UNIVERSITI PUTRA MALAYSIA

EFFECTS OF CALF MASSAGE ON STANDING DISCOMFORT AND MUSCLE ACTIVITY DUE TO PROLONGED STANDING IN UPRIGHT POSITION AMONG PRODUCTION LINE WORKERS

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By

KALAI SELVAN A/L RAMALINGAM

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January 2019

Chairman : Karmegam Karuppiah, PhD
Faculty : Medicine and Health Sciences

Introduction: Many occupations (especially in assembly production lines) require the workers to stand for prolonged periods of time without enough interventions such as breaks or resting periods. Previous studies have shown that prolonged standing is the cause of pain and discomfort in the back and lower limbs. During prolonged standing, the muscles and ligaments undergoes static loading which causes the compression of tissue in the joints and venous pooling in the leg areas which leads to the cause of fatigue. **Objective:** Therefore, the aims of this study is to determine the effect of intervention (calf massage) on discomfort due to prolonged standing in upright position**. Materials and Methods:** This study was conducted among male workers at a manufacturing with production line workers. List of all production workers were obtained from HR Department and simple random sampling were done by number categorization. A total of 108 respondents (54 respondents for each control and experimental group) participated in this study. The experiment took place in a room with a similar setup of production line. Each respondent was requested to perform simulated task for 2 hours. For the experimental group, the calf massager was turned on at every 15 minutes. At every 15 minutes interval, respondents from both groups were required to evaluate their discomfort level on Borg's scale CR-10 questionnaire. Meanwhile, surface electromyography (sEMG) was used to monitor the muscle activity (right and left lower leg around calf area specifically at gastrocnemius and tibialis anterior muscles in both experimental and control groups) throughout the experimental durations. **Results and Discussion:** The discomfort rating of the experimental group had showed reduction compared to the control group during the testing period. Results revealed that the discomfort rating for lower back, knees, thigh, calf and feet were significantly lower ($p<0.05$) among experimental group compared to the control group. Muscle activity of respondents showed that there are reductions of electromyography levels for both right and left calf muscles. The results also revealed that there were significant decline ($p<0.05$) of electromyography levels among experimental group compared to the control group with 2 hour prolonged

standing process. **Conclusion:** This study has provided new insights into the effects of calf massage prototype usage on prolonged standing workers in a controlled laboratory session. The use of calf massage prototype has provided a beneficial ergonomic feature which reduces muscle and body's discomfort. This also increases the workers comfort with less negative impact on muscle activity. Calf massage prototype could be an intervention that can provide better comfort for prolonged standing and eventually increase worker's performance.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan ijazah Master Sains

KESAN URUT TERAPI TERHADAP KETIDAKSELESAAN BERDIRI DAN AKTIVITI OTOT DISEBABKAN BERDIRI BERPANJANGAN DI KALANGAN PEKERJA PRODUKSI

Oleh

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Pengenalan: Banyak pekerjaan yang memerlukan pekerja berdiri untuk jangka masa yang lama tanpa sebarang intervensi seperti rehat. Mereka yang bekerja di bahagian pemasangan dan produksi adalah golongan pekerja yang paling banyak terdedah kepada keadaan berdiri berpanjangan. Terdapat beberapa kajian yang menyatakan berdiri berpanjangan merupakan penyebab kepada sakit dan ketidakselesaan di bahagian belakang dan bawah pinggang. Ketika berdiri berpanjangan, otot dan sendi mengalami tekanan statik yang menyebabkan tisu di sendi dimampat dan berlaku pengumpulan darah di kawasan kaki yang menyebabkan keletihan. **Objektif:** Tujuan kajian ini adalah untuk mengenalpasti kesan otot betis terhadap ketidakselesaan disebabkan berdiri berpanjangan. **Bahan dan Kaedah:** Kajian ini telah dijalankan di kilang produksi di kalangan pekerja produksi dan senarai pekerja produksi telah diterima daripada Bahagian Sumber Manusia. Persampelan rawak mudah telah digunakan dan semua responden dikategorikan sebagai nombor sebelum di tentukan kumpulan rawatan dan kawalan. Secara amnya, responden daripada kumpulan eksperimen dan kumpulan kawalan dipasangkan dengan alat terapi urut di betis dan keberkesanan alat terapi urut dikaji dengan meminta responden berdiri selama 2 jam dengan dan tanpa alat urut terapi. Satu borang soal selidik "Borg's Scale" diberi kepada responden setiap 15 minit ketika 2 jam berdiri untuk dijawab oleh responden dari awal hingga akhir 2 jam mereka berdiri. Borang soal selidik ini akan memberi maklum balas mengenai kesan alat urut terapi kepada aktiviti berdiri berpanjangan. "Surface Electromyography" dipasang kepada kawasan otot betis di kaki kiri dan kanan khususnya di otot "gastrocnemius" dan "tibialis anterior" untuk mengkaji otot betis di kedua-dua kumpulan eksperimen dan kumpulan kawalan. **Keputusan dan Perbincangan:** Hasil daripada kajian menunjukkan bahawa kadar ketidakselesaan lebih tinggi di kumpulan kawalan berbanding kumpulan eksperimen sepanjang 2 jam eksperimen dijalankan. Keputusan menunjukkan kadar ketidakselesaan untuk pinggang belakang, lutut, peha, betis dan kaki signifikan ($p<0.05$) apabila

dibandingkan antara kumpulan eksperimen dan kawalan. Aktiviti otot responden menunjukkan terdapat pengurangan aktiviti kadar electromyography di kedua kaki kiri dan kanan bagi otot betis. Hasil kajian juga menunjukkan terdapat penurunan yang signifikan ($p<0.05$) bagi kadar aktiviti electromyography di antara kumpulan eksperimen apabila dibandingkan antara kumpulan kawalan bagi proses berdiri berpanjangan selama 2 jam. **Kesimpulan:** Kajian ini telah memberi gambaran baru mengenai kesan alat urut terapi terhadap pekerja yang berdiri berpanjangan di dalam keadaan terkawal di makmal. Pengunaan alat urut terapi telah memberi faedah ergonomic yang mengurangkan ketidakselesaan badan dan otot. Ia juga telah meningkatkan keselesaan pekerja dan mengurangkan kesan negatif kepada aktiviti otot. Alat urut terapi ini mempunyai potensi untuk dijadikan intervensi yang boleh memberi keselesaan yang lebih bagus bagi aktiviti berdiri berpanjangan dan sekaligus meningkatkan prestasi pekerja.

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

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LIST OF ABBREVIATIONS

AORN	Association for Registered Nurses
BMI	Body Mass Index
EMG	Electromyography
MSD	Musculoskeletal disorders
NIOSH	National Institute for Occupational Safety and Health
sEMG	Surface Electromyography
SOCSO	The Social Security Organization of Malaysia
SPSS	Statistical Package Service and Solution

CHAPTER 1

INTRODUCTION

1.1 Background

Many occupations require the workers to stand for long periods of time without enough interventions such as breaks or resting periods. Examples of these occupations are nurses, doctors, hairdressers and assembly production lines. A number of studies proved that prolonged standing is the cause of pain and discomfort in the back and lower limbs (Redfern et al., 2000). Working under prolonged standing will make workers feel uncomfortable, pain and tired (Halim, 2011).

During prolonged standing, the muscles and ligaments undergoes static loading which causes the compression of tissue in the joints and venous pooling in the leg areas which leads to the cause of fatigue (Freitas et al., 2005). Postural muscles keep the body from falling over while standing or walking. Standing or walking for a long time without rest forces the muscles to work without a rest and the muscles become exhausted resulting in pain.

Previous researches revealed that industrial workers, especially those working in assembly production lines, are the most widely group of workers exposed to prolonged standing (Witana et al., 2009; Halim and Omar, 2011; Thomas and Robert, 2015). In Malaysia, this has been proven because manufacturing industries are the major production lines that produce a high volume capacity product within 24 working hours. Most of the industries working hours are 8 hours in a day and it can go up to 12 hours or even more.

According to a previous study, standing posture is identified as the highest level of discomfort, followed by sitting on a high stool, then sitting at a desk (Drury et al., 2008). Finding on a study showed that those who stand for long periods during the day reported statistically significant greater body parts discomfort in the back, legs and feet compared to those who sit most of the day (Drury et al., 2008). Fatigue rates in leg and lower back muscles were significantly higher in stationary standing posture as compared to dynamic standing posture, and perceived discomfort in the legs, shoulders and overall rating of discomfort were significantly higher for static posture than for dynamic posture. (Balasubramaniam et al., 2009).

The fatigue experienced in the lower extremities can be reduced by relaxation therapy that has been used for lower back pain (Linton et al., 1985). In a study conducted, massage therapy shows that it can reduce the pain associated with chronic fatigue syndrome (Field et al., 1997). Moreover, massage therapy has shown able to reduce

the anxiety and depression (Field et al., 1998). In another study, it is mentioned that massage therapy effects on lower back pain were improved. Self-reported pain depression, anxiety and sleep disturbance were decreased (Hernandez et al., 2001).

Based on other studies that have been done in previous, it can be suggested that massage therapy is effective to reduce pain, anxiety and to improve mood (Field et al., 1997). The massage therapy groups also experienced a significant pain reduction for their lower back pain (Hernandez et al., 2001). Massage treatment can be expected to increase the job productivity and reduce the absenteeism for individuals with low back problems and lower extremities fatigue.

1.2 Problem Statement

A study had done demonstrated that any discomfort or subjective fatigue occurring within an individual can be linked and recognized as a factor in the decline of alertness, mental concentration and motivation (Simonson et al., 1976). The effect of the discomfort and fatigue might have an impact on the work performance of the worker and lead to a dangerous situation for the worker to work in. It is found that 52% workers of an engine manufacturing plant had the symptoms of foot and ankle disorder due to prolonged standing (Werner et al., 2010). In Malaysia, The Social Security Organization (SOCSO) of Malaysia reported that in 2014, industrial workers suffered from a number of injuries totaling in fingers (8884 cases), hand (7103 cases), lower leg (4750 cases), shoulder (2579 cases) and musculoskeletal (675 cases) (SOCSO Annual Report, 2014).

The factory chosen for this study is a manufacturing plant that have been producing carbon products and operating for the past 4 years. It is based in Bintulu, Sarawak. The total production capacity is 50mt per day and they have a total of 150 workers. The production workers are required to stand along the conveyor lines to segregate the products from sticking together and manually handle for smooth production. The production line runs 24 hours, 3 shifts per day with more than 120 production line workers. The record of the Production Department shows that there are history of complaints on body pain by new production line workers after almost 3 months of production running. Therefore, management is keen on finding for alternatives that is reliable and cost effective to lower the complaints and provide better working condition.

Prolonged standing has been identified as one of the several risk factors associated with occupational injuries. It is summarized that from 17 previous studies that standing for more than 8 hours per day, major health risks that were identified are chronic venous insufficiency, musculoskeletal pain of the lower back and feet, preterm birth and spontaneous abortions (McCulloch, 2002).

In a 24 month prospective study of lower back pain and other musculoskeletal disease outcomes, it is reported that prolonged standing increases the reports of lower back pain and leg pain (Andersen et al., 2007). It is reported that an increase on measures of postural stability from adults and elderly individuals after 30 minutes of prolonged standing (Freitas et al., 2005). Less postural control is an indicator of physical fatigue.

Prolonged standing can be related from cardiovascular diseases to pregnancy issues and also lower extremities fatigues (Dick et al., 2015). As overall, previous studies supports that prolonged standing exerts harmful effects on lower extremities and massage treatment might be an intervention for the leg pain.

Strategies for interventions of prolonged standing adverse effects include the usage of compression stockings to reduce the leg swelling (Krijnen et al., 1997). In another study, shoe inserts, flooring conditions, mats and shoes were used to reduce the effects of prolonged standing (Redferm and Chaffin, 1995). Sit-stand chairs are also other interventions that can be applied to overcome prolonged studies (Irving, 1982). However, most of the interventions mentioned cannot be claimed under medical coverage therefore making it harder for both employer and employees to apply the interventions on their own at working place.

Thus, scientific data and research are needed concerning the effects of prolonged standing on the workers. Massage therapy had shown reduce in fatigue level in previous studies (Brooks et al., 2005). Calf muscles tibialis anterior (anterior legs) and gastrocnemius (posterior legs) are measured for surface EMG to detect the fatigue level due to prolonged standing (Halim et al., 2012). Massage therapy can be applied on the calf muscles and the calf muscles can be tested for any reduction in fatigue level using surface EMG. Massage therapy is one of the most strategic considerations for intervention because it can be included in medical coverage and eventually decrease the cost of treatment but there have to be enough studies to prove that massage therapy is a good intervention for prolonged standing.

Massage treatment is one of the most strategic considerations for intervention because it can be included in medical coverage and eventually decrease the cost of treatment but there have to enough studies to prove that massage treatment is a good intervention for prolonged standing. The massage therapy is in the form of vibration that are given at every 30 minutes for 2 minutes. Figure 1.1 is an example of the massage device that were used for this study.

Calf muscles support the whole body while standing and the muscles responsible for these are gastrocnemius muscle and anterior tibialis. While exposed to prolonged standing, a static posture is maintained and causing the blood to pool at the lower leg extremities. This will lead to fatigue and pain. When vibration is given it will enhance the blood circulation and improve the oxygen supply to these muscles eventually improving the pain and fatigue experienced by the workers. The production of the

products will result in the workers to be standing along the conveyors to manually handle, break to ensure smooth flow of production. This research aims to find out if calf massage be able to reduce the discomfort, if vibrational massage can reduce the muscle activity at the muscles and if the calf massage can reduce discomfort on other body parts. Does prolonged standing without any interventions pose significant discomfort to the prolonged standing workers at the calf muscle area? Therefore, the primary aim of this study is to determine the effect of calf massage on discomfort and muscle activity due to prolonged standing in upright position.

Figure 1.1: A prototype of calf massage that were attached to calf area

1.3 Research Justification

Studies on prolonged standing have mostly shown that there are adverse effects on the health outcomes of the workers such as lower back pain, leg pain, cardiovascular diseases, fatigue, discomfort and pregnancy related health outcomes. For example, it is found that 52% workers of an engine manufacturing plant had the symptoms of foot and ankle disorder due to prolonged standing (Werner et al., 2010).

In Malaysia, the Social Security Organization (SOCSO) of Malaysia reported that in 2014, musculoskeletal and lower leg injuries cases that were recorded are also a part of prolonged standing effects as well. Department of Occupational Safety and Health have issued a guideline on occupational safety and health for standing at work. It includes the importance of working posture, adverse health effects due to ergonomic risk from standing work and others. There are many studies about effects of prolonged standing on the health of worker but not much are related to the intervention for it.

Most common interventions studies that can be found are the use of shoe insole material, use of different shoe design, use of different mat with certain thickness but none are related to massage treatment. However, massage treatment is yet to be studied deeply related to prolonged standing therefore, the aim of this research is to study the effect of calf massage on standing fatigue due to prolonged standing in upright position. Thus, the result from this study can be used as reference for future research.

In a previous study, a future research on massage treatment relating to intervention studies was mentioned as a need (Munk et al., 2010). If there are sufficient data and research to prove that massage treatment can be used as an intervention, then accessibility for massage under medical coverage can be proposed and implemented. Massage treatments have shown improvements on discomfort but it is yet to be proved with a calf massage (Field et al., 2007).

This study is crucial to be carried out so that the adverse health effects on the workers can be minimized at an early stage. The preventive measures or interventions could be implemented to solve or prevent the adverse health effects to give a serious health impact to the workers. The result of this study could provide useful information to workers on how to manage their standing fatigue and minimize the adverse health effects on themselves. Together with the results obtained, appropriate actions could be done. In addition, further studies could be done on towards the intervention of adverse health effects due to prolonged standing.

1.4 Research Objectives

1.4.1 General objective

To determine the effect of calf massage on discomfort and muscle activity due to prolonged standing in upright position.

1.4.2 Specific objectives

The objectives of the study are;

i. determine data distribution of discomfort rating between experimental and control groups,
ii. compare differences of discomfort rating between experimental and control groups,
iii. determine data distribution of surface electromyography levels between experimental and control groups, and
iv. compare the differences of surface electromyography (EMG)'s levels between experimental and control groups.

1.4.3 Hypothesis

i. There will be reductions of discomfort rating and electromyography levels between experimental and control groups.

ii. There will be significant differences of discomfort rating between experimental and control groups.
iii. There will be reductions of surface electromyography levels between experimental and control groups.
iv. There will be significant differences of electromyography levels between experimental and control groups.

A summary of the Conceptual Framework for this research is given in Figure 1.2 to highlight the key topics that will be studied in this research.

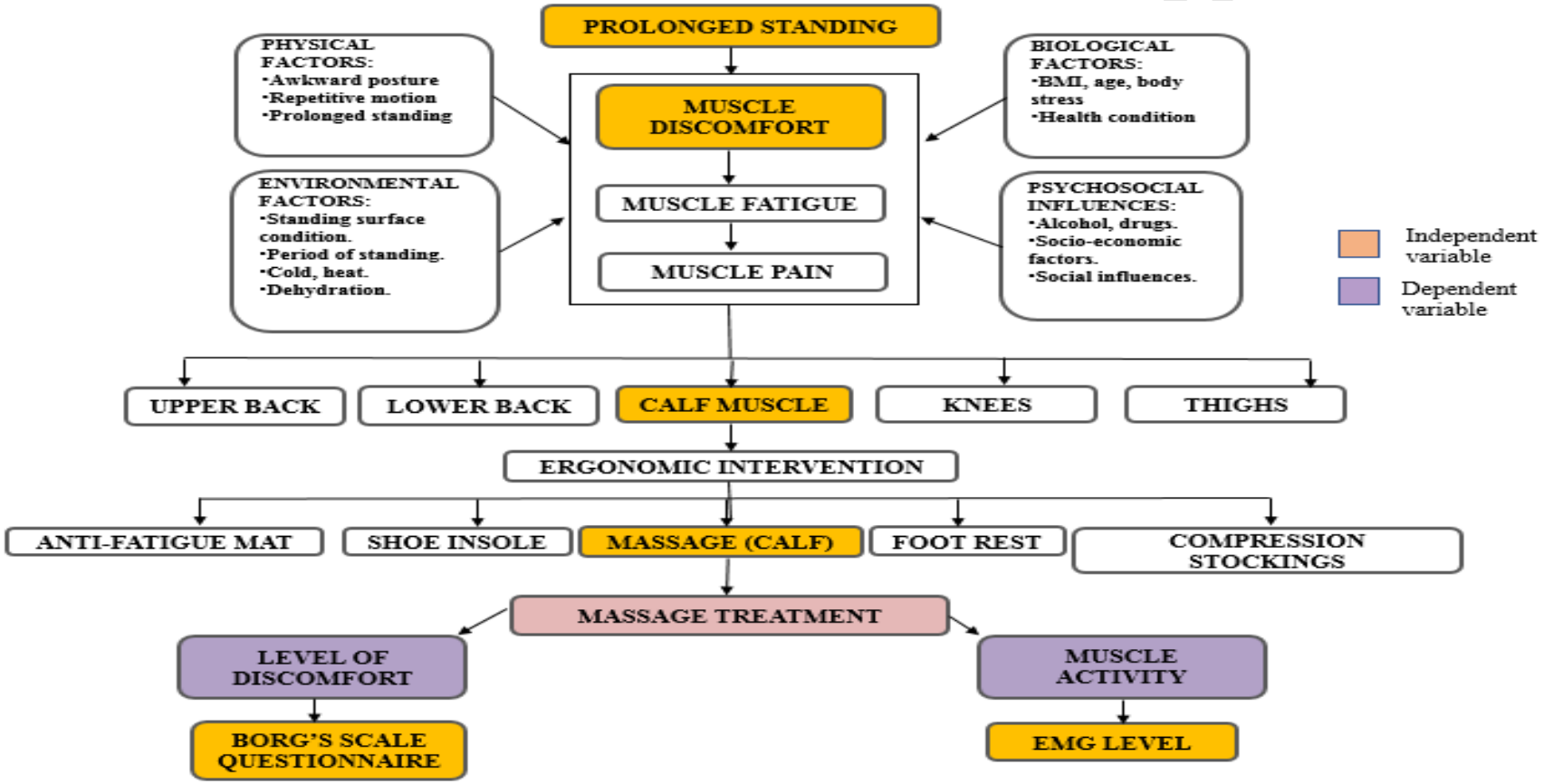

Figure 1.2: Conceptual framework on the calf discomfort assessment

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APPENDICES

Appendix 1: Ethical Approval

UNIVERSITI PUTRA MALAYSIA
BERILMU BERBAKTI

PEJABAT TIMBALAN NAIB CANSELOR (PENYELIDIKAN DAN INOVASI)
OFFICE OF THE DEPUTY VICE CHANCELLOR (RESEARCH AND INNOVATION)

Reff. : UPM/TNCPI/RMC/1.4.18.2 (JKEUPM)
Date : 20 January 2018

Dr. Karmegam Karuppiah
Department of Environmental and Occupational Health
Faculty of Medicine and Health Sciences
Universiti Putra Malaysia
Serdang, Selangor

Dear Madam/Sir,

RESEARCH PROJECT: EFFECT OF CALF MASSAGE ON STANDING COMFORT AND MUSCLE ACTIVITY DUE TO PROLONGED STANDING IN UPRIGHT POSITION

RESEARCHER : KALAI SELVAN RAMALINGAM
SUPERVISOR : DR. KARMEGAM KARUPPIAH

The Ethics Committee for Research involving Human Subjects of University Putra Malaysia (JKEUPM) has studied the proposal for the above project and found that there were no objectionable ethical issues involved in the proposed study.

Please find the list of documents received and reviewed with reference to the study and committee members who reviewed the documents (as attached).

Notwithstanding above, we will not be responsible for any misconduct on the part of researcher in the course of carrying out the research.

Ethical approval is required in the case of amendments/ changes to the study documents/ study sites/ study team.

Thank you.

"WITH KNOWLEDGE WE SERVE"

Sincerely yours,

PROF. DR. ZAMBERI SEKAWI
Chair
Ethics Committee for Research involving Human Subjects
Universiti Putra Malaysia

Pejabat Timbalan Naib Canselor (Penyelidikan dan Inovasi), Universiti Putra Malaysia, 43400 UPM Serdang, Selangor Darul Ehsan, Malaysia
Pejabat Timbalan Naib Canselor (P&I) 603-8947 1002 603-8945 1646, Pejabat Pentadbiran TNCPI 603-8947 1608 603-8945 1673,
Pejabat Pengarah, Pusat Pengurusan Penyelidikan (RMC) 603-8947 1601 603-8945 1596, Pejabat Pengarah, Putra Science Park (PSP)
603-8947 1291 603-8946 4121 http://www.tncpi.upm.edu.my

ETHICS COMMITTEE FOR RESEARCH INVOLVING HUMAN SUBJECTS
(JKEUPM)
UNIVERSITI PUTRA MALAYSIA

Research title	:	**Effect of Calf Massage on Standing Comfort and Muscle Activity Due to Prolonged Standing in Upright Position**
Study Site	:	**Bintulu, Sarawak**
JKEUPM Ref No.	:	**JKEUPM-2017-174**
Researcher	:	**Kalai Selvan Ramalingam**
Supervisor	:	**Dr. Karmegam Karuppiah**

Documents received and reviewed with reference to the above study:

1. Ethics Application Form, Version 1 dated 20/10/2017
2. Respondent Information Sheet & Consent (English), Version 2 dated 27/11/2017
3. Respondent Information Sheet & Consent (Malay), Version 2 dated 27/11/2017
4. Proposal (English), Version 3 dated 26/12/2017
5. Questionnaire (English)-Pre-Survey, Version 1 dated 20/11/2017
6. Curriculum Vitae of:
    a. Dr. Karmegam Karuppiah
    b. Dr. Shiamala Devi Ramaiya

The University Research Ethics Committee, Universiti Putra Malaysia (JKEUPM) operates in accordance to the ICH-GCP Guidelines.

Decision by JKEUPM:

[X] Approved

[ ] **Permission MUST BE OBTAINED from the respective hospitals/ institutions before conducting the research**

[ ] Disapproved

Please note that the approval is **VALID UNTIL 20 JANUARY 2019**

Researchers should comply with the following:

I. Complete a Study Final Report upon study completion (Form 3.2).

II. Ethical approval is required in the case of amendments/ changes to the study documents/ study sites/ study team.

III. Applicable for Clinical Trial Studies and Clinical interventional Studies only: Progress Report has to be submitted to JKEUPM at every 6 months from the date of approval (Form 3.1). Report occurrences of all Serious Adverse Events (SAEs), Suspected Unexpected Serious Adverse Reaction (SUSARs) and Protocol Deviation/ Violation at all JKEUPM approved sites to JKEUPM. SAEs are to be reported within 15 calendar days from awareness of event by investigator. Initial report of SUSARs are to be reported as soon as possible but not later than 7 calendar days from awareness of event by investigator, followed by a complete report within 8 additional calendar days.

The required forms can be obtained from the Ethics Committee for Research Involving Human Subjects (JKEUPM) website (http://www.rmc.upm.edu.my/muatturun).

Date of Approval: 20 January 2018

Members of the JKEUPM who reviewed the documents:

i. Primary Reviewer: Dr. Hayati Kadir
ii. Informed Consent Reviewer: Siti Rahayu Hussin

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.....

PROF. DR. ZAMBERI SEKAWI
Chair
Ethics Committee for Research involving Human Subjects
Universiti Putra Malaysia

JKEUPM is recognised by The Strategic Initiative for Developing Capacity in Ethical Review (SIDCER) in collaboration with the Forum for Ethical Review Committees in Asia and the Western Pacific Region (FERCAP) for its compliance with the Declaration of Helsinki, International Conference on Harmonization (ICH) Guidelines, Good Clinical Practice (GCP) Standards, Council for International Organizations of Medical Sciences (CIOMS) Guidelines, World Health Organization (WHO) Standards and Operational Guidance for Ethics Review of Health-Related Research and Surveying and Evaluating Ethical Review Practices, EC/IRB Standard Operating Procedures (SOPs), and Local Regulations and Standards in Ethical Review.

Appendix 2: Respondent Information Sheet

JAWATANKUASA ETIKA UNIVERSITI UNTUK
PENYELIDIKAN MELIBATKAN MANUSIA (JKEUPM)
UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG,
SELANGOR, MALAYSIA

FORM 2.4: RESPONDENT'S INFORMATION SHEET AND INFORMED CONSENT FORM

Please read the following information carefully and do not hesitate to discuss any questions you may have with the researcher.

1. STUDY TITLE :

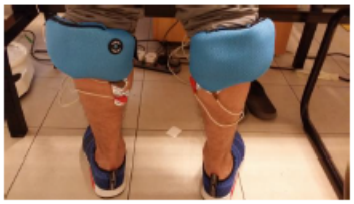
EFFECT OF CALF MASSAGE ON STANDING COMFORT AND MUSCLE ACTIVITY DUE TO PROLONGED STANDING IN UPRIGHT POSITION

2. INTRODUCTION:

We would like to invite you to participate in a research project on study of the evaluation of leg muscles comfort and muscle activity among prolonged standing workers. Before you decide to take part, it is very important for you to understand why this research is being done and what it will be involving. Prolonged standing has been identified as one of the risk factors which associated with occupational injuries (Halim *et al*, 2012). Massage therapy had shown reduce in fatigue level in previous studies (Brooks *et al*., 2005). Calf muscles tibialis anterior (anterior legs) and gastrocnemius (posterior legs) are measured for surface EMG to detect the fatigue level due to prolonged standing (Halim *et al*., 2012). This study will be focusing on finding out the effectiveness of calf massage on muscle discomfort and muscle activity due to prolonged standing. Participation is voluntary and you can withdraw from the study at any time. Please take time to read the following information carefully and discuss it with others if you wish. Please do ask us if there is anything that is not clear or if you would like to gain more information.

3. **WHAT WILL YOU HAVE TO DO?**

If you already agree to take part in this study, we will ask you to complete the questionnaire enclosed with this sheet. The questionnaire will need to be filled with information regarding your background information, your daily activities, your health information and your musculoskeletal disorder information. Participants who have previous history of cardiovascular, musculoskeletal disorder or any chronic illness are not recommended to take part in this study. If you are selected, you should answer the pre-survey questionnaire before using the massage therapy to rate your leg discomfort. Then, you will be instructed to stand for 2 hours with or without massage therapy. Surface Electromyography (sEMG) will be attached to both of your legs (further details will be explained below). You will be asked to stand with or without massage therapy in a quiet room in the laboratory. You need to attend experimental sessions either as a control group or experimental group. Each session will last for 2 hours. Meanwhile, you need to sort the mixed items and separate them in three different boxes on table based on color of the items during 2 hours period. Besides that, you need to complete the discomfort rating (Borg's scale) every 15 minutes from the beginning until the end of 2 hours session and the sEMG will monitor your muscle activity throughout the 2 hours prolonged standing duration. ***Participation is voluntary and you can withdraw from the study at any time. A translator help will be used if the respondents cannot understand the ICF form in terms of language.***



Back view of calf massage and sEMG attached

Side view of calf massage & sEMG attached

4. **WHO SHOULD NOT PARTICIPATE IN THE STUDY?**

Respondents are not selected based on these criteria:

i. Female.

ii. Age not in range between 18 – 35 years old.

iii. Not within normal range of Body Mass Index (BMI)(18.5 – 24.9)

iv. Have history regarding Musculoskeletal Disorders (MSD) or any injuries for the past 12 months

v. Any history of Cardiovascular Disease (CVD).

vi. Have immediate complaints during or before the study related to Musculoskeletal Disorders (neck, head, shoulder, upper back, arms, hands, low back, buttocks, thighs, knees, calf, ankles or feet regions).

vii. Inadequate of sleep and rest (e.g: respondents must have 8 hours sleep the night before and avoid doing any exercises or heavy work the day before such as jogging, gym activities, any kind of sports, lifting things for the body to have enough rest prior to the study)

5. WHAT WILL BE THE BENEFITS OF THE STUDY:

(a) TO YOU AS THE SUBJECT?

There are no individual benefits in taking part in this research study.

(b) TO THE INVESTIGATOR?

However, by volunteering you can help us to gain more understanding and determine the effect of massage therapy on muscle discomfort and muscle activity in prolonged standing

6. WHAT ARE THE POSSIBLE RISKS?

If you decide to take part in this study, participants who have previous history cardiovascular, musculoskeletal disorder or any chronic illness are not recommended to take part in this study. You may experience some discomfort due to the usage of massage therapy. The massager will be attached to the calf muscles and tightened until it comes to

contact with the muscles therefore, respondents might feel uncomfortable to work as usual. You may experience discomfort due to placing of Surface Electromyography (sEMG) onto your left and right gastrocnemius muscles (posterior legs) and tibialis anterior muscles (anterior legs) to monitor muscle activity. Besides that, there is a limitation of movement from respondents as it may affect the data collected. Participation is voluntary and you can withdraw from the study at any time.

7. **WILL THE INFORMATION THAT YOU PROVIDE AND YOUR IDENTITY REMAIN CONFIDENTIAL?**

Yes, all the information gathered will be kept strictly confidential. Any information which related to you such as personal information and results of sampling will not be identifiable in published material. Your data will not be disclosed to any regulatory body and it is for research purpose only.

8. **WHO SHOULD YOU CONTACT IF YOU HAVE ADDITIONAL QUESTIONS DURING THE COURSE OF THE RESEARCH?**

If you have queries regarding your involvement in this study, please feel free to contact the researcher with the number and email address provided below:

Kalai Selvan a/l Ramalingam
Postgraduate student MSc (Occupational Safety & Health)
Faculty of Medicine and Health Sciences,
University Putra Malaysia.
Tel: 016-7770692
Email: carlkalaiselvan@gmail.com

Dr. Karmegam Karuppiah (Supervisor)
Department of Environmental and Occupational Health,
Faculty of Medicine and Health Sciences,
University Putra Malaysia.
Tel: +603-8947 2643
Email: megam@upm.edu.my

9. CONSENT

I ..... Identity Card No. .....
address.....
.....hereby voluntarily agree to take part in the research stated above *(clinical /drug trial/video recording/ focus group/interview-based/ questionnaire-based).

I have been informed about the nature of the research in terms of methodology, possible adverse effects and complications (as written in the Respondent's Information Sheet). I understand that I have the right to withdraw from this research at any time without giving any reason whatsoever. I also understand that this study is confidential and all information provided with regard to my identity will remain private and confidential.

I* wish / do not wish to know the results related to my participation in the research

I agree/do not agree that the images/photos/video recordings/voice recordings related to me be used in any form of publication or presentation (if applicable)

* delete where necessary

Signature .....
(Respondent)

Signature .....
(Witness)

Date :.....

Name :.....

I/C No. :.....

I confirm that I have explained to the respondent the nature and purpose of the above-mentioned research.

Date .....

Signature .....
(Researcher)

Appendix 3: Questionnaire

QUESTIONNAIRE FOR PRE-SURVEY

TITLE OF PROPOSAL:

EFFECT OF CALF MASSAGE ON STANDING COMFORT AND MUSCLE ACTIVITY DUE TO PROLONGED STANDING IN UPRIGHT POSITION

SUPERVISOR NAME:

DR. KARMEGAM KARUPPIAH

(Department of Environmental and Occupational Health)

PREPARED BY:

KALAI SELVAN A/L RAMALINGAM

GS 49734

DEPARTMENT OF ENVIRONMENTAL AND OCCUPATIONAL HEALTH

FACULTY OF MEDICINE AND HEALTH SCIENCE

UNIVERSITY PUTRA MALAYSIA

2017

ID:

PRE-SURVEY QUESTIONNAIRE

This page contains questions that will provide your personal information. Please answer each question completely.

SECTION A: BACKGROUND INFORMATION

1. Age: _____ year
2. Weight: _____ kg
3. Height: _____cm
4. Race:

   ☐ Malay ☐ Chinese

   ☐ Indian ☐ Other: _____
5. Education level:

   ☐ UPSR ☐ PMR

   ☐ SPM ☐ STPM/MATRIKULASI

   ☐ Diploma ☐ Degree

   ☐ Master ☐ PhD

SECTION B: DAILY ACTIVITIES

6. On average, how many hours do you sleep per day?

   _____

7. Are you doing heavy work activities?

   ☐ Yes ☐ No

If yes, how often do you do heavy work activities in a week? _____

8. Do you play sports?

☐ Yes ☐ No

If yes, how often do you play sports in a week? _____

SECTION C: HEALTH INFORMATION

9. Have you ever experienced any health problems that have been diagnosed by a doctor?

☐ Yes ☐ No

If yes, please tick the list below, if not proceed to question 10.

Illness are as stated below:

Cardiovascular disease ☐

Musculoskeletal disease ☐

Others: Please state _____

10. At present, do you take any medical treatment from doctor?

☐ Yes ☐ No

If yes, please specify the type of medicine below:

_____

Appendix 4

The respondents doing the sorting activities while standing for 2 hours.

Calf massage and surface Electromyography attached to the calf muscle of the respondents

BIODATA OF STUDENT

The student was born in Kuala Lumpur on 06th December 1992. He received his diploma in Fisheries in 2013, degree in Environmental and Occupational Health in 2017 both from Universiti Putra Malaysia. Immediately after completing his degree studies, he took up a job as Safety and Health Officer in a Norwegian manufacturing company in Sarawak. In the same year, he also enrolled as a full time student to continue his master's degree in Occupational Safety and Health in 2017, under the supervision of Dr. Karmegam Karuppiah. His research focuses on Ergonomics studies in manufacturing line.

PUBLICATION

Kalai Selvan, R., Karmegam, K., Shiamala, D.R., Vivien, H., Enoch Kumar, P., Hassan Sadeghi, N., Sivasankar, S., Kulanthayan, K.C.M. (2019). Calf Massager: Intervention for Body Muscle Discomfort During Prolonged Standing. Human Factors and Ergonomics in Manufacturing & Service Industries (Accepted)

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NAME OF STUDENT: KALAI SELVAN A/L RAMALINGAM

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