



**UNIVERSITI PUTRA MALAYSIA**

***ASSESSMENT OF METHODS TO REDUCE LOWER BACK, NECK AND  
SHOULDER PAIN DISCOMFORT SCORES AND THEIR RANGE OF  
MOTION AMONG OFFICE WORKERS***

**ARDALAN SHARIAT**

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SHOULDER PAIN DISCOMFORT SCORES AND THEIR RANGE OF  
MOTION AMONG OFFICE WORKERS**

By

**ARDALAN SHARIAT**

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,  
in Fulfillment of the Requirements for the Degree of Doctor of Philosophy**

**November 2016**

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## DEDICATION

I would like to dedicate this thesis to my parents and my sister, who continue to learn, develop and grow and who have been a source of inspiration and encouragement to me through my life, my special appreciation for providing a 'writing space' and for nurturing me during the writing of this thesis, also for the countless love and support throughout my life that lightened my way to determine, realize and find my potential, which enabled me to make this contribution to our world.

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the Doctor of Philosophy

**ASSESSMENT OF METHODS TO REDUCE LOWER BACK, NECK AND SHOULDER PAIN DISCOMFORT SCORES AND THEIR RANGE OF MOTION AMONG OFFICE WORKERS**

By

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**November 2016**

**Chairman : Associate Profesor Shamsul Bahri Mohd Tamrin**  
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**Background:** Musculoskeletal discomforts (MSD), especially in the neck, lower back and shoulder areas, are some of the most common issues among office workers. The actual number of cases of musculoskeletal injuries/pain among Malaysian office workers is suspected to be much higher than the 10,000 cases claimed by SOCSO. MSD can lead to uncomfortable working conditions and subsequently lead to absenteeism as well as an increasing need to obtain medical certificates (MCs) among office workers during working hours. This is because of the physical pain/injuries caused by MSD, and these have a negative effect on the productivity and financial efficiency of companies/employers. A practical and cost-efficient treatment, without side effects, can be a helpful way to improve the productivity and financial efficiency of companies by reducing MSD-induced staff absenteeism.

**Objectives:** The three primary aims of this research were to: 1. Measure the incidence of MSD in a sample of office workers; 2. Test effective methods of reducing lower back, neck and shoulder pain in this sample by training exercise, or ergonomics modification, or both of them; and 3. Assess discomfort scores and the range of motion of the lower back, neck and shoulder muscles among the office workers after undertaking the different methods for a period of 6 months.

**Methods:** In a true experimental design, from 10,000 office workers of a selected company in Malaysia, 142 office workers (of whom 50 were male), aged between 20-50 years, who had MSD with medium/ high severity of pain and had volunteered to participate in this study, were allocated randomly, from 3 different locations (Bangsar, Puchong, and Damansara), to one of three intervention groups (receiving training exercise, receiving modified ergonomics, receiving a combination of exercise and

ergonomics modification) and a control group (receiving none of these interventions). The Cornell MSD Questionnaire was used to measure musculoskeletal discomforts, with focus on pain severity, before treatment and after 2, 4 and 6 months of the interventions. The range of motion (ROM) of the hip, neck, shoulder and knee were measured by a 30cm goniometer, and the Borg CR10 scale was used to measure the perceived exertion of training exercises. The rapid office strain assessment (ROSA) questionnaire was used to assess the strain associated with office work. Height and weight were also measured to calculate the body mass index (BMI).

**Results:** MSD was common and it was most frequent in the regions of the shoulder, neck, and lower back with high level in severity of pain. The mean value for ROM (pre- to post-intervention changes) in the hips and knees in the exercise (right hip: from  $71\pm 12$  degree to  $87\pm 5$  degree, left hip: from  $71\pm 11$  degree to  $88\pm 3$  degree; right knee: from  $153\pm 20$  degree to  $169\pm 15$  degree, left knee: from  $150\pm 20$  degree to  $164\pm 18$  degree (mean $\pm$ SD)) and exercise + ergonomics modification groups (right hip: from  $71\pm 11$  degree to  $86\pm 5$  degree, left hip: from  $72\pm 10$  degree to  $85\pm 6$  degree; right knee: from  $153\pm 19$  degree to  $172\pm 11$  degree, left knee: from  $151\pm 2$  degree to  $169\pm 13$  degree (mean $\pm$ SD)), but the ROM of the neck and shoulder were improved also in the ergonomics group significantly ( $p<0.05$ ). MSD mean value scores related to neck, shoulder and lower back decreased significantly ( $p<0.05$ ) in all three intervention groups. ROSA mean value scores decreased significantly ( $p<0.05$ ) only in the ergonomics modification and exercise + ergonomics modification groups. The Borg scale results showed acceptable levels of perceived exertion related to the exercise package.

**Conclusion:** 6 months of training exercise is able to increase the range of motion and it can be helpful in decreasing the prevalence of MSD. Ergonomic modifications are another way to decrease MSD rates by correcting the postures of office workers. A mixture of training exercise and ergonomic modifications can be more effective in lowering MSD rates, as it can also improve the ROM and working posture.

**Keywords:** Training exercise, office workers, musculoskeletal discomforts, range of motion, incidence

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**PENILAIAN KAEDAH YANG MENGURANGKAN SKOR  
KETIDAKSELESAAN DI BAHAGIAN BAWAH BELAKANG TUBUH,  
LEHER DAN BAHU SERTA JULAT PERGERAKANNYA DI KALANGAN  
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**Latar belakang:** Ketidakelesaan ‘muskuloskeletal’, atau lebih dikenali sebagai MSD (musculoskeletal discomforts), terutamanya di leher, bahu dan bahagian bawah belakang tubuh, merupakan satu isu kesihatan yang agak berleluasa dalam kalangan pekerja-pekerja pejabat. Oleh yang demikian, bilangan kes ketidakelesaan/kecederaan “muskuloskeletal” (MSD) yang sebenar dalam kalangan pekerja-pekerja pejabat di Malaysia disyaki lebih tinggi daripada anggaran 10,000 kes yang dilaporkan setiap tahun oleh Pertubuhan Keselamatan Sosial (PERKESO). Secara holistiknya, MSD boleh menyebabkan ketidakelesaan semasa bekerja, dan hal ini pula meningkatkan kadar ketidakhadiran serta kadar permohonan surat cuti sakit semasa waktu bekerja dalam kalangan para pekerja pejabat. Justeru, satu kesan negatif utama yang disebabkan oleh ketidakelesaan/kecederaan fizikal dalam kalangan pekerja-pekerja pejabat akibat MSD adalah kemerosotan terhadap produktiviti dan stabiliti kewangan syarikat-syarikat yang mengupah pekerja-pekerja tersebut. Sehubungan dengan itu, ianya didapati bahawa satu kaedah rawatan yang praktikal dan berkos rendah serta tanpa sebarang kesan sampingan mampu memulihara produktiviti dan stabiliti kewangan sesebuah syarikat dengan menurunkan kadar ketidakhadiran staf yang disebabkan oleh MSD.

**Objektif:** Kajian ini mempunyai tiga tujuan utama: pertamanya, mengenalpasti kekerapan MSD dalam kalangan pekerja-pekerja pejabat; keduanya, menguji kaedah-kaedah yang paling berkesan untuk mengurangkan kesakitan di bahagian bawah belakang tubuh, leher dan bahu melalui latihan bersenam, pengubahsuaian ergonomik atau kombinasi kedua-dua unsur tersebut; akhir sekali, menilai kadar ketidakelesaan dan julat pergerakan otot di bahagian bawah belakang tubuh, leher dan bahu dalam kalangan pekerja-pekerja pejabat selepas menjalankan kaedah-kaedah yang berlainan untuk tempoh 6 bulan.

**Kaedah:** Reka bentuk kajian: Daripada 10,000 orang ahli kakitangan Syarikat Telekom Malaysia, seramai 142 orang pekerja pejabat – termasuklah 50 orang pekerja lelaki – dalam lingkungan umur 20-50 tahun, telah dipilih secara rawak dari 3 lokasi yang pejabat yang berlainan, iaitu dari Bangsar, Puchong dan Damansara. Seterusnya, pekerja-pekerja tersebut dibahagikan kepada tiga kumpulan intervensi (kumpulan yang hanya menerima latihan senaman, kumpulan yang hanya menerima ergonomi yang diubahsuai serta kumpulan yang menerima kombinasi latihan senaman dan ergonomi yang diubahsuai) dan satu kumpulan kawalan yang tidak menerima sebarang intervensi. Soal selidik ‘Cornell MSD’ telah digunakan untuk mengukur MSD dengan memberikan tumpuan kepada tahap kesakitan sebelum intervensi serta 2, 4 dan 6 bulan selepas intervensi. Soal selidik MSD Cornell digunakan untuk mengukur gangguan ‘muskuloskeletal’, terutamanya dalam konteks tahap kesakitan, sebelum intervensi dan 2, 4 dan 6 bulan selepas intervensi. Julat pergerakan (ROM) bahagian pinggul, leher bahu dan lutut diukur dengan menggunakan Goniometer (12 inci), dan skala BORG CR10 pula digunakan untuk mengukur anggaran kadar stamina semasa latihan senaman. Di samping itu, soal selidik ‘Rapid Office StrainAssessment’ (ROSA) telah digunakan untuk menilai ketegangan badan yang berkaitan dengan tugas-tugas di pejabat. Ketinggian dan berat turut diukur untuk mengira indeks jisim badan (BMI).

**Keputusan:** MSD paling kerap dikesan di kawasan bahu (kiri 34.3% dan kanan 34.9%), leher (33.9%) dan bahagian belakang bawah tubuh (30%) dengan tahap yang agak teruk. Bacaan ROM di bahagian pinggul dan lutut untuk kumpulan senaman (pinggul kiri:  $71 \pm 11$  darjah ke  $88 \pm 3$  darjah; pinggul kanan:  $71 \pm 12$  darjah ke  $87 \pm 5$  darjah; lutut kiri:  $150 \pm 20$  darjah ke  $164 \pm 18$  darjah; lutut kanan:  $153 \pm 20$  darjah ke  $169 \pm 15$  darjah (min $\pm$ SD)) serta kumpulan senaman + pengubahsuaian ergonomik (pinggul kiri:  $72 \pm 10$  darjah ke  $85 \pm 6$  darjah; pinggul kanan:  $71 \pm 11$  darjah ke  $86 \pm 5$  darjah; lutut kiri:  $151 \pm 2$  darjah ke  $169 \pm 13$  darjah; lutut kanan:  $153 \pm 19$  darjah ke  $172 \pm 11$  darjah (min $\pm$ SD)). Namun demikian, bacaan ROM untuk leher dan bahu telah bertambah baik dengan ketara dalam kumpulan ergonomik ( $p < 0.05$ ). Kadar MSD yang berkaitan dengan leher, bahu dan bahagian belakang bawah tubuh pula menurun dengan ketara ( $p < 0.05$ ) dalam ketiga-tiga kumpulan intervensi. Kadar ROSA turut menurun dengan ketara ( $p < 0.05$ ) di dalam kumpulan pengubahsuaian ergonomik serta kumpulan kombinasi senaman dan pengubahsuaian ergonomik. Keputusan skala Borg pula menunjukkan tahap yang memuaskan dalam kadar anggaran stamina yang berkaitan dengan pakej latihan senaman. Dalam konteks ini.

**Kesimpulan:** Kajian ini mendapati bahawa jangka masa bagi latihan senaman selama 6 bulan dapat meningkatkan julat pergerakan (ROM) pekerja-pekerja pejabat dan seterusnya menurunkan kadar MSD dalam ruang pejabat. Sehubungan dengan itu, pengubahsuaian ergonomik dalam ruang pejabat juga dapat menurunkan kadar MSD melalui pembetulan postur tubuh para pekerja pejabat. Tambahan pula, kombinasi latihan senaman dan pengubahsuaian ergonomik didapati lebih berkesan dalam mengurangkan kadar MSD kerana kombinasi tersebut dapat meningkatkan julat pergerakan (ROM) serta membetulkan postur tubuh semasa bekerja.



**Kata kunci:** Latihan senaman, pekerja pejabat, gangguan 'muskuloskeletal', pelbagai gerakan, kekerapan



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I certify that a Thesis Examination Committee has met on 22 November 2016 to conduct the final examination of Ardalan Shariat on his thesis entitled "Assessment of Methods to Reduce Lower Back, Neck and Shoulder Pain Discomfort Scores and their Range of Motion among Office Workers" 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 Doctor of Philosophy.

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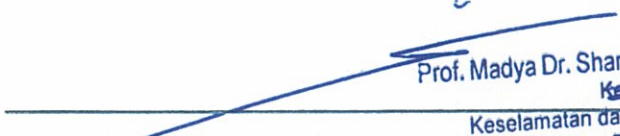
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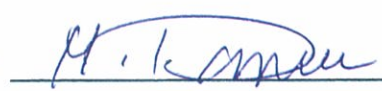
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## TABLE OF CONTENTS

|  | <b>Page</b> |
|--|-------------|
| <b>ABSTRACT</b>  | i           |
| <b>ABSTRAK</b>   | iv          |
| <b>ACKNOWLEDGEMENTS</b>                                      | viii        |
| <b>APPROVAL</b>  | ix          |
| <b>DECLARATION</b>   | xi          |
| <b>LIST OF TABLES</b>  | xvii        |
| <b>LIST OF FIGURES</b>                                       | xx          |
| <b>LIST OF ABBREVIATIONS</b>                                 | xxii        |
| <br>   |             |
| <b>CHAPTER</b>   |             |
| <b>1 INTRODUCTION</b>  | <b>1</b>    |
| 1.1 Research Background                                      | 1           |
| 1.2 Problem Statement  | 3           |
| 1.3 Study Research Question                                  | 4           |
| 1.4 Research Justification                                   | 5           |
| 1.5 Conceptual Framework                                     | 5           |
| 1.6 Objectives   | 7           |
| 1.6.1 General Objective                                      | 7           |
| 1.6.2 Specific Objectives                                    | 7           |
| 1.7 Null Hypotheses  | 7           |
| 1.8 Definition of Terms                                      | 8           |
| 1.8.1 Conceptual Definition                                  | 8           |
| 1.8.2 Musculoskeletal Discomforts                            | 8           |
| 1.8.3 Ergonomics Risk Factors                                | 8           |
| 1.8.4 Lower Back Pain  | 8           |
| 1.8.5 Neck Pain  | 9           |
| 1.8.6 Shoulder Pain  | 9           |
| 1.8.7 Protocol of Exercise                                   | 9           |
| Operational Definitions                                      | 9           |
| 1.8.8 Musculoskeletal Discomforts                            | 9           |
| 1.8.9 Ergonomics Risk Factors for office workers             | 10          |
| 1.8.10 Lower Back Pain, Neck Pain and Shoulder Pain          | 10          |
| 1.8.11 Protocol of Exercise                                  | 10          |
| <br>   |             |
| <b>2 LITERATURE REVIEW</b>                                   | <b>11</b>   |
| 2.1 Musculoskeletal Discomforts                              | 11          |
| 2.1.1 Non-Specific MSD                                       | 12          |
| 2.2 Lower Back, Neck and Shoulder Pain                       | 13          |
| 2.3 Signs and Symptoms of Lower Back, Neck and Shoulder Pain | 14          |
| 2.4 Causes of Lower Back, Neck and Shoulder Pain             | 15          |
| 2.5 Pathophysiology of Musculoskeletal Discomforts           | 15          |
| 2.5.1 Back Structures  | 15          |
| 2.5.2 Pain Sensation Pathway                                 | 18          |
| 2.6 Classification of Lower Back, Neck and Shoulder Pain     | 18          |
| 2.7 Musculoskeletal Disorder in Office Workers               | 18          |
| 2.8 Lower Back, Neck and Shoulder Pain in Office Workers     | 20          |

|          |   |           |
|----------|---|-----------|
| 2.9      | Tests to Measure Lower Back, Neck and Shoulder Pain   | 20        |
| 2.10     | Incidence of Musculoskeletal Discomforts  | 21        |
| 2.11     | Musculoskeletal discomforts Questionnaires  | 24        |
| 2.12     | Classifications and Pathophysiological Basis of injuries of MSD   | 24        |
| 2.13     | Management of Non-Specific MSD  | 25        |
| 2.14     | Common Approaches to Relieve Non-Specific MSD   | 26        |
| 2.15     | Lower Back, Neck and Shoulder Pain and Physical Activity  | 27        |
| 2.16     | Exercise and Pain/Disability  | 28        |
| 2.17     | Physical Activity and Movement among Office Workers   | 29        |
| 2.18     | Effect of Training Exercises on Neck, Shoulder, and Lower Back Pain Discomfort Scores among Office Workers                                    | 30        |
| 2.19     | Effect of Training Exercises on ROM of the Lower Back, Neck and Shoulder Muscles  | 31        |
| 2.20     | Effect of Training Exercises on Scores of Online ROSA among Office Workers  | 32        |
| 2.21     | Effect of Ergonomics Modification on Lower Back, Neck and Shoulder Pain Discomfort Scores among Office Workers                                | 33        |
| 2.22     | Effect of Ergonomic Modification on ROM of Lower Back, Neck and Shoulder Muscles among Office Workers   | 35        |
| 2.23     | Effect of Ergonomics Modification on Scores of Online ROSA among Office Workers   | 36        |
| 2.24     | Relationships among Lower Back, Neck and Shoulder Pain Discomfort Scores and Range of Motion of Lower Back, Neck and Shoulder Muscles and BMI | 37        |
| 2.25     | Summary   | 38        |
| <b>3</b> | <b>METHODOLOGY</b>  | <b>40</b> |
| 3.1      | Duration of Study   | 40        |
| 3.2      | Study Design  | 40        |
| 3.3      | Study Location  | 43        |
| 3.4      | Sampling Method   | 45        |
| 3.4.1    | Sampling Population   | 45        |
| 3.4.2    | Study Sample  | 45        |
| 3.4.3    | Study Criteria  | 45        |
|          | Inclusion Criteria  | 45        |
|          | Exclusion Criteria  | 45        |
| 3.4.4    | Sampling Unit   | 46        |
| 3.4.5    | Sampling Frame  | 46        |
| 3.4.6    | Sample Size   | 46        |
|          | Phase 1 – Descriptive Cross-Sectional Study (One Proportion)  | 46        |
|          | Phase 2 - Interventions   | 49        |
| 3.5      | Variables and Objectives  | 51        |
| 3.6      | Ethical Approval  | 53        |
| 3.7      | Instruments and Tools for Assessing the MSD in phase 1  | 53        |
| 3.8      | Musculoskeletal Discomfort Questionnaire (MSD)  | 53        |
| 3.9      | Data Collection Approach (Phase 1)  | 55        |
| 3.10     | Data Collection Approach (Phase 2)  | 55        |
| 3.11     | Body Mass Index (BMI) Measurement   | 55        |
| 3.12     | Instruments and Tools for Assessing Pain, etc.  | 56        |



|          |  |     |
|----------|--|-----|
| 3.12.1   | Goniometer   | 56  |
| 3.13     | Interventions  | 59  |
| 3.13.1   | Office Training Exercise   | 59  |
| 3.13.2   | Ergonomics Modification  | 62  |
| 3.13.3   | Combination of Training Exercises and Ergonomics Modification  | 62  |
| 3.14     | Measuring the Intensity of Package of Exercise   | 62  |
| 3.14.1   | Borg CR 10 Scale   | 62  |
| 3.14.2   | Data Collection Approach   | 63  |
| 3.15     | Online ROSA Questionnaire  | 64  |
| 3.15.1   | ROSA Ergonomic Evaluation Report   | 65  |
| 3.15.2   | Data Collection Approach   | 66  |
| 3.16     | Statistical Analysis   | 66  |
| <b>4</b> | <b>RESULTS</b>   | 68  |
| 4.1      | Phase 1 (survey)   | 68  |
| 4.2      | Phase 2 (intervention)   | 69  |
| 4.2.1    | Preliminary Tests for Repeated Measure ANCOVA / ANOVA  | 69  |
| 4.2.2    | Demographic Variables Among Groups   | 70  |
| 4.2.3    | Normality  | 70  |
| 4.2.4    | Homogeneity Test of Variance   | 70  |
| 4.2.5    | Sphericity   | 71  |
| 4.2.6    | Relationship between Socio-Demographic Variables and Research Variables  | 72  |
| 4.3      | Statistical Analyses   | 73  |
| 4.4      | Effect of Exercise Training, Modified Ergonomics, and a Combination of Exercise Training and Modified Ergonomics on the ROM of the Neck, Shoulders and Lower Back                | 74  |
| 4.5      | Effect of Exercise Training, Modified Ergonomics, and a Combination of Exercise Training and Modified Ergonomics on the ROSA scores  | 105 |
| 4.6      | Effect of Exercise Training, Modified Ergonomics, and a Combination of Exercise Training and Modified Ergonomics on the Cornell Musculoskeletal Discomforts Scores               | 109 |
| 4.7      | Measuring the Intensity of the Package of Exercise Training Using Borg CR-10 Scale   | 125 |
| <b>5</b> | <b>DISCUSSION</b>  | 128 |
| 5.1      | Incidence of Different Types of Musculoskeletal Discomfort among Office Workers in Malaysia, Assessed by the Cornell Questionnaire   | 130 |
| 5.2      | Discussion on Effect of Exercise Training, Modified Ergonomics, and a Combination of Exercise Training and Modified Ergonomics on the ROM of the Neck, Shoulders, and Lower Back | 131 |
| 5.3      | Discussion on Effect of Exercise Training, Modified Ergonomics, and a Combination of Exercise Training and Modified Ergonomics on the ROSA Scores                                | 134 |

|          |  |            |
|----------|--|------------|
| 5.4      | Discussion on effect of exercise training, modified ergonomics, and a combination of exercise training and modified ergonomics on the Cornell Discomforts Scores   | 135        |
| 5.5      | Differences between Treatments - that Consist of Exercise alone, Ergonomics Modification alone, and Exercise Combined with Ergonomics Modification – for, the ROM of the Lower Back, Neck and Shoulder Muscles, ROSA Scores, and Discomfort Scores | 138        |
| 5.6      | Relationships between Lower Back, Neck and Shoulder Pain Discomfort Scores, the Ranges of motion of the Lower Back, Neck and Shoulder Muscles, the ROSA Scores and BMI   | 140        |
| <b>6</b> | <b>CONCLUSIONS, IMPLICATION, LIMITATIONS AND RECOMMENDATIONS</b>   | <b>142</b> |
| 6.1      | Conclusions  | 142        |
| 6.2      | Implications   | 145        |
| 6.3      | Limitations  | 145        |
| 6.4      | Strengths of the Study   | 146        |
| 6.5      | Recommendations and Further Investigations Based upon the Current Findings   | 147        |
|          | <b>REFERENCES</b>  | <b>148</b> |
|          | <b>APPENDICES</b>  | <b>173</b> |
|          | <b>BIODATA OF STUDENT</b>  | <b>217</b> |
|          | <b>LIST OF PUBLICATIONS</b>  | <b>218</b> |

## LIST OF TABLES

| <b>Table</b> |  | <b>Page</b> |
|--------------|--|-------------|
| 2.1          | Past studies on different methods of treatment for musculoskeletal discomfort, especially lower back, neck and shoulder pain | 23          |
| 3.1          | Dependent and independent variables and objectives   | 51          |
| 3.2          | Sample size related to different objectives  | 52          |
| 3.3          | Instruction for hip range of motion measurement  | 57          |
| 3.4          | Instruction for knee range of motion measurement   | 58          |
| 3.5          | Instruction for shoulder range of motion measurement   | 58          |
| 3.6          | Instruction for knee range of motion measurement   | 59          |
| 3.7          | Borg CD-10 scale rating  | 64          |
| 4.1          | Propensity rate of musculoskeletal discomforts based on the severity of pain (N=752)   | 69          |
| 4.2          | Levene's test of equality of error variances   | 71          |
| 4.3          | Results for Sphericity for all research variables  | 71          |
| 4.4          | Correlation coefficient between demographic variables research variables   | 72          |
| 4.5          | Statistical analyses used in this study based on the objectives  | 74          |
| 4.6          | Descriptive statistics for right hip range of motion (degree)  | 75          |
| 4.7          | Summary of two way repeated-measures ANCOVA for range of motion of the right hip   | 75          |
| 4.8          | Pairwise comparisons across time for both control and intervention groups (within group comparison)                          | 76          |
| 4.9          | Descriptive of statistics for left hip range of motion (degree)  | 78          |
| 4.10         | Summary of two ways repeated-measures ANCOVA for range of the motion of the left hip   | 79          |
| 4.11         | Pairwise comparisons across time for both control and intervention groups (within group comparison)                          | 80          |

|      |   |     |
|------|---|-----|
| 4.12 | Descriptive statistics for range of motion of the right knee (degree)                                 | 82  |
| 4.13 | Summary of two way repeated-measures ANCOVA for the range of motion of the right knee                 | 83  |
| 4.14 | Pairwise comparisons across time for both control and intervention groups (within group comparison)   | 84  |
| 4.15 | Descriptive statistics for range of motion of the left knee (degree)                                  | 86  |
| 4.16 | Summary of two way repeated-measures ANCOVA for the range of motion of the left knee                  | 87  |
| 4.17 | Pairwise comparisons across time for both control and intervention groups (within group comparison)   | 88  |
| 4.18 | Descriptive statistics of flexion range of motion of the right shoulder (degree)                      | 90  |
| 4.19 | Summary of two way repeated-measures ANCOVA for flexion range of motion in the right shoulder         | 91  |
| 4.20 | Pairwise comparisons across time for both control and intervention groups (within group comparison)   | 92  |
| 4.21 | Descriptive statistics for flexion range of motion of the left shoulder (degree)                      | 94  |
| 4.22 | Summary of two way repeated-measures ANCOVA for flexion range of motion of the left shoulder          | 95  |
| 4.23 | Pairwise comparisons across time for both control and intervention groups (within group comparison)   | 96  |
| 4.24 | Descriptive statistics for bending range of motion (to the right) of the neck (degree)                | 98  |
| 4.25 | Summary of two way repeated-measures ANCOVA for bending range of motion (to the right) of the neck    | 99  |
| 4.26 | Pairwise comparisons across time for both control and intervention groups (within group comparison)   | 100 |
| 4.27 | Descriptive statistics for bending range of motion (to the left) of the neck (degree)                 | 102 |
| 4.28 | Summary of two way repeated-measures ANCOVA for the bending range of motion (to the left) of the neck | 103 |

|      |   |     |
|------|---|-----|
| 4.29 | Pairwise comparisons across time for both control and intervention groups (within group comparison) | 104 |
| 4.30 | Descriptive statistics for ROSA   | 106 |
| 4.31 | Summary of two way repeated-measures ANCOVA for ROSA  | 107 |
| 4.32 | Pairwise comparisons across time for both control and intervention groups (within group comparison) | 108 |
| 4.33 | Description of statistics for the neck  | 110 |
| 4.34 | Summary of two way repeated-measures ANCOVA for the neck*   | 111 |
| 4.35 | Pairwise comparisons across time for both control and intervention groups (within group comparison) | 112 |
| 4.36 | Description of statistics for the right shoulder  | 114 |
| 4.37 | Summary of two way repeated-measures ANCOVA for right shoulder*                                     | 115 |
| 4.38 | Pairwise comparisons across time for both control and intervention groups (within group comparison) | 116 |
| 4.39 | Descriptive of statistics for the left shoulder   | 118 |
| 4.40 | Summary of two way repeated-measures ANOVA for the left shoulder*                                   | 119 |
| 4.41 | Pairwise comparisons across time for both control and intervention groups (within group comparison) | 120 |
| 4.42 | Descriptive statistics for lower back   | 122 |
| 4.43 | Summary of two way repeated-measures ANCOVA lower back*   | 123 |
| 4.44 | Pairwise comparisons across time for both control and intervention groups (within group comparison) | 124 |
| 4.45 | Perceived exertion after 5, 10 and 15 minutes   | 126 |

## LIST OF FIGURES

| <b>Figure</b> |   | <b>Page</b> |
|---------------|---|-------------|
| 1.1           | The conceptual framework of the research program  | 6           |
| 2.1           | Back muscles  | 16          |
| 2.2           | Different layers of back muscles  | 17          |
| 3.1           | Research flow chart   | 42          |
| 3.2           | Bangsar office map  | 43          |
| 3.3           | Cyberjaya office map  | 44          |
| 3.4           | Puchong office map  | 44          |
| 3.5           | Damansara office map  | 44          |
| 3.6           | Sampling for phase 1  | 48          |
| 3.7           | Sampling in phase 2   | 50          |
| 3.8           | The Cornell Questionnaire   | 54          |
| 3.9           | Goniometer 30 cm  | 56          |
| 3.10          | The in-office exercise protocol, showing the sequence of actions starting from a seated position                | 60          |
| 3.11          | ROSA score from online ROSA questionnaire software  | 65          |
| 4.1           | Means of range of motion of the right hip in the intervention and control groups during the course of the study | 77          |
| 4.2           | Means range of motion of the left hip in the intervention and control groups across the study times             | 81          |
| 4.3           | Means of range of motion of the right knee for the intervention and control groups during the study             | 85          |
| 4.4           | Mean range of motion of the left knee in the intervention and control groups across the study                   | 89          |
| 4.5           | Means flexion range of motion for right shoulder in the intervention and control groups across the study        | 93          |
| 4.6           | Mean flexion range of motion in the left shoulder in the intervention and control groups across the study       | 97          |

|     |  |     |
|-----|--|-----|
| 4.7 | Mean bending range of motion (to the right) for the neck in the intervention and control groups across the study | 101 |
| 4.8 | Mean left neck range of motion for interventions and control groups across the time                              | 105 |
| 4.9 | Means of score for Borg CR-10 scale across the study   | 127 |



## LIST OF APPENDICES

| Appendix |   | Page |
|----------|---|------|
| A        | Sample size formula   | 173  |
| B        | Ethic letter  | 174  |
| C        | Consent form (Company)  | 175  |
| D        | Consent form (UPM)  | 176  |
| E        | Cornell questionnaire (Malay)   | 180  |
| F        | Permission letter for translation of Cornell questionnaire  | 181  |
| G        | Expert validation letter  | 182  |
| H        | Package of exercise training  | 183  |
| I        | ROSA instruction  | 196  |
| J        | Pairwise comparisons across time among the control and intervention groups (between group comparison) | 204  |



# CHAPTER 1

## INTRODUCTION

This chapter provides a contextual perspective on the study by presenting an orientation to the topic, identification and description of the problem statement, along with stating the aims of this study, significance, limitations and delimitations of the study are also presented. The operational definitions of terms used in the study are the last part of this chapter.

### 1.1 Research Background

Lower back, neck and shoulder pain are the most widespread musculoskeletal conditions worldwide and they have both personal and socioeconomic consequences (Petersen, 2003). These musculoskeletal issues are particularly prevalent in industrialized countries, affecting roughly 70% to 80% of adults at some point in their lives, with approximately 1% of the U.S. population chronically disabled as a result of lower back, neck or shoulder pain (Helmick et al., 2008; Knox et al., 2011). Such a disability causes poor quality of life while increasing the amount of daily work absenteeism and the number of long-term disability claims (Sundstrup et al., 2014). Those who are affected often experience sleep disturbances, chronic fatigue and nervousness, and many fall victims to prescription medication abuse (Knox et al., 2011; Painter & Crofford, 2013). The scale of this problem is anticipated to grow with both an aging population and increasing pace of industrialization in the developing world (Robertson et al., 2013). A variety of risk factors contribute to lower back, neck and shoulder pain, including age, race, sex, and marital status, but the most prevalent factor - especially among adolescents - is the amount of time spent sitting down (Kroenke et al., 2011; Smith & DeJoy, 2012; Tamrin et al., 2007).

The World Health Organization (WHO) has pointed to a variety of risk factors, such as an individual's physique and work organization, in addition to differing psychosocial and sociological risks, that contribute to work-related discomforts in varying degrees (Lerberghe, 2008). These theoretical reasons have been supported by empirical evidence which suggests a link between working conditions and musculoskeletal discomforts (MSD) among office workers (Kessler et al., 2011; Cavill et al., 2006). Malaysia, as a rapidly developing country in recent years, contains a great number of offices and office workers, with employees working different shifts and often standing or sitting for extended periods of time without sufficient rest (Tamrin et al., 2007). Several studies in Malaysia have shown that MSD are common among those who work in offices (Adon et al., 2011; Tamrin et al., 2007). The National Institute of Occupational Safety and Health (NIOSH) in Malaysia stated that 61% of the nation's workforce uses computers at work, a fact which indicates the

increasing use of advanced technology in the workplace (Hassim, 2012; Zakerian & Subramaniam, 2009). In this regard, and with attention to the high rate of MSD in Malaysia, finding a practical treatment seems vital.

A number of studies have supported the claim that people who work in offices are particularly prone to experiencing musculoskeletal discomfort, creating an increased awareness of, and concern for, the welfare of office workers (Choobineh et al., 2011; Mahmud et al., 2012; Sethi et al., 2011; Taieb-Maimon et al., 2012). The Social Security Organization (SOCISO) in Malaysia caps the number of cases involving musculoskeletal injuries at a maximum of 10,000 per year, which is a disconcertingly low figure, given the large scale of these kinds of problem in the country (Murad et al., 2013). The most frequently reported issues were lower back, neck and shoulder pain, comprising more than 50% of all claims related to musculoskeletal problems (Cho et al., 2012; Tamrin et al., 2007). The most commonly cited reasons for the high percentage of lower back, neck and shoulder pain are related to factors including the ergonomics conditions of the workplace and a sedentary lifestyle, with an absence of routine physical activity (Sitthipornvorakul et al., 2011). Unfortunately, the incidence of claims for musculoskeletal problems in the work place is increasing, but there is not enough attention paid to this issue by the government and companies, even though the problems associated with sitting and working for a long time have become a big issue.

According to the European Guidelines for prevention of lower back, neck and shoulder pain, pain is generally divided into three categories: acute, sub-acute and chronic pain (Dagenais et al., 2008). The principle upon which this subdivision is based on the duration of the pain. Acute pain is an episode which lasts less than 6 weeks; sub-acute pain lasts between 6 and 12 weeks, and chronic pain persists for 12 weeks or more (Dagenais et al., 2008; Dagenaise 2010; George et al., 2011). Several studies (Choobineh et al., 2011; Tamrin et al., 2007) point to physical inactivity associated with a sedentary lifestyle, resulting from prolonged periods of time spent in wrong sitting positions and having incorrect posture (which leads to damage and weakening of the postural muscles, following a decrease in range of motion and flexibility associated with the spine). Another potential issue is muscle spasms resulting from various forms of psychological stress. All of these issues are related to the workplace environment and physical inactivity and can decrease the ability of muscles to move (decrease the range of motion and flexibility), decrease the support they normally provide, and finally lead to MSD, especially in lower back, shoulder, and neck pain, and this MSD can be the main reason for sleep disturbance, fatigue, medicine abuse, and having physical pain (Dagenais et al., 2010). Nevertheless, it seems that having a short break or short walk during the working time can be useful (Taylor et al., 2013).

Physical activity is considered as an essential predecessor to healthy living, and important to maintain the musculoskeletal system to function in proper order (Smith & DeJoy, 2012). Insufficient exercise may cause or worsen pain in lower back, neck and shoulder due to increased weakened and stiffness muscles. Individuals with an

inactive lifestyles not only lose their strength but also the muscles flexibility, both of which are vital constituents of health-related physical fitness and natural posture (Taieb-Maimon et al., 2012). Nonetheless, these individuals fail to benefit from regular physical activity in such ways which is away from the more obvious and common relations with muscular flexibility of the spinal area and is provided by regular exercise (Johnston et al., 2014). When a person's lifestyle lacks exercise, these tissues become malnourished and begin to degenerate (Sitthipornvorakul et al., 2011), and this lack of physical activity will be the main reason for having a high body mass index (BMI) (Johnston et al., 2014). In addition, sitting in an office chair for hours at a time can cause or worsen existing lower back, neck and shoulder pain. Sitting forward or slouching in a chair for extended periods can overstretch the spinal ligaments and put undue strain on the intervertebral discs and surrounding structures in the spine (Hassim, 2012; Smith & DeJoy, 2012). Over time, incorrect sitting posture and poor workplace ergonomics can contribute to or cause recurrent episodes of MSD, especially in lower back, neck and shoulder areas (Choobineh et al., 2011; Taieb-Maimon et al., 2012), and it is suggested that, ergonomic modification, based on the ergonomic standards can be helpful.

## **1.2 Problem Statement**

In recent decades, Malaysia has become one the largest growing countries in Asia (Zakerian & Subramaniam, 2009). For example, Malaysia has transformed itself from a producer of raw materials in the 1970s into an emerging multi-sector economy now. Meanwhile, the number of white-collar workers is on the rise. The National Institute of Occupational Safety and Health (NIOSH) in Malaysia states that 61% of the nation's workforce uses computers at work, and the number of office workers in Malaysia continues to grow (Zakerian & Subramaniam, 2009).

Because of their busy schedules, these workers need to sit in front of a computer for extended hours under unfavorable ergonomic conditions without proper breaks or physical activity (Murad et al., 2013; Tamrin et al., 2007). The long time sitting, and absence of physical activity causes a loss of muscular strength, endurance and flexibility, leading to feelings of fatigue, soreness and pain in their muscles after long periods spent working. As a result, most of these office workers have developed musculoskeletal discomfort (MSD), especially in the areas of the neck, shoulders, and lower back (Choobineh et al., 2011). The actual number of cases of musculoskeletal injuries/pain among Malaysian office workers is suspected to be much higher than the 10,000 caps on claims by SOCSO (Tamrin et al., 2007). In 2008, Siti et al., showed that the overall prevalence of MSDs among office workers in universities in Malaysia was high (80.4%) (Siti, 2008). In 2011, Mahmud et al., showed that there were high 12 month prevalence rates of musculoskeletal symptoms in the shoulder (51.6%), neck (48.2%), and back (42.2%) among workers (Mahmud et al., 2011).

MSD can lead to uncomfortable situations at work and then absence of work and taking medical certificate (MC), due to physical pain/injuries, which has a negative effect on productivity and financial efficiency for the company (Amin et al., 2014; Brooks, 2006). MSD not only affects the quality of life of these individuals, but also has a negative impact on the productivity of the organization where they work (Amin et al., 2014). In Malaysia, the compensation estimation of one work-related death is RM 1.2 million, whereas the cost of permanent disability resulting from a work-related injury is RM 120, 000 (Amin et al., 2014). The total temporary disablement's disbursement for permanent disability benefits in the year 2010 was RM 109 million, increasing to RM306 million, additionally, dependent benefits cost RM205 million (Amin et al., 2014). This high cost must be considered by human resource departments and governments.

The treatments and/or interventions recommended by previous studies are often generalized and costly, with many requiring the consultation of specialists. Conversely, there has been past academic scholarship carried out in several developed nations, such as the U.S.A and Europe, but the treatments and/or interventions they recommend are not home-based and very often require specific and expensive facilities (Farioli et al., 2014; Kim et al., 2015). A gap has also been identified in these studies, whereby the interventions and/or treatments were mostly short-term in nature, therefore providing no insight into these interventions/treatments' long-term effects. Finally, these past studies share another common gap, namely the exclusion of cost-efficient measurements in the workplace.

### **1.3 Study Research Question**

Listed below are the research questions for objectives of this study:

1. What would be the incidence of MSD among office workers in Malaysia?
2. Would exercise training, modified ergonomics, and a combination of exercise training and modified ergonomics have an effect on the ROM of the neck, shoulders, and lower back of office workers?
3. Would exercise training, modified ergonomics, and a combination of exercise training and modified ergonomics have an effect on the ROSA scores of office workers?
4. Would exercise training, modified ergonomics, and a combination of exercise training and modified ergonomics have a significant effect on the Cornell discomforts scores of office workers?
5. Would there be any differences among different types of treatments related to Cornell discomforts scores, the ROSA scores, and the ROM of the neck, shoulders, and lower back of office workers?
6. Would there be a relationship among the Cornell discomforts scores, the ROSA scores, the ROM of the neck, shoulders, and lower back, and BMI?

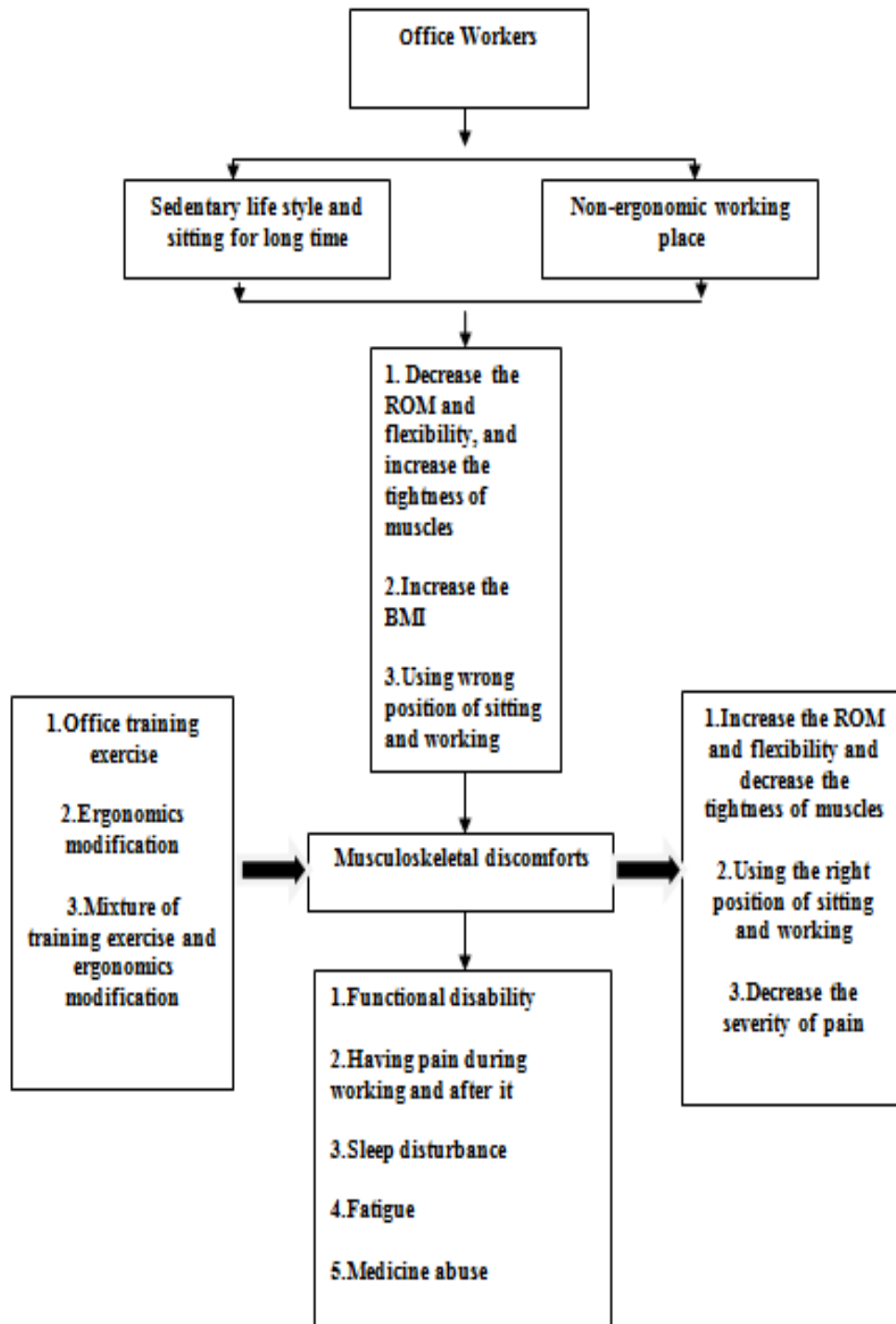
## **1.4 Research Justification**

The prevalence of MSD poses the risk of adverse effects on a country's economy, because it not only causes the productivity of office workers to decline, it also results in them requesting longer or additional periods of sick leave, which means that employers often have to invest more money even when little work is completed (Yelin & Callahan, 1995). This high rate of MSD prevalence shows the need for emphasis on both prevention and cure. A good deal of research has been done on this topic in Malaysia, but most of it has simply highlighted the prevalence of these issues among office workers while other studies have suggested general and simple training protocols for the whole body, or suggested ways to modify the ergonomic conditions of work environments (Tamrin et al., 2007) . However, there has been a lack of research related to a practical, easy and cost effective treatment. Exercise and intensive multidisciplinary pain treatment programs effectiveness for non-specific MSD is supported by strong evidence. Performing regular exercise increases people's overall ability to perform daily tasks. As a result, the amount of pain they experience is reduced, thereby allowing for easier and more restful sleep, which in turn lowers levels of fatigue (Sitthipornvorakul et al., 2011). Lack of sufficient sleep not only cripples the performance of individuals in the workplace, but also their health and, in the long run, the efficiency of the companies where they work (Martinez & Lenz, 2010).

However, there is potential for the eradication of this burden through implementation of cost-efficient office-based interventions that do not require sophisticated facilities with a focus on injured areas, rather than general treatments. As such, it is crucial to investigate cost-efficient and standardized methods to obtain better insight into this issue by conducting physical tests without side-effects, especially in the office setting. Based on the results of these tests, physiotherapists and occupational therapists can then determine the pain severity while evaluating the effects of the aforementioned methods. The present study aims to examine MSDs from the perspective of sports science, in the hope that it can help eradicate the prevalence of MSD's through the implementation of low cost active prevention in the office setting.

## **1.5 Conceptual Framework**

Sedentary lifestyle, sitting for long time and non-ergonomics working place in office workers, lead to decreases in the range of motion and flexibility, increase the BMI, and using wrong position of sitting (Mahmud et al., 2011) . These are the main reasons for musculoskeletal discomforts (MSD) among this population. This study hypothesized that office exercise training, ergonomic modification and a mixture of these interventions can affect MSD and decrease the severity of pain, by using an ergonomic working place and increasing the range of motion and flexibility (Figure 1.1).



**Figure 1.1: The conceptual framework of the research program**

## **1.6 Objectives**

### **1.6.1 General Objective**

To determine an effective method for reducing lower back, neck and shoulder pain discomfort scores and improving the range of motion (ROM) of lower back, shoulder and neck muscles among office workers.

### **1.6.2 Specific Objectives**

1. To examine the incidence of MSD among office workers in Malaysia.
2. To examine the effect of exercise training, modified ergonomics, and a combination of exercise training and modified ergonomics on the ROM of the neck, shoulders, and lower back of office workers
3. To examine the effect of exercise training, modified ergonomics, and a combination of exercise training and modified ergonomics on the ROSA scores of office workers.
4. To examine the effect of exercise training, modified ergonomics, and a combination of exercise training and modified ergonomics on the Cornell discomforts scores of office workers.
5. To compare among treatments that consist of exercise alone, ergonomics modification alone, and exercise combined with ergonomics modification for Cornell discomforts scores, the ROSA scores, and the ROM of the neck, shoulders, and lower back of office workers.
6. To examine the relationship among the Cornell discomforts scores, the ROSA scores, the ROM of the neck, shoulders, and lower back, and BMI.

### **1.7 Null Hypotheses**

1. Exercise training, modified ergonomics, and a combination of exercise training and modified ergonomics would have no significant effects on the ROM of the neck, shoulders, and lower back of office workers.
2. Exercise training, modified ergonomics, and a combination of exercise training and modified ergonomics would have no significant effects on the ROSA scores of office workers.
3. Exercise training, modified ergonomics, and a combination of exercise training and modified ergonomics would have no significant effect on the Cornell discomforts scores of office workers.
4. There would be no significant differences between the three types of intervention (designed for reducing lower back, neck and shoulder pain discomfort scores and improving the ROM of lower back, neck and shoulder muscles) and the scores of online ROSA.

5. There would be no significant relationship among the Cornell discomforts scores, the ROSA scores, the ROM of the neck, shoulders, and lower back, and BMI.

## **1.8 Definition of Terms**

### **1.8.1 Conceptual Definition**

### **1.8.2 Musculoskeletal Discomforts**

Musculoskeletal discomforts (MSD) can be defined as pain in or injuries to muscles, nerves, joints, connective tissues (like ligaments and tendons), or any other bodily structures that support or are part of the limbs, neck and back (Kuorinka et al., 1995). MSD can be caused by sudden exertion, from repetitive motions performed over time or continued exposure to force, awkward posture for extended periods of time. Some common MSD are scoliosis (abnormal twisting and curvature of the spine) and lordosis (exaggerated lumbar curve in the spine) that can be happen because of wrong posture during working times or because of long time sitting or standing. MSD are widespread across a broad range of occupations, including those heavy biomechanical loads, in addition to those with light loads like office work (Hales et al., 1994).

### **1.8.3 Ergonomics Risk Factors**

Ergonomics risk factors refer to the aspects or conditions of a given situation that can increase the risk of developing musculoskeletal discomforts through biomechanical stress imposed on a worker (Keyserling et al., 1992). These include such factors as incorrect posture, over-exertion, bending and repetitive motion in working environments, and they can be measured by the Rosa online questionnaire and the Borg scale. Modifying the working environment can include setting appropriate heights of their chair and working table; also, the respondents' sitting posture can affect their scores in these two questionnaires (Keyserling et al., 1992).

### **1.8.4 Lower Back Pain**

Lower back pain, also referred to as lumbago, is a common condition which involves the back bones and muscles. About 70% of all people are influenced by this condition at some point throughout their lives. Lower back pain (often abbreviated as LBP) is normally categorized (based on its duration) into three categories: acute, with pain duration of less than 6 weeks; sub-chronic, which pain lasts 6 to 12 weeks; or chronic, which lasts for more than 12 weeks. This situation may be further categorized using



the fundamental reason, as mechanical, non-mechanical, or referred pain (Roy et al., 1989).

### **1.8.5 Neck Pain**

A feeling of discomfort around the neck area is called neck pain (Hoy et al., 2010). The cause of neck pain can be due to disorders of any of the structures in the neck, such as muscles, the intervertebral discs and cervical vertebrae, nerves, blood vessels, lymphatic organs, esophagus, trachea, larynx, parathyroid glands or thyroid gland. Neck pain is caused by from several various conditions which is sometimes known as cervical pain (Fejer et al., 2006; Hoy et al., 2010).

### **1.8.6 Shoulder Pain**

This term refers to pain in the shoulder because of a disease or an injury. The shoulder joint design is in a way that stability is sacrificed for mobility; being a tremendously mobile joint which has a vital role in the major extremity's (the arm) action, the shoulder is at high risk for injury (Windt et al., 2000). An injury can include the bursa, ligaments, the shoulder joint's surrounding tendons, the cartilage, bones of the joint, or labrum. Pain may also happen in the shoulder because of conditions and diseases of the bones surrounding the shoulder and soft tissues, or from the nerves which the sensation is transmitted from these areas (Leclerc et al., 2004; Windt et al., 2000).

### **1.8.7 Protocol of Exercise**

A set of endorsed standards and qualified and validated exercises will be used to improve the flexibility and strength of office workers who do not engage in sufficient physical activity. The protocol has been designed for office training and tailored for sedentary individuals, as has been used for shoulder, neck and back pain (Kuhn, 2009).

## **Operational Definitions**

### **1.8.8 Musculoskeletal Discomforts**

Diagnosis is based on self-reported symptoms of pain, aches or discomfort in any of the following regions: neck, shoulder, elbow, hands or arms, upper back, lower back, one or both thighs, one or both knees, and one or both ankles. These symptoms can be determined by the Cornell Musculoskeletal Discomfort Questionnaire (Erdinc et al., 2011) which will be used in this research, focusing on the neck, shoulder and back.

### **1.8.9 Ergonomics Risk Factors for office workers**

Ergonomics risk factors for office workers in this study are qualitatively identified by modifying them with the standards which would be considered acceptable for an office environment (Sonne et al., 2012). These risk factors include the distance of the working chair to the table and monitor, position of monitor, mouse and keyboard and the subject's dominant hand, as well as the angle and height of the subject's chair.

### **1.8.10 Lower Back Pain, Neck Pain and Shoulder Pain**

The incidence of lower back pain will be determined based on the self-reported results of the questionnaire and try to find the most prevalent areas of pain, based on the results of Cornell musculoskeletal questionnaire among office workers. The incidence will be calculated based on the severity of pain (Erdinc et al., 2011) and those with higher severity of pain will be selected.

### **1.8.11 Protocol of Exercise**

The protocol will consist of a sequence of stretching and strengthening exercises that have been approved by ACSM (American College of Sports Medicine) (Thompson et al., 2013) and form a standardized training program of stretching that has been designed for prevention and treatment purposes and is appropriate for people aged 14 to 50 years old. This program has been modified slightly, creating a new order of exercises and modifying those aimed at the spine, so that they are suitable for use in the office. The duration of each training exercise is 10-15 seconds for each side of body. The ROM (range of motion) test will be used to measure the flexibility of the hip, knee, neck and shoulders in response to the training protocol.

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## LIST OF PUBLICATIONS

- Shariat, A., Tamrin, S. B. M., Arumugam, M., & Ramasamy, R. (2016). The Bahasa melayu version of Cornell musculoskeletal discomfort questionnaire (CMDQ): Reliability and validity study in Malaysia. *Work*, (Preprint), 1-8 **(ISI, SCOPUS, PUBMED)**.
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