surveillance Study. *American journal of industrial medicine*, *40*(6), 646-654.

Pekkarinen, A., Anttonen, H., & Hassi, J. (1991). Prevention of accidents in reindeer herding work. *Arctic medical research*, *51*, 59-63.

Pheasant, S. T., & Haslegrave, C. M. (2006). *Bodyspace: anthropometry, ergonomics, and the design of work*. CRC Press.

Picavet, H. S. J., & Schouten, J. S. A. G. (2003). Musculoskeletal pain in the Netherlands: prevalences, consequences and risk groups, the DMC 3-study. *Pain*, *102*(1), 167-178.

Piedrahita, H. (2006). Costs of work-related musculoskeletal disorders (MSDs) in developing countries: Colombia case. *International journal of occupational safety and ergonomics*, *12*(4), 379-386

PLANTATION, A. H. I. O. P. (2014). Effectiveness of a participatory action oriented training intervention approach among harvesters in oil palm plantation. *American Journal of Applied Sciences*, *11*(4), 681-693.

Poosanthanasarn, N., Lohachit, C., Fungladda, W., Sriboorapa, S., Pulkate C. (2005a). Reduction of low back muscular discomfort through an applied ergonomics intervention program. *The Southeast Asian Journal of Tropical Medicine and Public Health, 36*(4): 262-70.

Poosanthanasarn, N., Sriboorapa, S., Fungladda, W., & Lohachit, C. (2005b). An ergonomics intervention program to prevent worker injuries in a metal auto parts factory. *Southeast Asian J Trop Med Public Health. 36*(2):512-22.

Puntumetakul R, Siritaratiwat W, Boonprakob Y, Eungpinichpong W, Puntumetakul M. (2011). Prevalence of musculoskeletal disorders in farmers: Case study in Sila, Muang Khon Kaen, Khon Kaen province. *Journal of Medical Technology and Physical Therapy. 23*(3): 297-303.

Raanaas, R. K., & Anderson, D. (2008). A questionnaire survey of Norwegian taxi drivers' musculoskeletal health, and work-related risk factors. *International Journal of Industrial Ergonomics*, *38*(3), 280-290.

Rahman, M. N. A., Rani, M. R. A., & Rohani, J. M. (2011). A reliability and usability study of the workplace ergonomic risk assessment (WERA) tool. *Malays J Ergon*, 5-6.

Rani, N. H., Abidin, E. Z., Ya'acob, N. A., Karuppiah, K., & Rasdi, I. (2016). Musculoskeletal Symptoms Risk Factors and Postural Risk Analysis of Pineapple Plantation Workers in Johor. *Journal of Occupational Safety and Health*, *13*(1).

Rautiainen, R., Lehtola, M. M., Day, L. M., Schonstein, E., Suutarinen, J., Salminen, S., & Verbeek, J. H. (2008). Interventions for preventing injuries in the agricultural industry. *The Cochrane Library*.

Rautiainen, R. H., & Reynolds, S. J. (2002). Mortality and morbidity in agriculture in the United States. *Journal of agricultural safety and health*, *8*(3), 259.

Rivilis, I., & Cole, D.C. (2006). Individual factors and musculoskeletal disorders. In Fundamentals and Assessment Tools for Ocuupational Ergonomics, pp1-10. America: CRC Press.

Rocha, L. P., Cezar-Vaz, M. R., Almeida, M. C. V. D., Piexak, D. R., & Bonow, C. A. (2014). Association between pain and agricultural workload. *Acta Paulista de Enfermagem*, *27*(4), 333-339.

Rosecrance, J., Rodgers, G., & Merlino, L. (2006). Low back pain and musculoskeletal symptoms among Kansas farmers. *American journal of industrial medicine*, *49*(7), 547-556.

Rosenbaum, D., & Hennig, E. M. (1995). The influence of stretching and warm-up exercises on Achilles tendon reflex activity. *Journal of sports sciences*, *13*(6), 481-490.

Rufin Jr, T. M. (1998). Safety and operation management considerations for Port-Island coastal-protection works. In *The Eighth International Offshore and Polar Engineering Conference*. International Society of Offshore and Polar Engineers.

Scuffham, A. M., Legg, S. J., Firth, E. C., & Stevenson, M. A. (2010). Prevalence and risk factors associated with musculoskeletal discomfort in New Zealand veterinarians. *Applied ergonomics*, *41*(3), 444-453.

Shan, C. L., Adon, M. Y. B., Rahman, A. B. A., Hassan, S. T. S., & Ismail, K. B. (2012). Prevalence of neck pain and associated factors with personal characteristics, physical workloads and psychosocial among male rubber workers in FELDA settlement Malaysia. *Global journal of health science*, *4*(1), 94.

Shipp, E. M., Cooper, S. P., Del Junco, D. J., Delclos, G. L., Burau, K. D., & Tortolero, S. R. (2007). Severe back pain among farmworker high school students from

Starr County, Texas: baseline results. *Annals of epidemiology, 17*(2), 132-141.

Singh, S., & Arora, R. (2010). Ergonomic intervention for preventing musculoskeletal disorders among farm women. *J Agri Sci*, *1*(2), 61-71.

Social Security Organization (SOCSO). (2013). Annual report 2013. Available from http://www.perkeso.gov.my/my/laporan/laporan-tahunan.html

Social Security Organization (SOCSO) Malaysia (2014). *Annual Report. Ministry of Human Resources, Malaysia.* Retrieved from http://www.perkeso.gov.my/images/Laporan_Tahunan_2012.pdf (accessed May, 2015).

Sugiyama R. (2010) edited. Kiken-Yochi Training (KYT) for nurse. *Osaka Medika Syuttupan, (in Japanese).*

Tamrin, S. B. M., & Aumran, N. B. (2014). 3 A Comparison of the Hazards, the Risks, and the Types of Control in Three Selected Agricultural Industries. *Occupational Safety and Health in Commodity Agriculture: Case Studies from Malaysian Agricultural Perspective*, 93.

Thurman, J. E., Louzine, A. E., & Kogi, K. (1988). *Higher productivity and a better place to work: practical ideas for owners and managers of small and medium-sized industrial enterprises*. International Labour Organization.

UNdata (Revised June, 2016). *A world of information. Employment: Agriculture (% of employed).* Retrieved from http://data.un.org/CountryProfile.aspx?crName=MALAYSIA

Viester L., Verhagen E.A., Hengel K.M., Koppes L., van der Beek A.J. (2013). The relation between body mass index and musculoskeletal symptoms in the working population. *BMC Musculoskeletal Disorder. 14*:238.

Vink, P., Koningsveld, E. A., & Molenbroek, J. F. (2006). Positive outcomes of participatory ergonomics in terms of greater comfort and higher productivity. *Applied ergonomics*, *37*(4), 537-546.

Walker-Bone, K., & Palmer, K. T. (2002). Musculoskeletal disorders in farmers and farm workers. *Occupational medicine*, *52*(8), 441-450.

Walsh, N. E., Brooks, P., Hazes, J. M., Walsh, R. M., Dreinhöfer, K., Woolf, A. D., ... & Lidgren, L. (2008). Standards of care for acute and chronic musculoskeletal pain: the Bone and Joint Decade (2000–2010). *Archives of physical medicine and rehabilitation*, *89*(9), 1830-1845.

Ward, R. B. (2012). Revisiting Heinrich's law. *Chemeca 2012: Quality of life through chemical engineering: 23-26 September 2012, Wellington, New Zealand*, 1179.

Woolf, A. D., & Pfleger, B. (2003). Burden of major musculoskeletal conditions. *Bulletin of the World Health Organization*, *81*(9), 646-656.

World Bank (Revised May, 2016). *Employment in agriculture (% of total employment).* Retrieved from http://data.worldbank.org/indicator/SL.AGR.EMPL.ZS

Xia, S. (2011). Notice of Retraction Study on safety culture construction in coal mines. In *Emergency Management and Management Sciences (ICEMMS), 2011 2nd IEEE International Conference on* (pp. 494-496). IEEE.

Xiang, H., Stallones, L., & Keefe, T. J. (1999). Back pain and agricultural work among farmers: an analysis of the Colorado Farm Family Health and Hazard Surveillance Survey. *American journal of industrial medicine*, *35*(3), 310-316.

Yasuda, M., Kato, K., Uchiyama, Y., Sakiyama, K., Shibata, M., Sanbe, T., & Nakazawa, Y. (2013). [Effect of Kiken-Yochi training (KYT) induction on patient safety at the department of radiological technology]. *Nihon Hoshasen Gijutsu Gakkai zasshi*, *69*(7), 788-794.

Yu, I., Yu, W., & Li, Z. (2011). The effectiveness of participatory training on reduction of occupational injuries: a randomised controlled trial. *Occupational and Environmental Medicine*, *68*(Suppl 1), A24-A25.

Zyroul R., Hossain M.G., Abbas A.A., Kamarul T. (2014).Knee laxity of Malaysian adults: gender differentials, and association with age and anthropometric measures. *Knee. 21*(2):557–562.