EFFECTIVENESS OF THE MULTIDIMENSIONAL ERGONOMIC INTERVENTION (MEI) MODEL TO REDUCE MUSCULOSKELETAL DISCOMFORT AMONG STREET SWEEPERS

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ประสิทธิผลของรูปแบบการยศาสตร์แบบพหุมิติเพื่อลดความปวดเมื่อยล้าของกล้ามเนื้อและกระดูกในพนักงานกวาดถนน

นางกาญจนา ปินตาคำ

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาสาธารณสุขศาสตรดุษฎีบัณฑิต
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Thesis Title	EFFECTIVENESS OF THE MULTIDIMENSIONAL ERGONOMIC INTERVENTION (MEI) MODEL TO REDUCE MUSCULOSKELETAL DISCOMFORT AMONG STREET SWEEPERS
By	Mrs. Kanjanar Pintakham
Field of Study	Public Health
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Accepted by the College of Public Health Sciences, Chulalongkorn University in Partial Fulfillment of the Requirements for the Doctoral Degree

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กาญจนา ปินตาคำ : ประสิทธิผลของรูปแบบการยศาสตร์แบบพหุมิติเพื่อลดความปวดเมื่อยล้าของกล้ามเนื้อและกระดูกในพนักงานกวาดถนน (EFFECTIVENESS OF THE MULTIDIMENSIONAL ERGONOMIC INTERVENTION (MEI) MODEL TO REDUCE MUSCULOSKELETAL DISCOMFORT AMONG STREET SWEEPERS) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: รศ. ดร.วัฒน์สิทธิ์ ศิริวงศ์{, หน้า.

มีการรายงาน พบอัตราความชุกของความปวดเมื่อยล้าของกล้ามเนื้อและกระดูกค่อนข้างสูงในพนักงานกวาดถนน ซึ่งปัจจัยเสี่ยงของการเกิดมีความสัมพันธ์กับท่าทางในการทำงาน จากการกวาดที่เคลื่อนไหวแบบซ้ำซ้ำ และท่าทางการทำงานที่ไม่ถูกต้อง การศึกษานี้จึงมีวัตถุประสงค์ เพื่อประเมินประสิทธิผลของรูปแบบการยศาสตร์แบบพหุมิติ ในการลดความปวดเมื่อยล้าของกล้ามเนื้อและกระดูก การเพิ่มสมรรถภาพทางกาย และการเพิ่มความตระหนักในความปลอดภัยจากการทำงาน การวิจัยนี้เป็นแบบกึ่งทดลองดำเนินการในพื้นที่จังหวัดเชียงราย โดยใช้รูปแบบการยศาสตร์แบบพหุมิติ ซึ่งบูรณาการมาจากสี่องค์ประกอบคือ การบำบัดพฤติกรรมทางปัญญา การให้ความรู้ทางการยศาสตร์ การยืดเหยียดกล้ามเนื้อ และการใส่ปลอกโฟมด้ามไม้กวาด กลุ่มตัวอย่างคือ พนักงานกวาดถนนที่มีคะแนนความปวดเมื่อยล้าของกล้ามเนื้อตั้งแต่ 4 คะแนน ขึ้นไป โดยนักกายภาพบำบัดเป็นผู้ตรวจคัดกรองให้กับพนักงานอาสาสมัคร จำนวนทั้งหมด 75 คน เครื่องมือที่ใช้ในการประเมินในครั้งนี้คือ แบบสอบถามโดยใช้วิธีการสัมภาษณ์แบบตัวต่อตัวถึงความความปวดเมื่อยล้าของกล้ามเนื้อและกระดูก การตรวจคัดกรองและประเมินความปวดเมื่อยล้าของกล้ามเนื้อและกระดูกโดยนักกายภาพบำบัด การประเมินสมรรถภาพของกล้ามเนื้อโดยนักวิทยาศาสตร์การกีฬา และการประเมินส่วนของร่างกายทั้งหมดอย่างรวดเร็วจากการบันทึกวีดีโอ ผลการศึกษาพบว่า รูปแบบการยศาสตร์แบบพหุมิติ มีประสิทธิผลในการลดความปวดเมื่อยล้าของกล้ามเนื้อและกระดูก เพิ่มสมรรถภาพทางกาย และเพิ่มความตระหนักในความปลอดภัยจากการทำงานในกลุ่มทดลองเมื่อเทียบกับกลุ่มควบคุมอย่างมีนัยสำคัญทางสถิติ ที่ระดับ 0.01 ในช่วงหลัง 3 เดือนที่ได้รับรูปแบบกิจกรรม ข้อเสนอแนะจากงานวิจัยนี้คือ รูปแบบการยศาสตร์แบบพหุมิติ มีความเหมาะสมในการลดความปวดเมื่อยล้าของกล้ามเนื้อและกระดูก เพิ่มสมรรถภาพทางกาย และเพิ่มความตระหนักในความปลอดภัยจากการทำงาน ที่มีความสัมพันธ์กับการเคลื่อนไหวแบบซ้ำซ้ำ และการทำงานด้วยท่าทางที่ไม่ถูกต้องอย่างไรก็ตาม ความยั่งยืนและความต่อเนื่องของรูปแบบการยศาสตร์แบบพหุมิติจะเกิดขึ้นได้นั้น ต้องอาศัยความร่วมมือจากหน่วยงาน ในการติดตามดูแลสุขภาพของพนักงานก่อนการปฏิบัติงานในแต่ละวัน หรือใช้สำหรับให้คำแนะนำแก่พนักงานใหม่ก่อนเริ่มต้นทำงาน

สาขาวิชา สาธารณสุขศาสตร์	ลายมือชื่อนิสิต ....
ปีการศึกษา 2557	ลายมือชื่อ อ.ที่ปรึกษาหลัก ....

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KANJANAR PINTAKHAM: EFFECTIVENESS OF THE MULTIDIMENSIONAL ERGONOMIC INTERVENTION (MEI) MODEL TO REDUCE MUSCULOSKELETAL DISCOMFORT AMONG STREET SWEEPERS. ADVISOR: ASSOC. PROF. WATTASIT SIRIWONG, Ph.D.{, pp.

High prevalence of work related musculoskeletal discomfort among street sweepers is reported worldwide. Street sweepers may be at risk for musculoskeletal discomfort (MSD) from their daily working activities. Repetitive movement of the broom, improper sweeping, poor posture may cause MSD. The aim was to evaluate the effectiveness of the Multidimentional Ergonomic Intervention (MEI) model on reducing MSD, improving physical performance and increasing awareness of safe work practices. A quasi-experiment was conducted in Chiang Rai province, Thailand. The MEI model was designed of four core components, the first as cognitive behavior therapy, the second as ergonomic education training, the third as stretching exercise and the fourth as foam sleeve broom handle grip. Seventy-five street sweepers volunteered were conducted a screening process on MSD of having level score ≥ 4 by physiotherapist. Face to face interviewed was used the musculoskeletal discomfort assessment questionnaire, physical exam by physiotherapist, physical performance by sports scientist and REBA measured from video record. Finding showed that the MEI model among intervention group was significantly reduced MSD, improved the physical performance and increased awareness safe work practice compared with among control group at exit model and follow up ($p<.01$). Research suggests that the MEI model was appropriated to reduce MSD, improve physical performance and increases awareness safe work associated with repetitive movement and awkward postures on task. The MEI model for sustainability should be conducted to provide among street sweepers during working daily and the new street sweepers before start working from organization.

Field of Study:	Public Health	Student's Signature	....
Academic Year:	2014	Advisor's Signature	....

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LIST OF ABBREVIATION

MEI	Multidimensional ergonomic intervention
WMSD	Work related musculoskeletal disorders
MSD	Musculoskeletal discomfort
CBT	Cognitive behavioral therapy
MSDA	Musculoskeletal discomfort assessment
REBA	Rapid entire body assessment
ASWP-MSD	Awareness safe work practice of musculoskeletal discomfort
SNQ	Standardized Nordic Questionnaire

CHAPTER I
INTRODUCTION

1.1 Background and Rationale

"Street sweepers" can be regarded as poor and unhealthy occupation. These people are behind the enhancing traffic safety for removing harmful pollutants, preventing illnesses or diseases from wastes such as garbage, sand, soil and dust in the municipality (Seera, 2005). Thus, street sweepers are important people who are working for sweeping and cleaning up the accumulation of garbage and decreasing pollutants on the roads, footpaths and entering environment (Yogesh & Zodpey, 2007).

In general, street sweepers used brooms and a dustpan for cleaning wastes including garbage, sand, soil and stone. They are exposed to hazards directly and indirectly which may affect to their body health problems (International Labor Organization, 2007). Stambuli, indicated that street sweepers are exposed to unhealthy working environment condition (Stambuli, 2012). Occupational street sweepers exposed to a variety of health risk factors such as dust, volatile organic matter, bio-aerosols and mechanical stress, caused them to certain occupational diseases (Krajewski, Tarkowski, Cyprowski, Szarapinska-Kwaszewska, & Dudkiewicz, 2002) such as eye irritation, cough, skin irritation, diarrhea abdominal pain and musculoskeletal disorders (International Labor Organization, 2007). According to Reddy, the morbidity rate of street sweepers were valued at 11.30% of upper respiratory tract infections, 12.90% of chronic bronchitis, 21.50% of anemia, 9.90% of hyperacidity and 6.50% of hypertension (Reddy, 2013). Also, work related musculoskeletal discomfort among street sweepers was a high prevalence worldwide (Das et al., 2013).

Prevalence of musculoskeletal discomfort among street sweepers are 65.00% from Mansoura, Egypt (Mehrdad, Majlessi-Nasr, Aminian, & Malekahmadi, 2008) 49.20% from Brazil (Da Silva, Hoppe, Ravanello, & Mello, 2005). Moreover, the musculoskeletal discomfort in - Thailand report that 79.00% from Hatyai municipal, Songkhla province (Losakul, Chanprasit, & Kaewthummanukul, 2007), 79.12% in the past 7 day and 85.71% in the past 12 months from Bangkok (Theerawanichtrakul & Sithisarankul, 2014) and 88.00% from screening survey in Chiang Rai Municipality, Chiang Rai province ("<A Clean Sweep Safe Work practices for custotodiaqms.PDF>," ; Pintakham, Taneepanichskul, & Siriwong, 2014).

The musculoskeletal discomfort correlated positively with work shift (Toulouse et al., 2012). The European Agency for Safety and Health at Work indicated that approximately millions of workers related musculoskeletal discomfort in 2008, type of musculoskeletal discomfort are pain, tingling, cramp, numbness, tightness, weakness, heaviness, feeling cold or hot, and swelling (Korhan, 2012). Street sweepers are at risk exposing musculoskeletal ache and pain of the neck, shoulders, elbows, hands, back and lower limbs that caused from their activities on work (European Agency for Safety and Health at Work, 2007). According to survey of cleaners, European Agency for Safety and Health at Work (2007), 74.00% experiences of ache and pain are muscular discomfort.

The risk factors of musculoskeletal discomfort are caused primarily by work condition including awkward posture, repetitive motion, static postures, and forceful exertions (European Agency for Safety and Health at Work, 2007; NIOSH, 2007). The occupation related musculoskeletal discomfort among street sweepers are repetitive movement from using broom sweeping, bending back for removing garbage and walking area. Repetitive movement condition, using upper limb frequently, lead to musculoskeletal discomfort among street sweepers. Amick reported that approximately one million workers had musculoskeletal discomfort according to repetitive movement and over exertion (Amick III et al., 2003). According to Podniece, Heuvel and Blatter (2008), 62.00% of street sweepers are exposed to repetitive hand or arm movements. In addition, the locations of musculoskeletal discomfort are back pain from bending down position and walking distance while sweeping that lead to leg and feet pain or numbness. Back pain, a physically discomfort is divided into two types: acute and chronic pain in the lumbar or buttock area (European Agency for Safety and Health at Work, 2007). Moreover, awkward posture may cause by poorly understood and lack of safety practice during working. Yogesh and Zodpey (2007), pointed out that street sweepers are one exposed of occupational health hazards due to poo education, lack of knowledge or practice to protect themselves. Moreover, the health risk has been increasing from ignorance of health prevention, low educational level and lack of information (Salimena, Coelho, Melo, Greco, & Almeida, 2012). Thus, musculoskeletal discomfort are influent various and poorly understood among workers in the workplace, which may help to explain why discomfort is high risks and need to provide the intervention for improving musculoskeletal discomfort (Mekhora, Liston, Nanthavanij, & Cole, 2000).

According to The National Institute for Occupational Safety and Health (2010), the intervention for example safety training, policies, and procedures can improved musculoskeletal health among workers. Multidimensional interventions are more effectiveness than single interventions (Fujishiro, Weaver, Heaney, Hamrick, & Marras, 2005). Therefore, the intervention model was designed an integration of cognitive behavior therapy, education training, stretching exercise and adding foam sleeve broom handle grip. With expectation that it would reduce musculoskeletal discomfort, improve muscular strength and endurance, as well as increase awareness of self-practice and safety behavior ergonomic related occupational health among street sweepers. Multidimensional ergonomic intervention model was designed according to the Occupational Safety and Health Administration's recommendation - that the training is a significant element of the ergonomics process. Training information should involve risk of ergonomics issues in the workplace and provide easy language that workers can understand. Adjusting of equipment or tools and improving awareness of safe work practices are effective to reduce musculoskeletal discomfort and improve work practices (Occupational Safety and Health Administration (OSHA), 2008).

Hence, the integrated cognitive behavior theory is important for motivate thought and behavior which lead to individual safety. Cognitive behavior is one of suggested treatments that using complementary and alternative practices to increase awareness of self-practices and safety behaviors. Spillman and Long (2009) point out that cognitive behavior provide positive effect of psychological outcomes such as motivating mental health and good feeling, increasing prevention of health, perceiving protect themselves, and displeasure; moreover it can improve the quality of life (Glanz & Schwartz, 2008; Ross, 2011). The cognitive behavior technique also can prevent asymptomatic return of human (Hollon, Stewart, & Strunk, 2006).

Many researchers recommended that the exercise program is significant to promote physical movement and reduce musculoskeletal discomfort. Fenety and Walker (Fenety & Walker, 2002). found that exercises program was an appropriate tool for prevention in short term which decreased in the both postural immobility and musculoskeletal discomfort. The stretching exercise was more effective way to improve musculoskeletal discomfort related prolonged activities or static postures. Hinrichs et al., reported that the stretching exercises can improve functional ability and reduced low back pain (Hinrichs et al., 2009) . Choi and Woletz suggested that the benefits of stretching exercise can improve blood circulation, posture and range of motion (Choi & Woletz, 2010). In addition, it was increased flexibility of muscles, tendons and ligaments. Research indicated that the flexibility and stretching exercise programs can reduce to occurrence of occupational related musculoskeletal discomfort and injuries (Drennan, Ramsay, & Richey, 2006).

A foam sleeve is a device creating for applications which requires extra hand grip and needs to prolong handle tool such as safety bars, fitness equipment and long broom handle (GripWorks, 2011). California Department of Industrial Relations (2005) indicated that adding foam sleeve in the broom handle can be reducing pressure handle and comfortable to use. Moreover, Grip Work (2011) recommended that the smooth foam tubes are appropriate and simple to use because it relieves pressure from hands and becomes comfortable. Tools with foam sleeve handles is a greater efficiency hand grip as foam sleeve handles is a comfortable cushioned feel with no-slip grip motion (California Department of Industrial Relations, 2005). From the reasons, the intervention of this study was conducted to add foam sleeve grip on the broom handle and free support for sweeping in Chiang Rai municipality.

From all above, literatures were suggested that education training, cognitive behavior therapy, stretching exercises and add foam sleeve handle grip are the appropriate tools using for reducing musculoskeletal discomfort. Establishing multidimensional an ergonomic intervention (MEI) model was integrated the four core components including the first as education; the second as cognitive behavior therapy; the third as stretching exercise; and the fourth as foam sleeve broom handle grip. With an intention to reduce musculoskeletal discomfort, improve physical performance, and increase awareness of safe work practices among street sweepers in Chiang Rai municipality.

Surprisingly, there was limitation of existing interventions for reducing musculoskeletal discomfort related occupational (Amick III et al., 2003). According to Yogesh and Zodpey, They were a few ergonomics training researches on reducing and preventing health risk in street sweepers (Yogesh & Zodpey, 2007). Also in Thailand, only a few ergonomic programs has conducted studies on technique to reduce musculoskeletal discomfort among street sweepers (Losakul et al., 2007; Theerawanichtrakul & Sithisarankul, 2014).

Therefore, this study was integrated 4 elements including cognitive behavior; education tanning; stretching exercise; and adding foam sleeve handle grip on the model. The aimed of this study was to evaluate the effectiveness of multidimensional ergonomic intervention (MEI) model to reduce musculoskeletal discomfort, improve physical performance and increase awareness of safe work practices among street sweepers in Chiang Rai municipality

1.2 Objective

To evaluate the effectiveness of the multidimensional ergonomic intervention (MEI) model on:

1. Reducing musculoskeletal discomfort.
2. Improving physical performance.
3. Increasing awareness of safe work practices.

1.3 Research question

Did the multidimensional ergonomic intervention (MEI) model affect musculoskeletal discomfort, physical performance, and awareness of safe work practices among street sweeper?

1.4 Hypothesis

1. Hypothesis 1

H0: The MSD in street sweepers receiving the MEI model is not different.

H1: The MSD in street sweepers receiving the MEI model is different.

2. Hypothesis 2

H0: The physical performance in street sweepers receiving the MEI model is not different.

H1: The physical performance in street sweepers receiving the MEI model is different.

Hypothesis 3

H0: The awareness of safe work practice in street sweepers receiving the MEI model is not different.

H1: The awareness of safe work practice in street sweepers receiving the MEI model is different.

1.5 Operational definition

The multidimensional ergonomic intervention (MEI) model refers to a process of the intervention that comprise of four core components of model, the first as ergonomic education, the second as cognitive behavior therapy, the third as stretching exercise and the fourth as foam sleeve broom handle grip. The MEI model developed based on ergonomics concept and literature review, to reduce musculoskeletal discomfort, improve muscular strength and endurance, and increase awareness of safe work practices among street sweepers. The model comprises of lecture training (ergonomic and cognitive behavior therapy), demonstrating (safety posture of working and stretching exercise), and supporting free foam sleeve boom handle grip. Moreover, there was a booklet about the model to provide information which helped to recall after finishing implementation of activities. The booklet contained appropriate information about ergonomic safety practice such as measurement tool for working condition, safety working practice, posture of work, and stretching exercise to reduce musculoskeletal discomfort in workplace.

Ergonomic education refers to a set of information carefully design to provide knowledge, skill and practice through training for instance, risk factors of musculoskeletal discomfort, consequences of musculoskeletal discomfort, appropriate equipment for working (broom, dustpan and foam sleeve broom handle grip), and ergonomic safe work practice. The ergonomic education was conducted to increase awareness of safe work practices among street sweepers.

Cognitive behavior therapy refers to the dynamic interaction involving thoughts, perception, and behavior. It motivated thought and behavior to increase awareness of safe work practice on musculoskeletal, it led to sustainability of safe work practice.

Stretching exercises refers to program which focusing on movement on specific part of body relating to musculoskeletal discomforts of street sweepers. This motion includes upper limbs (shoulder, arms and hand), back, legs and feet. Type of stretching exercises relating to work condition of street sweepers includes wrist and hand, shoulder and arm, back, leg and feet. Duration was 30 minute a time, 3 times a week and continues until 12 weeks.

Foam sleeve broom handle grip refers to smooth foam tube; the tube was added by wrapping around the handle broom approximately 45 centimeters. This handle grip helps reduce compression pressure on the hand, provides a comfortable cushioned feel, and become less slippers on a grip. It increased greater efficiency on hand grip.

Musculoskeletal discomfort refers to the feeling conditions of group such as pain, tingling, cramp, numbness, tightness, weakness, heaviness, feeling cold or hot, and swelling (Korhan, 2012). These conditions involved repetitive movements and awkward postures from occupational among street sweeping.

Street sweepers refer to both male and female who are working for cleaning garbage by broom sweeping and using dustpan to remove wastes in Chiang Rai municipality, Chiang Rai province, Thailand.

Awkward postures refer to part of body which changed from natural position. The type of awkward positions such as reaching overhead or behind the head, twisting at the waist, bending the torso forward and backward, squatting, kneeling and bending wrist, it was awkward positions related to occupational street sweepers.

Repetitive movements refer to repeating the same motion every few seconds or repeating a cycle of motion involving the same body parts more than twice per minute for more than 2 consecutive hours in a row.

Working experience refers to a period of any experiences that street sweepers gain while working in a field and received income from municipality.

Working hour refers to a period of time for activities street sweepers in daily work.

Walking distance refers to street sweepers sweeping distance –assigned zone in daily working.

Using broom per month refers to street sweepers' change the broom to sweep on field per month due to different reasons such as damaged broom or lost broom.

Proportion of chin height and broom refers to the proportion between the street sweepers' chin and the length of broom.

Proportion of height and broom refers to the proportion between the street sweepers' chin and the height of broom.

Physical performance refers to the ability for performing function a physical task of street sweepers, including range of motion and muscle strength.

Awareness of safe work practices refers to the prevention of health risk and the enhance of safety among street sweepers in their workplace, involving the type of safety ergonomic occupational related musculoskeletal discomfort such as safety practice of working condition, equipment tool, and stretching exercise.

Intervention group refers to street sweepers from Robe Wiang and Sansai sub – districts in Chiang Rai municipality, Chiang Rai province, where street sweepers received the MEI model.

Control group refers to street sweepers from Wiang and Rimkok sub–districts in Chiang Rai municipality, Chiang Rai province, where was not taken any intervention of this study model, they conducted their work as usual and received practice technique of the MEI model after the study finished.

1.6 Expected Benefits and Applications

Individual

1. The MEI model was provided benefit to reduce occupational related musculoskeletal discomfort among street sweepers.

2. The MEI model was reduced or prevented work-related musculoskeletal disorders among street sweepers.

3. The MEI model was improved physical performance and raise awareness of safe work practices related to the enhancement of musculoskeletal health among street sweepers in Chiang Rai municipality.

Organization

1. The MEI model was benefited anyone who is interested in the practice of the intervention model for decreasing prevalence rate of musculoskeletal discomfort among workers in Chiang Rai municipality.

2. The MEI model was relieved musculoskeletal discomfort and improve quality of life among street sweepers or other workers which may result to be a happy workplace.

3. The MEI model was suggested to put in policy for strengthen the sustainability of organization.

CHAPTER II
LITERATURE REVIEW

Several concepts was outlined in this chapter provide explanation about the overall conceptual framework into which the research was laid. Below are specific studies which were reviewed to support this research as follows;

2.1 Street sweepers

2.1.1 The context of street sweepers

2.1.2 Type of street sweeping

2.1.3 Equipment for street sweeping

2.1.4 Source of street wastes

2.1.5 Health risk factor among street sweepers

2.1.6 Safe work practice

2.2 Ergonomics

2.2.1 Nature of ergonomics

2.2.2 Ergonomics risk factors

2.2.3 Ergonomics control risk factors

2.2.4 Benefits of ergonomics

2.2.5 Mechanisms of musculoskeletal discomfort

2.3 Cognitive behavioral

2.3.1 Cognitive behavioral theory

2.3.2 Definition of cognitive behavior therapy

2.3.3 Practice of cognitive behavior therapy

2.3.4 Goals of cognitive behavior therapy

2.3.5 Benefits of cognitive behavior therapy

2.4 Stretching exercises

2.4.1 Concept of stretching exercises

2.4.2 Benefit of stretching exercises

2.1 Street sweepers

2.1.1 The context of street sweepers

Street sweeper refers to a person's occupation that cleans the streets by using broom and shovel to clean off litter and garbage. They are a group of workers who enhance traffic safety by removing debris lying, coarse sediment and leaves on the road. Also, their works help improving aesthetics, removing harmful pollutants, preventing pollution and illnesses or diseases from wastes such as garbage, sand, soil and dust in the municipality (Seera, 2005). Thus, street sweeper occupation is important in sweeping, cleaning up the accumulation of garbage at the same time decreasing pollutants from roads, footpaths and entering environment (Yogesh & Zodpey, 2007). Moreover, they are essential in taking responsibilities for part of preventative or maintenance pollutants, cleaning off garbage in municipalities. Street sweepers are common practice undertaking in urban municipalities by improvements of the environmental conditions and preventing pollutants on urban street surfaces (Walker, Wong, & Wootton, 1999).

The sweeping area usually has two elements; footways and channels on street. Normally, occupational street sweepers using broom for cleaning wastes include garbage, sand, soil and stone, which exposes directly and indirectly on the body lead to health problems (International Labor Organization, 2007). Stambuli indicated that street sweepers are considered unhealthy as they expose to polluted working environment condition (Stambuli, 2012). Normally, among street sweepers are required to work 8-hour of the labor force and given take a break for an hours half. Period of work time can be dividing into two time period: a) 4 to 5 hours in the morning and b) 3 to 4 hours in the afternoon. Quite frequently the work force is utilized in a group in the afternoon hours, which is highly unproductive. Responsible area for cleaning is allotted individually and each cleaning area will be monitored daily by their supervisor. Yogesh and Zodpey pointed out that street sweepers are occupational health hazards due to lack of knowledge or practice to protect themselves and they have limited educational opportunities (Yogesh & Zodpey, 2007). Moreover, the health risks are increasing from ignorance of health prevention, low educational level and lack of information (Salimena et al., 2012).

2.1.2 Type of street sweeping

Over hundreds of years, most municipalities use two types of street sweeping: 1) manual broom; and 2) mechanical broom. Uses of appropriate tool play an important role in improving the efficiency of the work force. Manual broom sweeping uses labor efforts to push or shovel trash, dirt, vegetation and animal droppings (Schilling, 2005).

The Mechanical broom sweeping include vacuum sweeper wet or dry, captive hydrology technique and regenerative-air sweeper, the process removes the garbage can be conducted by sweeping broom material with gutter rearward into the path of a pick-up broom (McClellan, 2000). Two types of street sweeping are described below:

1. Manual brooms

Street sweeping workers commonly use manual effort by using broom to push and shove garbage. Broom is used outdoor to clean surfaces by sweeping all kinds of debris. Long handled brooms are not require bending which reduce fatigue and increase productivity levels (Ministry of Urban Development Government of India, 2000). Different style of broom requires a specific handle to maximize its function. Wood handles offer great value, they are not electrostatic and their texture is not cold. Many professionals indicated that wood broom is the most comfortable for tactile touch compare to other handle materials (Fulford, 2012). Moreover, wood handle broom can be adjusted to a custom fit with selected handle length; this length should be equal to the level of user’s chin. Quality of a handle depends on a thickness: the thicker the handle is the stronger and more comfortable it will be. The key to proper ergonomic comfort is to match the handle to the individual. The handle broom should be placed just under the chin [L2] of street sweepers (Atlas Graham, 2010).

Figure 1 Specification of a broom

Source: Safe work practices for street sweepers: Booklet (Pintakham & Siriwong, 2015)

2. Mechanical broom

Mechanical broom sweeping is more effective equipment in helping to clean the streets. It can clean more garbage while running for a longer distance than individual manual sweeping (Schilling, 2005). The United States used mechanical broom sweeping removes garbage by gutter brooms material into the path of a pick-up broom and to move with in conveyor system into a hopper (McClellan, 2000). According to Campos, mechanical broom has advantage in picking-up gross pollutants such as gravel, road debris, coarse sand and vegetation (Campos, 2006). The machine can conduct wet and dry sweeping operations in the roadways. Mechanical brooms sweepers are effective to remove coarse materials and gross pollutants, which higher efficiency for pollutant removal on street. Even though, mechanical broom is more effective for cleaning garbage but it is more expensive compare to other pollution control practice such as settling or filtering devices, or detention ponds. These methods prolongs their operational efficiency, and required maintenance that is cost-effective for street sweeping (Schilling, 2005).

In this study, the area of study was conducted in Chiang Rai municipality which was more appropriated to use manual broom sweeping rather than mechanical broom, as the roadways of municipality was suitable for using manual broom and dustpan. Besides it was not too expensive for working in the community.

2.1.3 Equipment for street sweeping

Nowadays, sanitation workers use outdated and inefficient cleaning tools which need to be replaced. However, a process to induce workers to change their habit of using familiar equipment – is not easy. They normally resist any change even though the change will be good for them. It is therefore, necessary to convince workers to adopt more appropriated tools and new practice to sanitation work by raising their awareness. Equipment using for manual street sweeping are explained in the following section (Ministry of Urban Development Government of India, 2000).

1. Brooms

There is no yardstick about the number of brooms to be setting for usage e.g., how many piece used per month or per year. Street sweepers were given brooms monthly or sometimes quarterly. One long handled broom per month is considered to be adequate for street sweeping. The handle itself – the long-handle bamboo (long-handle) to which the broom is attached need not to be given once a month as it lasts a long life. The old handle bamboo should be reused for making brooms. The bamboo may be replaced when required. It could be replaced in six months or once a year depending upon the local conditions of the city (Hardy & Fontillas, 2003). According to Ministry of Urban Development, Government of India, (2000) the characteristic of broom is below:

Length of the broom: 80-85 cm

Weight of the broom: 1 kg

Binding material: 20 gauge MS sheet and ring having width of 1.5-2 cm

Handle of the broom: Bamboo of 135 cm length, 3-4 cm diameter

Weights of the bamboo handle (approximately): 900 gm.

The bamboo sticks should be free from ruts, and insects to be a good quality for sweeping outdoor. The broom handle should be solid and smooth in texture and has a pointed edge on one end for proper fixing with the broom.

2. Dustpan

Function of a dustpan or waste receptacle is used to collect the street wastes. The material for collecting waste by sweeping comprised of a pan and/or base, a set of walls, and a handle that typically extend laterally from a rear wall of the pan (Fulford, 2012). Normally, street sweepers are using broom to sweep debris into the dustpan. The characteristic of dustpan is to receive and contain debris include a base contact with a surface to be cleaned, the base having a front edge over which debris can be swept into the dustpan, a wall extending upward from at least a portion of the base other than the front edge and a handle having a substantially arcuate cross-section coupled to the wall of the dustpan and to allow a user to place the base in contact with the surface to be cleaned (Hardy & Fontillas, 2003). Moreover, the dustpan is appropriate tool which has low weight and the height is always a shoulder height of workers.

In this study, the Chiang Rai municipality was supported the equipment for working consists of two types including broom and dustpan. Street sweepers can be changed equipment at any time when the equipment was damaged or unavailable.

2.1.4 Sources of street wastes

Street wastes fall into three main categories; (Ministry of Urban Development Government of India, 2000).

1. Natural wastes

These include dust blown from unpaved areas, sometimes from within the city and sometimes from a great distance, and decaying vegetation such as fallen leaves, blossoms and seeds which originate from trees and plants in the city. Natural wastes cannot be avoided, but may be controlled by such measures as the careful selection of the types of tree planted in the city.

2. Road traffic wastes

Motor vehicles deposit oil, rubber and mud; in addition, there is sometimes accidental spillage of a vehicle's load. Animals drawing vehicles deposit excrement on the road surface. At large construction sites mud is often carried out by motor vehicles and deposited on adjacent roads; in wet weather this can cause danger to other traffic by skidding. Traffic wastes are largely unavoidable but some legislative control is possible in the cases of load spillage and construction sites.

3. Behavior wastes

The main source of wastes is litter thrown by pedestrians and house or shop-wastes swept or thrown out of private premises instead of being placed in the suitable container meant for the purpose. Human spittle and the excrement of domestic pets also fall into this category and together provide health risk, which arises from street wastes due to inhalation of dust contaminated by dried spittle and excrement. Behavior wastes are largely avoidable provided an efficient refuse collection service is in operation and litter bins are provided for the use of pedestrians. But success requires a continuing program of public education and awareness backed up by legislation and rapidly operating enforcement procedures.

2.1.5 Health risk factor among street sweepers

Occupational street sweepers are exposed to a variety of health risk factors such as dust, volatile organic matter, bio-aerosols and mechanical stress, which make them lead to certain occupational diseases (Krajewski et al., 2002). Street sweeper is a significant worker who expose to more than one incidence of illness such as eye irritation, cough, skin irritation, diarrhea and abdominal pain (International Labor Organization, 2007). According to Reddy morbidities detected among street sweepers were 21.5% of anemia, 12.9% of chronic bronchitis, 11.3% of upper respiratory tract infections, 9.9% of hyperacidity and 6.5% of hypertension (Reddy, 2013). During working, dust is raised during sweeping by brooms. Therefore, the street sweepers who are exposure to dust will affect respiratory system (Nku, Peters, Eshiet, Oku, & Osim, 2006). Moreover, the researcher found that the common disorders of women street sweepers are pulmonary disease, chest pain, respiratory problem, skin disease, ring worm and musculoskeletal disorder (Das et al., 2013).

Work related musculoskeletal discomfort among street sweepers are a high prevalence (Theerawanichtrakul & Sithisarankul, 2014). In 2008, according to the European Agency for Safety and Health at Work indicate that approximately millions of workers related musculoskeletal discomfort. Type of musculoskeletal discomfort includes ache, pain, numbness, cramp, tingling, heaviness, weakness, tightness, feeling hot or cold, and swelling (Korhan, 2012). The musculoskeletal discomfort correlated positively with increase more than half of work shift (Toulouse et al., 2012). There are 65% of street sweepers from Mansoura, Egypt (Mehrdad et al., 2008), 49.2% from Brazil (Da Silva et al., 2005). Moreover, in Thailand the musculoskeletal discomfort are 79% from Hatyai municipal, Songkhla province (Losakul et al., 2007), and 88% from Chiangrai Municipality, Chiang Rai province (Pintakham et al., 2014). Street sweepers are at risk exposing musculoskeletal ache and pain of the neck, shoulders, elbows, hands, back and lower limbs as a result from their activities on work (European Agency for Safety and Health at Work, 2007). According to survey of cleaners, European Agency for Safety and Health at Work (2007) indicated that 74% of street sweepers experience muscular discomfort, aches and pains. The risk factor of musculoskeletal discomfort includes awkward posture, repetitive movements, static postures and forceful exertions (NIOSH, 2007). The causation of musculoskeletal discomfort on among street sweepers are repetitive movement from use broom sweeping, bend back for removing garbage and walking area to be responsible (Theerawanichtrakul & Sithisarankul, 2014). According to California Department of Industrial Relations (2005) workers who sweeping may involve awkward posture of wrists and prolonged contact pressure on hands. Moreover, the back and neck are often in an awkward forward bent posture. Musculoskeletal discomforts are caused primarily by work condition (repetitive movement, force and awkward posture) and by individual behavior (self-practice safety practice) (European Agency for Safety and Health at Work, 2007). Repetitive movement condition use upper limb frequently such as scapula, shoulders, hands and wrists, which lead to musculoskeletal discomfort among street sweepers. Amick

III et al., showed that approximately one million workers are musculoskeletal discomfort due to repetitive movement and over exertion (Amick III et al., 2003). According to Podniece et al., suggest that 62% of the workers exposed to repetitive hand or arm movements (Podniece et al., 2008). In addition, the locations of musculoskeletal discomfort were back pain from bending down position and walk for responsibility sweeping area in daily working that lead to leg and feet pain or numbness. Back pain, a physically discomfort, can be defined as acute pain or chronic pain in the lumbar or buttock area (European Agency for Safety and Health at Work, 2007). Moreover, awkward posture may come from poorly understood and lack of safety practice on work. Yogesh and Zodpey point out that street sweepers are one type of occupational health hazards due to lack of knowledge or practice to protect themselves and poor education (Yogesh & Zodpey, 2007). Moreover, the health risk has been increasing from ignorance of health prevention, low educational level and lack of information (Salimena et al., 2012).

In this study, the illness among street sweepers in Chiang Rai municipality was showed that 88% as musculoskeletal discomfort, 68% as respiratory systems and 53% as stress (Pintakham et al., 2014). Thus, this study was helped to prevent musculoskeletal discomfort among street sweeper in Chiang Rai Municipality and reduce occupational related musculoskeletal discomfort.

2.1.6 Safe work practice

1. Safe Sweeping

Street sweepers were significantly involved repetitive movement and awkward position of wrists, back and neck. According to Occupational Health and Safety (2000) repetitive movement and awkward posture can affect to any part of the body. An unnatural position can be influenced musculoskeletal discomfort among street sweepers. In addition, the worker can be protecting this activity by take care of musculoskeletal discomfort as follows; (California Department of Industrial Relations, 2005)

1. Use lightweight brooms and stand up straight, don't bending back.

Figure 2 Sweeping in awkward positions

Source: Safe work practices for street sweepers: Booklet (Pintakham & Siriwong, 2015)

2. Take a rest breaks several times per hour (30 seconds–2 minutes) to relax your muscles & prevent injury by taking several rest breaks is better than taking one long lunch break.

3. Add foam sleeve over broom handle to relieve pressure on the hand & for a better comfortable grip.

Figure 3 Add a foam sleeve over the broom handle to relieve pressure on the hand

Source: Safe work practices for street sweepers: Booklet (Pintakham & Siriwong, 2015)

4. Alternate right and left hands at the top of the broom handle.

Figure 4 Alternate hands when holding the handle

Source: Safe work practices for street sweepers: Booklet (Pintakham & Siriwong, 2015)

5. Keep elbows close to body during sweeping motion and avoid for over-reaching

6. Stretching muscle at the beginning and throughout workday for reduce discomfort and fatigue.

2. Safe bending posture

According to California Department of Industrial Relations (2005) proper bending techniques can reduce symptom of musculoskeletal disorders. The posture for bending as maintain a neutral spine, body and shoulder position during working, bend knees and keep back straight during activities as follows; ; (Occupational Health and Safety, 2000).

Figure 5 Bending posture

Source: Safe work practices for street sweepers: Booklet (Pintakham & Siriwong, 2015)

3. Safe walking posture

Anatomically, the spine is straight; do not bend body as it will damage those nerves by bending or twisting the spine excessively as follows; (Occupational Health and Safety, 2000).

Figure 6 Walking posture

Source: Safe work practices for street sweepers: Booklet (Pintakham & Siriwong, 2015)

4. Safe standing posture

Good posture consists of keeping the spine straight and carrying the shoulders neither rounded nor pulled back. Maintain this posture even when bending over at the waist while working as follows; (California Department of Industrial Relations, 2005)

Figure 7 Standing posture

Source: Safe work practices for street sweepers: Booklet (Pintakham & Siriwong, 2015)

2.2 Ergonomics

2.2.1 Nature of ergonomic

Ergonomics is rooted from Greek, which divided into two words, "ergo" means work and "nomos" means natural law of work (Warren, 2004). Ergonomics may be applied from scientific concerned on procedures and products for safety. Ergonomics is one solution which needs to modify tools and tasks to meet the needs of people, rather than forcing people to accommodate the task or tool. Consider how ergonomics might positively impact the workers throughout their professional lifespan (Harutunian, Gargallo Albiol, Figueiredo, & Gay Escoda, 2011).

Ergonomics is the science to design the fit work tasks of the worker's body, rather than the physical on the job (Karwowski & Marras, 2003). Adapting tasks, work stations, equipment, and tools to fit among worker can reduce physical stress on the workers. According to the Social Security Office in Thailand reported that unnatural working posture on workers are 5,047case in 2010 and 3,246 case in 2011 (Social Security Office, 2011). Ergonomics risk factors related to perceived physical demand of task, behavioral of personal and policy of organization. The workers can learn to anticipate what might go wrong and modified tools and the work environment to make tasks safer for their workers (Occupational Safety Health Administration, 2004).

2.2.2 Ergonomics risk factors

Ergonomic risk factors were involved tasks such as equipment or tool, work station, practice, policy of organization and personal behavior (OHCOW, 2012). This evidence support findings that exposure of ergonomic risk factors in the workplace can contribute to the risk of developing musculoskeletal disorders (Occupational Safety Health Administration, 2004). Ergonomics risk factors related to physical demand, psychosocial demands and individual factors. The three components as follows; (Karsh, 2006).

1. Physical demand

Physical demand related to tasks and organizations lead to injury, musculoskeletal system and illness of workers (Canadian Centre for Occupational Health and Safety, 2010). Risk factors of working condition, Occupational Safety and Health Administration indicated that the workplace guidelines physical risk factors. The risk factors of ergonomics related working condition on the work often exposed as follows:(Occupational Safety Health Administration, 2004).

1.1 Awkward posture

1.2 Static posture

1.3 Forceful exertions

1.4 Repetitive Movements

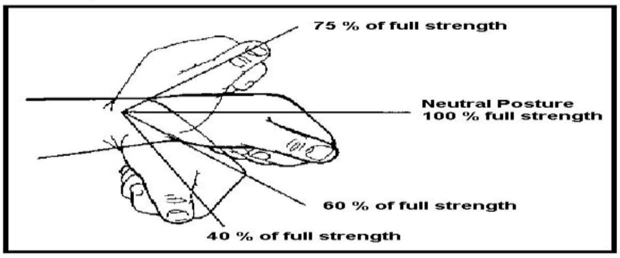
1.5 Vibration

1.6 Extreme temperature

1.1 Awkward Postures

Awkward postures refer to a term part of the body that the joints ranges of motion are not used near the middle the position for activity. The good of nature position is means the joints are range of motion near the middle body structure (Occupational Health and Safety Council of Ontario (OHSCO), 2007). In addition, joints moves out range of motion from neutral body become to awkward posture and lead to muscles strain, ligaments and tendons around the joint. Occupational Safety Health Administration (Occupational Safety and Health Administration (OSHA)) indicated that assumption of awkward posture is position that musculoskeletal stress on the body including prolonged-static posture, repetitive movement -such as prolonged or repeated reaching above the shoulder height, bending down, twisting, kneeling and squatting (Occupational Safety Health Administration, 2004). Awkward postures are often from poor work techniques, which affect to stress musculoskeletal structures and ligaments (OHCOW, 2012). According to Jarvholm et al. (1989) suggested that forward shoulder flexion or abduction approximately 30 degrees can cause a significant influence in blood circulation around the neck and shoulder. Prolonged awkward posture can cause to musculoskeletal discomfort and fatigue (W. Keyserling, 2000).

Figure 8 Wrist strength and posture



Source: Ergonomics and dental work by Occupational Health Clinics for Ontario Workers (OHCOW, 2012).

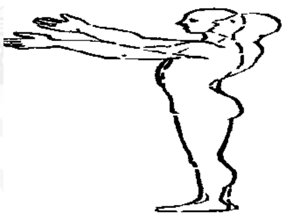
Awkward postures can affect to any part of the body is in an unnatural position or uncomfortable, repetitive and movements postures. Other types of postures and movements can contribute to MSD risks. According to general guideline, awkward posture that means repetitive movement as follows; (Occupational Health and Safety, 2000).

1. Bending the head forwards or sideways more than 20 degrees

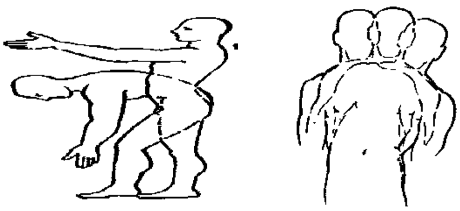
2. Bending the head backwards more than 5 degrees

3. Twisting the neck more than 20 degrees

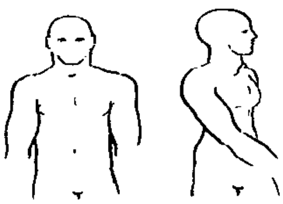
4. Backward bending of the back more than 5 degrees



5. Bending the back forwards or sideways more than 20 degrees



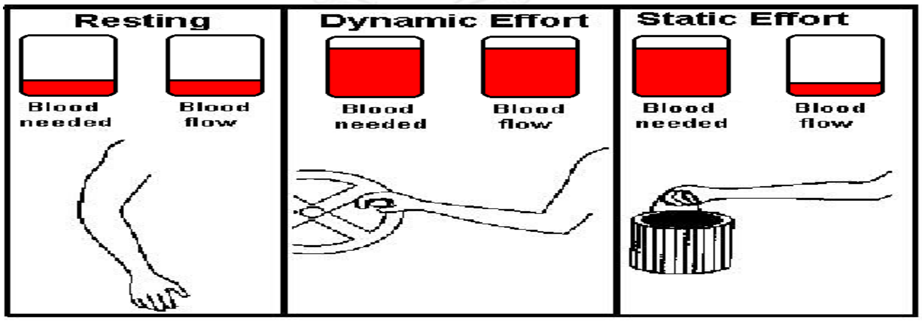
6. Twisting the back more than 20 degrees



1.2 Static Postures

Static postures refer to hold a prolonged period of time for activity, which affect to deliver of oxygen and blood to the musculoskeletal that lead to fatigue, injury and musculoskeletal stress (OHCOW, 2012). Because the activities are held postures for a long time, there is effect to decrease blood flow in the tissues. According to Park (2009), an increased physical force can lead to musculoskeletal overload and decreased blood circulation on muscles and joints. Repeated and continuous local contact can cause concentrated pressure between tool or equipment and body tissue among workers (Keyserling, 2006).

Figure 9 Changes in blood flow to any given muscle



Source: Nexgen Ergonomics (2010)

1.3 Forceful exertions

Force refers to physical activity of using effort by muscles that lead to amount of pressure on body part (OHCOW, 2012). Increasing force can influence increasing physical demands such as pushing, pulling and lifting while force overload can affect muscles, ligaments, joints and tendons (W. Keyserling, 2000). According to the Occupational Health and Safety Council of Ontario (OHSCO) (2007), all tasks need to use force of muscle, however, under force overloaded condition; it will lead to damage muscles, tendons, joint and tissue on body part. Additionally, the study has showed results that the amount of muscle effort is significant to perform all tasks in work (Occupational Safety Health Administration, 2004).

1.4 Repetitive Movements

Repetitive movements refer to performing the same high frequency range of motion for a prolonged period of time (Occupational Safety Health Administration, 2004). According to Silverstein and Clark (2004) high repetition on working condition was a threefold higher risk of the wrist and hand than low repetition in workers. Highly repetitive movement on tasks can cause to discomfort, tissue damage, fatigue and eventually injury, which repetitive movement can occur despite the low level of force and not awkward postures (Occupational Health and Safety Council of Ontario (OHSCO), 2007). Repetitive movement continual exposure may lead to discomfort and fatigue such as wrists, hands, back, shoulders, and occurs other body parts (NIOSH, 2007). According to Occupational Health Clinics for Ontario Workers there are three critical elements of repetitive motion to consider as follows; (OHCOW, 2012)

1.4.1 Frequency

Frequency refers to amount of times an activity is repeated such as repetitive wrist motions and shoulder movement.

1.4.2 Duration

Duration refers to amount of period of time an activity is performed such as length of time movement in a static posture and the total length of working day.

1.4.3 Recovery time

Recovery time refers to the time which breaks a repetitive cycle such as scheduled breaks and time spent stretching.

1.5 Vibration

Vibration refers to the system in motion which occurs to continue excitation response (W. Keyserling, 2000). Generally, vibration can contribute to the onset vascular disorder such as neurological disorder, carpal tunnel, white fingers syndrome, wrist or shoulder or arm problem (Silverstein & Clark, 2004).

1.6 Extreme temperature

Extreme temperature refers to temperature change related with work such as hot and cold temperature (W. Keyserling, 2000). Exposing to the temperature for a long period of time can lead to illness or injury on workers (Silverstein & Clark, 2004).

In this study, ergonomics risk factors was related to physical demand among street sweepers included repetitive movements (sweeping), awkward postures (sweeping, bending, walking and standing) and static postures (prolong on holding the broom).

2. Psychosocial demands

Psychosocial demands at work have become specific types of stress including availability of social support, conflict of work, job strain, job control, job security and job satisfaction (Edwards D.F, 2004). In addition, psychosocial demands consist of three elements for instance, emotional time pressure, cognitive demands, and high psychosocial risk factors (Cooper, Dewe, & O'Driscoll, 2001). According to Tweeedy (2005) the work related psychosocial risk factors are significant to develop prevalence of musculoskeletal disorders. Furthermore, psychosocial risk factors adversely effect on work condition and tend to occur more frequently. Therefore, the issue of psychosocial risk factors needs an attention from management level (Silverstein B. & Evanoff B., 2006).

3. Individual factors

Individual factors like gender and age could effect change in the responses of long term health outcomes (Norman, 2004). Therefore, the workers may choose to use a specific technique or method at work within the frames of individual experience, problem solving skills, a policy on the workplace, motivation, training and knowledge in the occupation (Llndegård et al., 2003). According to Tweedy (2005) individual factors which involve musculoskeletal disorders including gender, age, education, length of employment physical condition, practice, smoking, illness and other factors.

2.2.3 Ergonomics risk factors control

According to Occupational Safety and Health Administration (OSHA) (2000) the ergonomic risk factors control could prevent or reduce MSD hazards by using procedures to correct, properly designing work station, selecting the appropriate equipment or tools for that job. The strategy of ergonomics to prevent and control risk factors consists of three components as follows; (Occupational Safety and Health Administration (OSHA), 2008)

1. Engineering

Engineering involves a process of management to supply appropriate tool or equipment for workers, in which these tool and equipment can be designed (Occupational Safety and Health Administration (OSHA), 2000). Establish engineering controls of ergonomic risk factors by tool or equipment and work station is importance for reducing ergonomic risk factors According to Clark (2004)engineering controls involve workstation design, tools or equipment, proper maintenance and environmental layout. Engineering controls such as work station design, design for work methods, tool and handle design that appropriately designed will reduce repetitive motion, excessive force static, extreme, awkward postures, and reduce ergonomic risk (Occupational Safety and Health Administration (OSHA), 2008).

2. Administrative

Administrative is important for reduce ergonomic risk factors by changing the work process which will help to reduce the magnitude, duration and frequency ergonomic of exposure (Silverstein & Clark, 2004). Administrative control can be operated through supporting of supervisors such as worker rotation, more task variety, and increased rest breaks (Occupational Safety and Health Administration (OSHA), 2000). The policies of administration are significant to manage ergonomic risk factors on workers. Moreover, administrative controls may be reduced the frequency, duration, number of repetitions per hour, short rest, job rotation and severity of exposures to ergonomic hazards (Occupational Safety and Health Administration (OSHA), 2008).

3. Personal (Behavioral)

Personal characteristic is more significant for decrease ergonomic risk factors on workers. Personalities based on experience, age, knowledge, skill, awareness, perceive and behavior. In addition, physical demand is also effect on workers such as fatigue, body discomfort, muscle pain, injury and other musculoskeletal system (Canadian Centre for Occupational Health and Safety, 2010). According to Clark (2004) work practice helps to prevent ergonomic risk factors on workers and illness. Providing participatory ergonomics program for safety and health on workers by training and education ergonomic risk factors work practices, techniques safety on work, and personal protective equipment (Occupational Safety and Health Administration (OSHA), 2008). According to OSHA (2000) personal protective equipment is important for protection risk factors among worker such as knee pad and gloves (Occupational Safety and Health Administration (OSHA), 2000). Ergonomic training is one of the most effective for interactive and full participation among workers (NIOSH, 2007).

This study was created control for three risk factors among street sweepers in Chiangrai municipality. Engineering control will be designed by adding foam sleeve handle grip to reduce pressure and help to prolong holding the broom comfortably. Administrative control will design the relationship between staff and street sweepers for stretching exercise. As part of personal behavioral factors, an integration of training course for safe work practice, cognitive behavior therapy, stretching exercise and provide to use foam sleeve handle grip, will be conducted to control musculoskeletal discomfort of street sweeper. The intervention model consists of four components which will be focused on personal change by cognitive behavior theory to help to motivating safe work practice for sustainability among street sweepers.

2.2.4 Benefits of ergonomics

Ergonomics help the workplace as follows; (Occupational Safety and Health Administration (OSHA), 2008)

1. Decrease prevalence or incidence MSD rates.
2. Increase comfortable to make jobs easier for workers
3. Decrease errors lead to use automated processes that exert less physical effort
4. Reduce absences on workers due to taking more time to rehab from fatigue, muscle soreness and other problem related musculoskeletal disorder.
5. Reduce costs for illness from workers.
6. Improve safety among workers in workplace.
7. Improve morale among workers in workplace.

2.2.5 Mechanisms of musculoskeletal discomfort

The musculoskeletal system was consisted of skeletal muscle, bone, connective tissues and tendons. The main function of musculoskeletal system can helped to protect and support the part of body. Moreover, it was provided physical movement related to move and contract involved bone, muscles and joints to work together. Muscular system was consisted 50% of total human body weight and more than 600 skeletal muscles to move and contract. Muscular system was divided into three types including skeletal muscle, smooth muscle and cardiac muscle. In this study, specific skeletal muscle was addressed according to the function.

Musculoskeletal disorders (MSDs) was an injury or disorder of the musculoskeletal system resulting from repeated exposure to various hazards and/or risk factors in the workplace (Occupational Health and Safety Council of Ontario (OHSCO), 2007). Musculoskeletal system such as all muscles, nerves, blood vessels, bursa, ligaments, bones, joints, intervertebral discs, tendons, and tendon sheaths (Public Services Health & Safety Association, 2010). Therefore, musculoskeletal disorders increase high risk on body parts in the workplace continuously. MSDs are injuries and disorders of the soft tissues (muscles, tendons, ligaments, joints, and cartilage) and nerve system. They affect nearly all tissues, including the nerves and tendon sheaths, and most frequently and back. Occupational safety and health professionals have called these disorders a variety of names, including cumulative trauma disorders, repeated trauma, repetitive stress injuries, and occupational overexertion syndrome. These disabling injuries are painful and generally develop gradually over weeks, months, and years (Occupational Safety and Health Administration (OSHA), 2000). Musculoskeletal disorders are often involved wrist, elbow, shoulder and back in occurring to expose over time such as repetitive movement, awkward postures and forceful exertions (Chaffin, Andersson, & Martin, 2006). The musculoskeletal disorder was regarded as multifactorial causation including physical or mechanical factors, psychosocial factors or organizational, and individual or personal factors (EUOSHA, 2008). Moreover, awkward and static postures, repetitive handling, repetitive or monotonous work, demanding, straining work, lack of recreation times, high time pressure, frequently of overtime hours and reduced physical capacity were all the risk factors may contribute to musculoskeletal disorders (Korhan, 2012).

Researchers founded symptoms of discomfort for dental workers occurred in the wrists/hands (69.5%), neck (68.5%), upper back (67.4%), low back (56.8%) and shoulders (60.0%). They also found that 93% of those surveyed stated that they had at least one job-related ache, pain, or discomfort in the 12 months prior to the survey (Anton, Rosecrance, Merlino, & Cook, 2002). According to Hou and Shiao (2006) was 91.6% experienced musculoskeletal discomfort in body part related to different working condition such as twisting of waist, bending and standing for a prolonged period of time. The risk factors of musculoskeletal discomfort were significant to increase discomfort on different part of body region in increasing on body region (Fogleman & Lewis, 2002).

Thus, the causes of musculoskeletal discomfort in the workplace were various and poorly understood among workers. This explains why discomfort was high risk and needed to provide the intervention for improving musculoskeletal discomfort (Mekhora et al., 2000).

2.3 Cognitive behavior

2.3.1 Cognitive-Behavioral Theory

A cognitive behavior theory based on relation of two therapies, it is a combination between cognitive and behavior therapy (Schacter, Gilbert, & Wegner, 2010). Cognitive behavioral theory is one type of concept on thoughts which plays an important role in behavior change and problem solving. According to the British Association for Behavioural and Cognitive Psychotherapies (2005) cognitive and behavior therapy are a method based on concepts and principles theory of human emotion and behavior from psychological models. Cognitive involve positive thought which leads to resolve problems or events in life, this positive thought will lead to behavior change for risk prevention (Jacofsky M.D., Melanie T. Santos, Sony Khemlani-Patel, & Fugen Neziroglu, 2013). Cognitive behavior therapy (CBT) is one important techniques which uses motivation related healthy thoughts referring to healthy feeling and behaviors in the workplace (Ruwaard, Lange, Bouwman, Broeksteeg, & Schrieken, 2007). This technique focuses on relationships between thoughts, feelings and behaviors, which cognitive behavior therapy is one aspect to increase decision on person's ability. According to Grazebrook and Garland (2005) cognitive behavior is based on principles and concepts bringing to psychological and behavior of human’s emotion, by using continuously to help individual, family and groups. Cognitive behavioral focus on occurring of learning that helps human achieve optimal short- and long-term outcome (Abramowitz, 2013). Cognitive behavior can be used strategies and skills to apply for many challenges in life such as management chronic pain, mental and behavioral disorders, control drinking and maintain exercise. Moreover, cognitive behavioral therapy involved with emotion and actions of situation responses which- leads to adaptation of life events (Prendes & & Resko, 2012). Hence, cognitive behavior therapy focuses on the interaction between thinking, feeling and behavior that usually linked with current problems and limited period of time (Freeman et al., 2007).

Cognitive therapy is one technique of therapy that focuses on the relationships and connections between our thoughts, feelings and actions. Recognizing that each circumstance is affected by the environment in which live and environment involves both our current situations such as family, friends, job, culture, various stressor and supports, etc., as well as our past family history, past relationships, previous successes and failures, etc. Within our environment, there are four elements that interact with each other which will be presented as below; (Greig, Zito, Wexler, Fiszdon, & Bell, 2007)

1. Cognitive: thoughts, cognitions, beliefs, self-talk.

The identifying and re-evaluating negative thoughts, learning more effective problem-solving and decision-making strategies, beliefs and patterns of thinking and using mindfulness to deal with “uncontrollable” and racing thoughts, allowing to let go of unnecessary thoughts without getting caught up in them.

2. Behavioral: actions, behaviors

The changing unhelpful behaviors include social isolation, procrastination and inactivity, avoiding situations, learning to be more assertive and communicate more effectively and make life more meaningful and fulfilling and pursuing pleasurable activities and interests that promote happiness and health outcome.

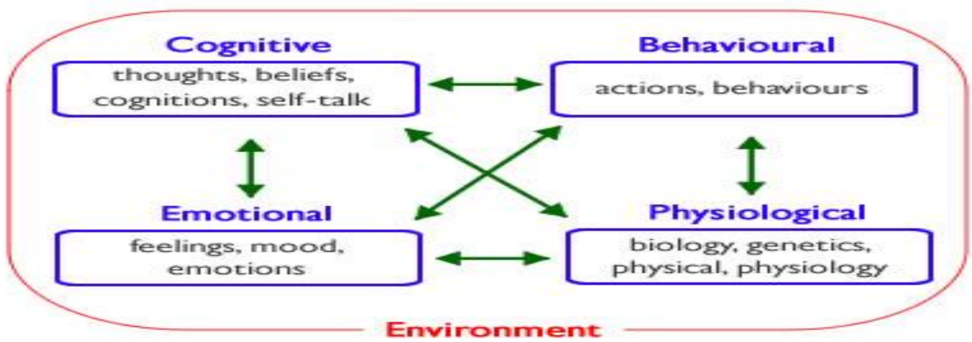
3. Emotional: feelings, moods, emotions

The learning how to experience and accept negative emotions without becoming overwhelmed, techniques to transform painful emotions into more manageable feelings and strategies to help tolerate emotional distress and manage extreme emotional reactions include intense anger, anxiety or sadness.

4. Physiological: biology, genetics, physical, physiology

The breathing exercises and relaxation techniques to calm physiological responses and reduce stress levels, improving sleep, diet and exercise habits to improve physical well-being, mindfulness practices to cope with stress and physical discomfort or pain and sometimes cognitive therapy is rendered in conjunction with medications describe by a physician.

Figure 10 The relationships four elements in environment



This figure describes from the arrows in the above diagram present as follows; (Dror et al., 2011)

1. Thoughts affect behavior, emotions and physiological state.
2. Behaviors affect thoughts, emotions and physiological state.
3. Emotions affect thoughts, behaviors and physiological state.
4. Physiological state affects thoughts, feelings and behaviors.

In this study, the cognitive relationships are covering four elements including cognitive, behavioral, physiological and emotional. There an involvement of individual system cycle, that helps developing program to improve musculoskeletal discomfort for street sweepers.

2.3.2 Definition of Cognitive Behavior Therapy

The cognitive behavior therapy theory focuses on mental processes, such as feeling, thinking, attending, remembering, wishing, fantasizing and planning. There are more difference meaning of cognitive behavior therapy defined by other researcher, as follows:

Cognitive behavior therapy refers that effective decisions is a cognitive skill. That focuses on how individuals perceive risks and make decisions about risk taking during early stage how individuals move from concrete operational thinking to formal operating thinking this is ability to think abstractly (Carol, CAROL, & Priscilla, 1993).

Cognitive behavior therapy refers to all behavior which is reflection of brain function and that thought process represents a range of function mediate in brain, which controls feeling, perception, learning and thinking. It helps maintain maladaptive behaviors, distortion in logic and systematic distortion in thinking (Otong, 1995). Cognitive behavior therapy refers to automatic thought and skill, that change behavior, and the role of appraisal (Kazantzis, Pachana, & Secker, 2003).

Cognitive behavior therapy refers to mental process include thinking, remembering, perception, wishing, planning and fantasizing in relations with one-self (Matlin, 2005).

Cognitive behavior therapy refers to mental processes and their individual memory structure. That deciding factor is ability to perform it under thought (Hatch et al., 2007).

In this study, cognitive behavior therapy refers to psychological processes on work related musculoskeletal discomfort among street sweepers. It will include combination between coping skills and automatic thought (thought challenging, positive thinking, change you're thought), and beliefs and attitudes which lead to raising awareness to change behavior among street sweepers.

2.3.3 Practice of cognitive behavior therapy

Cognitive behavior therapy refers to psychological process such as feeling, thinking, accepting, planning and reasoning (Matlin, 2005). The levels of the practice are difference which depends on skill levels of an individual or group. Therefore, the evaluation is varied as follows; (Dobson & Dobson, 2009).

1. Approaches: This is specific for problem areas of cognitive behavior therapy interventions such as coherent training to prevention work in people, motivate, diagnosis, identification of symptoms, this is not a look of psychotherapy as the health care provider are implementing a technical intervention, and they are not exact on formulation and adaptation of the treatment. The health workers will be acquired training in specific interventions for particular problem areas, and should be receiving supervision from a cognitive behavior therapy psychotherapist.

2. Assisted self-help: A self-help material offered to support individuals or groups by a health worker, such as a graduated mental health worker or assistant of psychologist. This is only limited and is not a look of psychotherapy, if available, formal cognitive behavior therapy training or skills are acquired by the individual introducing the approach, such individuals should not be claiming that they are doing cognitive behavior therapy.

3. Self-help: self-help is not a look of psychotherapy and no cognitive behavior therapy training or skills are acquired the self-help material by the individual reading.

However, there was some evidenced for the efficacy of cognitive behavior therapy approaches to many different levels; the purposes of this document term are referring to cognitive behavior therapy psychotherapy outlined in level one above.

2.3.4 Goals of cognitive behavior therapy

Goals of cognitive behavior therapy help individuals to achieve a remission and prevent a relapse of workers. Most of them in sessions was involved assisting individuals in solving problems and teaching or suggestion them to modify their negative thinking, distressing affect, and dysfunctional behavior. The therapists using treatment base on the basis of a cognitive formulation of humans' disorders and connecting individualized cognitive (Beck, 1995). The goals of cognitive behavior therapy is using at the beginning of treatment. It can help human' disorders understand how they will be able to reach their goals and feel better. At every session, it helps human' disorder solve problems that are of greatest stressor. The important parts of each session include a mood check, between sessions, sequencing an agenda, discussing specific problems and teaching skills in the context of solving these problems, setting of self-help assignments, summary, and feedback. Goal of cognitive behavior therapy can help individual, families and friend bring about coping, moreover, who can changes behavior or thinking as follows; (Townend, 2008)

1. Changing behavior include being more appropriate expression;
2. Changing feelings include motivate or being less fearful;
3. Changing thought patterns include identification automatic thought, solve problems, positive or negative thinking; and
4. Improving coping include self-esteem, avoidance or dealing panic.

The cognitive behavior therapy used to understand how life events and experiences bring to the core beliefs, underlying assumptions, and coping strategies, particularly in human' disorders. Which is educative, and human are taught cognitive, behavioral, and emotional regulation skill.

This study, the cognitive behavior therapy essentially involves helping an individual and group think in more effective ways and aims to uncover the irrational and problematic thinking styles that often accompany psychological process. The goal of cognitive intervention in this study that first priority focus is to thinking patterns change and self-defeating cognitions that link to respectively action for feelings change, changing of behavior and improving coping. Simple to learn cognitive strategies provide street sweepers with practical and powerful skills that can be applies over a lifetime as effective tools in life management for improving occupational related musculoskeletal discomfort, increasing muscular strength and endurance and also contribute to increase awareness of self-practices and appropriate safety behaviors among street sweepers in Chiang Rai municipality.

2.3.5 Benefits of cognitive behavior therapy

Cognitive behavior therapy is a generally form of psychological treatment that short-term to help people to understand the thoughts or feelings with influence behaviors (Cherry, 2005). According to the British Association for Behavioral and Cognitive Psychotherapies (2005), cognitive behavior therapy focused on helping peoples resolve with a very specific problem and focuses on the actual behaviors that are contributing to the problem such as people learn how to identify event of life and change destructive thought patterns that have a negative influence on behavior. In addition, cognitive behavior therapy is one method to use specifically with change on the thought or feeling of people and outcome can be measured relatively easily. Cherry (2005) reported that the cognitive behavior therapy is also a greatest benefit measurement for helping people to develop coping skills and emotion that can be useful both now and in the future. Due to cognitive behavior therapy is many benefits technique as follows; (Torres et al., 2007)

1. Development of positive thinking, which helps to handle certain situations. It helps to change pattern of management and become less likely to engage in destructive.

2. Enhancement of self-esteem for many people, low self-esteem is one of the primary factors underlying on themselves. Cognitive behavioral therapy can help improving their self-image. As their self-esteem blossoms, they will no longer desire

nor feel the need to engage in behaviors that are self-destructive. Constantly reinforcing a person's self-worth will help them start to believe that they truly deserve a better life than the one they currently have.

3. Learning to resist peer pressure

Peer pressure can be difficult for many people to resist are particularly vulnerable. During cognitive behavioral therapy, they will learn to practice new behaviors that will help them reach their desired goals. With regards to peer pressure, they might first imagine themselves followed by practicing doing so in a controlled setting. This will prepare them to resist when others pressure them to use. Ultimately, they'll feel more and more confident doing this in real life situations as they present themselves.

4. Cost effectiveness

Cognitive behavioral therapy is often chosen for treatment, it helps to significantly reduce the cost of treatment. It is also often covered by medical insurance plans as well.

5. Continuity of normal activities

Cognitive behavioral therapy is often conducted on people basis, those who are continuity of normal activities and can keep up their daily routines. Cognitive behavioral therapy has many benefits that play a significant role in helping them to successfully overcome unhealthy habits and behaviors. Additionally, many people have also found that the tenets of cognitive behavioral therapy can be applied with great benefit to other aspects of their life as well.

2.4 Stretching exercises

2.4.1 Concept of stretching exercises

Stretching is important to offer benefits that strengthen muscle and can also be performed by oneself. Stretching exercises are effective to reduce musculoskeletal discomfort and pain related to static posture and repetitive movement (da Costa & Vieira, 2008). Moreover, the effectiveness of stretching can increase power activities and strengthen to prevent muscle injury and soreness (Lavender, Conrad, Reichelt, Kohok, & Gacki-Smith, 2007; Rubini, Costa, & Gomes, 2007). According to Valachi and Valachi (2003) stretching the muscles helps to remain strong and healthy. Stretching is the action to perform a particular exercise for improving flexibility and joint range of motion; it is traditionally considered the joint range of motion that can be measured (Magnusson & Renström, 2006). Stretching exercises are effective ways to reduce muscle discomfort associated with prolonged use or static postures. Exercises should be conducted at regular intervals and should not wait until discomfort appears. For instance, people who work on intensive tasks (e.g., data entry) should stop working in every 30 minutes to perform stretching exercise. Normally, stretches should be starting out easy and can be performed regularly. Stretching exercises is one type to reduce muscle discomfort and to prevent muscles injury/illness and improve performance (Magnusson & Renström, 2006). A fundamental of stretching exercises affects the mechanical properties of the musculoskeletal discomfort.

2.4.2 Type of stretching exercise

Stretching exercise has to apply different types of stretching techniques to improve muscle strength and flexibility. Different types of stretching are listed below; (Odunaiya, Hamzat, & Ajayi, 2005)

1. Static Stretching

Static stretching refers to a stretch which is held in a challenging a fitness class when instructor leads at the end of a class. This static stretching involves extending a body part to its farthest position, usually somewhere between 10 to 30 seconds of duration. It does not involve bouncing or rapid movements, just a mild, painless pulling sensation. Static stretching is the most common form of stretching found in general fitness and is considered safe and effective for improving overall flexibility. However, many experts consider static stretching much less beneficial than dynamic stretching for improving range of motion for functional movement, including sports and activities for daily living.

2. Passive Stretching

Passive stretching is similar to static stretching, except that using some sort of outside assistance or partner provides the force to stretch the muscle. Passive stretching relieves muscle spasms and helps reducing muscle fatigue and soreness after a workout.

3. Dynamic Stretching

Dynamic stretching involves controlled swinging of the arms and legs that gently takes them to the limits of their range of motion. Here, parts of the body are moved with gradually increasing speed, reach or both, usually 10 to 12 times. Although dynamic stretching requires more thoughtful coordination than static stretching (because of the movement involved), it is gaining favor among athletes, coaches, trainers, and physical therapists because of its apparent benefits in improving functional range of motion and mobility in sports and activities for daily living. Moreover, dynamic stretching is controlled, smooth, and deliberate, whereas ballistic stretching is uncontrolled, erratic, and jerky. Although there are unique benefits to ballistic stretches, they should be done only under the supervision of a professional because, for most people, the risks of ballistic stretching far outweigh the benefits.

4. Ballistic Stretching

Ballistic stretching forces a body part to go beyond its normal range of motion by making it bounce to a stretched position. It increases range of motion and triggers the muscle's stretch reflex. Performing ballistic stretching can make you more susceptible to injury. Only highly conditioned and competent athletes preparing for strenuous activity should employ it. This type of stretching is not considered useful and can lead to injury. It does not allow your muscles to adjust to, and relax in, the stretched position.

5. Active Isolated Stretching

Active isolated stretching is most commonly used by professionals: athletes, trainers, massage therapists and others. To complete at active isolated stretch, you reach a certain position and hold it steady without any assistance other than the strength of your own muscles. Kick a leg up high, for example, and hold it up in that extended posture. Active isolated stretching works with natural physiological processes to increase muscle and fascia elasticity and improve circulation.

6. Isometric Stretching

In isometric stretching, a muscle is stretched into position, resist the stretch. Isometric stretching is the safest and most effective method for increasing the joints' range of motion, and it strengthens tendons and ligaments while retaining their flexibility.

7. Proprioceptive Neuromuscular Facilitation

Proprioceptive neuromuscular facilitation combines isometric, static and passive stretching to foster a high level of flexibility. Performing by passively stretching a muscle; isometrically contracting, it against resistance in the stretched position; and passively stretching it through, the resulting increased range of motion. It is an advanced form of flexibility training that also helps improve strength.

In this study, types of stretch was static stretching exercise due to the most common form of stretching found in general fitness, considered safe and effective for improving overall flexibility and reducing musculoskeletal discomfort. Duration of stretching exercise on body part was 30 seconds in the study.

2.4.3 Duration

According to Kay and Blazevich (2012) significant percentage of stretching performance duration in increasing muscle strength are 14% as stretching duration < 30 seconds, 22% as stretching duration 30-45 seconds, 61% as stretching duration 60-120 seconds, 63% as stretching duration > 120 seconds. However, Chan et al (2001) founded that static stretching individual with hamstrings for any time for a period of 15 and 120 seconds under protocol of 8 weeks can be effective in improving flexibility of hamstrings. Whereas a 30 and 60 second stretch had been reported to be more effective than a 15 second stretch (Bandy, Irion, & Briggler, 1998).

2.4.4 Safety exercise

1. Warm-up your muscles before you start stretching (e.g. walking in place)
2. Wear comfortable clothing (clothing should not limit movement)
3. Stretch to a point of feel mild discomfort, not pain.
4. No bouncing
5. Hold stretches for 10-30 seconds

6. Shake out limbs between stretches
7. Repeat each stretch 2-3 times
8. Do not hold your breath when stretching.
9. Do stretching exercises at least 2-3 times a week.

2.4.5 Benefits of stretching

Stretching exercises are easy, safety and also do not need many of accessories and is low cost for workers. To have main benefit, workers need to exercise at least 2-3 times a week. This frequent stretch can prevent physiological changes and injury from occurring to muscles and other tissues (Rovinelli & Hambleton, 1976). Key benefits of stretching are listed below:

1. Reduce muscle tension;
2. Decreases risk of injury;
3. Improve flexibility;
4. Improve circulation or increase blood flow to muscles;
5. Reduce anxiety, stress and fatigue;
6. Improve muscle coordination;
7. Improve physical performance;
8. Enhances enjoyment of physical activities; and
9. Increase range of motion and endurance.

Stretches should be performed for the entire body and focus on the movement patterns that are opposite to the habitual positions experienced during work (Sanders & Turcotte, 1997). Moreover, stretching exercise can effect physiological that help contributing to reduce musculoskeletal discomfort and pain (da Costa & Vieira, 2008).

2.5 Foam sleeve

A foam sleeve was a device creates for applications which require extra hand grip and need to prolong handle tool such as safety bars, fitness equipment and long broom handle (GripWorks, 2011). According to California Department of Industrial Relations (2005), it was added foam sleeve in the handle can be reducing pressure on handle and feel more comfortable to use. Moreover, Grip Work (2011) recommended that the smooth foam tubes are appropriate and simple to use as it feels comfortable while relieving pressure on the hand. Using tools with foam sleeve handles will provide a comfortable cushioned feel, no-slip grip and greater efficiency hand grip (California Department of Industrial Relations, 2005). These straight foam tubes had a shiny exterior surface and are popular on long handle tools, rakes, brooms and u-shaped handle bars (GripWorks, 2011). Sizes of foam sleeve tubes can be used in practically any handles inside diameter. In addition, almost applications indicated that using handle grips are 0.125”, which smaller than the handle that can be covering. The foam sleeve tubs have difference sizes that provide fit foam tube for instrument. Length of foam sleeve tubes are no mechanical limitations as a foam tube can be adjusted to fit the length of equipment or tool, the maximum length was approximately 25” (GripWorks, 2011)

Therefore, the foam sleeve hand grip was applied to add handle broom among intervention group in this study. This study was designed to add a smooth foam sleeve on handle broom with expectation to reduce pressure compression on the hand, protect nonslip handles and increase comfortable on a hand-grip of the broom for street sweepers. The researcher was providing approximately 45 centimeter length of smooth foam sleeve for adding on handle broom and free foam sleeve was provided.

Figure 11 Foam sleeve

Source: (GripWorks, 2011)

Figure 12 Add a foam sleeve over the broom handle

Source: Safe work practices for street sweepers: Booklet (Pintakham & Siriwong, 2015)

2.6 Relevant research to relate of this study

Street sweeper

Theerawanichtrakul and Sithisarankul (2014) investigated the prevalence and related factors of musculoskeletal discomfort among road sweepers in Bangkok. A cross-sectional study, the participants conducted multi-stage random sampling were 273 road sweepers. The questionnaires include personal factors, occupational factors and musculoskeletal discomfort modified from Nordic musculoskeletal questionnaire. Brooms and basket bins were weighed and broom handle length was measured. Handgrip strength test was done in every road sweeper. Results showed that the prevalence of overall MSD were 79.12% of 7 day and 85.71% of 12 months. Shoulders were the most and knees were the second prevalent sites of MSD. Sickness absence due to overall MSD was 11.72%. The factors related of musculoskeletal discomfort significant were housework and work duration of 21-40 years. The researchers suggested that it is necessary to carry out the prevention program of MSD among road sweepers in Bangkok.

Losakul (2007) examined the health status and health promoting behaviors among street sweepers in Hatyai municipal, Songkhla province. A cross sectional study 181 street sweepers was conducted July to August 2006. Findings showed health status related to work were 79.00% of muscle strain and fatigue, 51.93% of headache, 41.99% of eyes irritations, 28.73% of cough with phlegm or nose irritations, 24.86% of tinnitus, 24.86% of stress, and 18.23% of cuts and injuries. Health promoting behavior including exercise, nutrition, work safety and accident prevention, stress management was found that 67.95% at a moderate level. Interpersonal relationship was found that 45.00- 77.00% at a moderate level. The researchers suggested that occupational health nurses should be aware to protect themselves and a systematic development of health behavior for safety work on workers.

Lee, Myong, Jeong, Jeong, and Koo (2007) evaluated the musculoskeletal symptomatic features among street cleaners of municipalities in Seoul and GyeongGi Province, Korea. A cross sectional study 315 street cleaners are concern of musculoskeletal symptom during 2 weeks of September 2006. The measurement tools used the questionnaires were consisted of general characteristics, occupational and musculoskeletal symptoms, and used the REBA for observed and evaluated their movement and posture on work. Results showed that 43.2% of musculoskeletal symptoms on upper limb among street cleaners. The REBA indicated that over high risk stage in street cleaners. Street cleaners were complained musculoskeletal symptoms due to more repetitive motions on upper limbs. The researcher suggests that it is necessary for conduct the program to prevent or reduce musculoskeletal symptoms among street cleaners such as job rotation, stretching exercise, reducing work hours and using automatic street sweepers are helpful to prevent of musculoskeletal symptoms on the upper limb.

Boonchoo (2005) conducted the prevalence of lung factors among street sweepers who work in inner and outer region of Bangkok Metropolis. A random used two-step sampling proportional to size. The measurement tool use an interview questionnaire, air sampling, and spirometer for pulmonary function test. Results showed that the mean FVC and FEF25-75% of the street sweepers in the Rattanakosin group are significantly lower than the Srinakarin group. Moreover, the prevalence of lung abnormality was 29.74% in the Rattanakosin group and 15.95% in Srinakarin group.

Musculoskeletal discomfort

Korhan (2012) reported that symptoms and frequency of work related musculoskeletal discomfort in the shoulder due to computer use. Findings showed that the prevalent discomfort of shoulder were 46.15% of experienced ache, 34.62% of experienced pain, 17.69% of experienced heaviness, 9.23% experienced of tightness, 8.46% of experienced weakness, 6.15% of experienced cramp, 3.85% of experienced numbness, 2.31% of experienced hot and cold, and 1.54% of experienced swelling. The study was significant findings discomfort related shoulder during computer use; ache and pain are the common types in the shoulder.

Kolstrup (2012) investigated the work-related musculoskeletal discomfort of dairy farmers and employed workers in Sweden. The measurement tool used general Standardized Nordic Questionnaire for analyses nine different on body parts of perceived musculoskeletal discomfort and ergonomic work factors questionnaire for analyses perceived physical discomfort. Results showed that the most frequently of work-related musculoskeletal discomfort among farmers were 50% of lower back, 47% of shoulders, 33% of neck, 23% elbows and 21% of feet. The farm workers were 43% of lower back, 43% of shoulders, 41% of hands/wrist. The reported of female farmers and farm workers both were significantly higher frequencies more than their male. In addition, female workers had significantly higher reported frequencies of the ergonomic work factor as causing physically discomfort from 50% of repetitive and 16% of monotonous work.

Ghasemkhani, Mahmudi, and Jabbari (2008) examined musculoskeletal discomfort on 75 workers were consisted of 18 packing, 18 boxing, 19 manufacturing and 20 filling workers. A cross-sectional study used the standardized Nordic questionnaires for analysis the prevalence of musculoskeletal symptoms. Findings showed that musculoskeletal symptoms were 44.0% of the low back, 33.3% of shoulders and 32.0% of neck. The prevalence were stronger significantly associated between muscle pain (neck, shoulders and wrists/hands) and musculoskeletal symptoms. The researcher suggested that the hazards of musculoskeletal related to discomfort postures and repetitive movements that can be reduced or controls with engineering, administrative and stretching exercises.

Training

Das et al (2013) reported the effectiveness of occupational health awareness intervention among female sweepers working under the Midnapore municipality of west Bengal, India. Results showed that a considerable increase in the awareness levels and preventive approaches of diseases among the women sweepers. Overall health knowledge increased significantly post-awareness stage than pre-awareness stage ($P<0.001$). The study concluded that positive affect of awareness level the female sweepers which may change their health habits.

Mahmud, Kenny, Zein, & Hassan (2011) indicated that the effects of ergonomic training on musculoskeletal complaints, sickness absence, and psychological well-being. The study conducted a cluster randomized control trial designed at 6 and 12 months as the experimental groups received office ergonomic training and the control groups no received training. The experiment group was conducted via a course train by the National Institute of Safety and Health (NIOSH) for 1 day which consisted of 2 sessions. The first session (9.00 am to 1.00 pm) focused on the training of relationship between musculoskeletal discomforts and office ergonomics, improve office ergonomics or adjustments of workstations, stretching exercises and the importance of break time. The second session (2.00 pm to 4.30 pm) involved a practical training such as the trainers visited participants on workstations and suggested suggestion on how to adjust workstations effectively. Moreover, the control groups received a leaflet consisting of an office ergonomic diagram, tips on how to take a break, how to reduce their workload, and stretching exercises. Results showed that significant reductions in neck and upper and lower back complaints among workers. In addition, the ergonomics training can be useful to reduce musculoskeletal risks factors and stress of workers.

Amick III et al (2003) reported the ergonomics intervention to reduce musculoskeletal symptoms among office workers. The study was designed into three groups; a group only training, a group receives office ergonomics training and a highly adjustable chair; and a control group. The investigated the symptom and body pain was 2 months and the intervention conducted at 2, 6, and 12 months. Resulted shown that the lowered symptom over the workday on ergonomics training with chair intervention (P=0.012) after 12 months of follow-up. No evidence indicated that lowered symptom over the workday on only training (P = 0.461). The average pain levels in both groups were reduced over the workday. Conclusion indicated that a highly adjustable chair and office ergonomics training on workers had reduced symptom growth over the workday. The lack of a training-only group effect supports implementing training in conjunction with highly adjustable office furniture and equipment to reduce symptom growth. The ability to reduce symptom growth has implications for understanding how to prevent musculoskeletal injuries in knowledge workers.

Stretching

Methatip and Yuktanandana (2011) conducted the chronic neck complaint 60 female office among computer users. The volunteers were workers who using computer more than 4 hours per day and had not been treated by physiotherapy and/or medicine program. The study was designed short break neck stretching exercise and relaxation breathing of 4-week. Stretching exercise group was focused in cervical erector spine and both upper trapezius at 30 seconds for 3 times. The breathing exercise was diaphragmatic deep breathing for relaxation 5 minutes. Results found that it significantly reduced pain score in both groups after 4 weeks. The stretching group reduced VAS from 48.80±18.41 to 26.30±22.22 (p<0.001) and the breathing group reduced VAS from 42.83±22.20 to 19.33±20.37 (p<0.001). Conclusion: The effects of stretching or breathing exercise as a short break exercise at work twice a day in 4 weeks program provided decreased pain level and increased quality of life. The stretching exercise potentially improved muscle fatigability of the neck muscles in the non-dominant side.

Rahnama, Bambaeichi, and Ryasati (2010) evaluated the effect of eight weeks corrective exercise with ergonomic intervention on musculoskeletal disorders among Loabiran Industry Workers. The study conducted 91 workers for exercise program at 8 weeks consist are 3 sessions per week and each session 45 to 90 minutes. The Nordic Musculoskeletal Questionnaire was used to study the prevalence of MSD. Resulted found that a significant difference between part of body was found (P < 0.05); low back (26.3 %), shoulder (18.9 %) and knee (17 %) were the most prevalent sites. The severity and rate of disorders decreased significantly following 8-weeks training in low back, shoulder, knee, neck and hand/wrist areas ($P < 0.05$). This concluded that prevalence of MSD among workers of Loabiran industry was relatively high and corrective exercise program was effective to decrease it. Therefore, corrective exercise for reducing risk level would be recommended.

Jepsen and Thomsen (2008) reported the effects of stretching exercise to prevent upper limb disorders among computer operators 184 workers. The stretching intervention focused on four different right arm regions includes the volar forearm flexors, the pronator muscle, the median nerve and the radial nerve. Findings showed the experiment was consisted of self-reported pain levels and neurological findings. The study found that a significant improvement of upper limb disorders among computer operators.

Da Costa and Vieira (2008) reviewed studies stretching exercise to reduce work related musculoskeletal disorder from nine databases and approximately 334 references include PubMed, AMED, Cinahl, Medline, EMBASE, PASCAL, Science Direct, Scopus and web of Science databases. Results showed that the physiological effects of stretching exercise are effective to prevent or reduce work related musculoskeletal disorders. In addition, the stretching exercise can contribute to reduce discomfort and pain. The effectiveness of demonstrated stretching exercise help to reduce of work related musculoskeletal disorders.

Multidimensional intervention

M. M. Robertson and O'Neill (2003) evaluated the effect of an office ergonomic workplace and provided training intervention to reduce musculoskeletal discomfort, at the same time increase knowledge and awareness. This quasi experimental study conducted with two intervention groups, group one received a training ergonomic practice and adjustable workstation, group two received adjustable workstation only. The control group did not receives either the training or adjustable workstation in this study. The work environment survey, ergonomic knowledge, Standardized Nordic questionnaire were used to measure the data.

Results were found that office ergonomics knowledge and skills were significantly increased. Moreover, this increase was significantly in the last 3 months. The percentage reduction of musculoskeletal discomfort between 1st time and 2nd time was 5% in control group, 27% in adjustable workstation only group, and 46% in training ergonomic practice and adjustable workstation group.

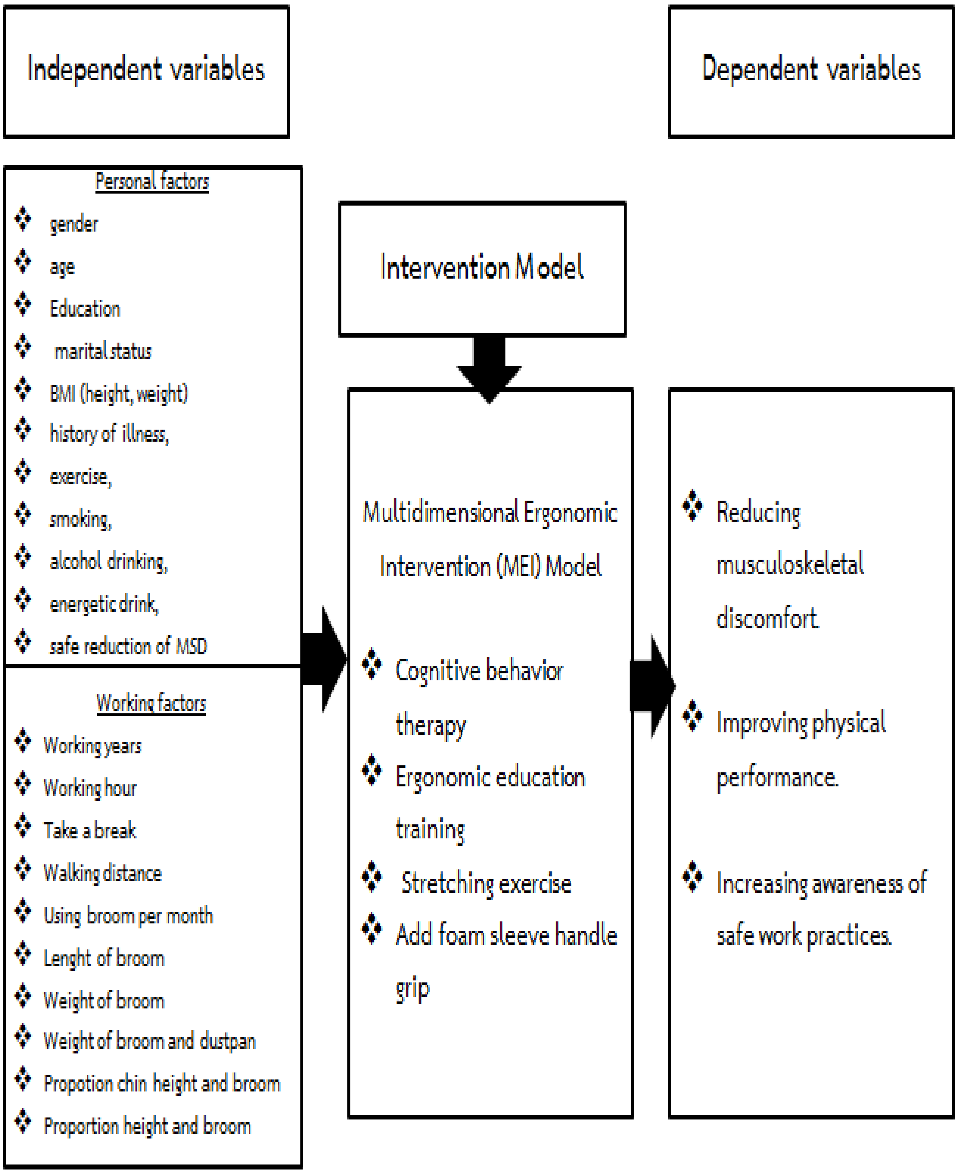
Linton, Boersma, Jansson, Svärd, and Botvalde (2005) reported that the effect of cognitive-behavioral and physical therapy preventive interventions could reduce pain and sick leave. The samples were 158 patients with back or neck pain, who were conducting a cognitive-behavioral and preventive physical therapy that focused on activity and exercise. The results indicated significantly fewer frequencies in pain and sick leave among intervention group during the 12-month follow-up. This study showed that adding cognitive-behavioral intervention and preventive physical therapy could enhance the prevention of long-term disability.

M. Robertson et al. (2009) studied 219 workers participated an office ergonomics training and chair intervention among worker in public sector department of revenue services, who involved collecting tax revenues. Work Environment and Health (WEH) survey, Office Environment Assessment observational tool, Rapid Upper Limb Assessment (RULA, and office ergonomics workshop evaluation were used at 1 month and at 2, 6, and 12 months follow-up. The study indicated the significant increase of an ergonomic knowledge, higher level behavioral translation, and lower musculoskeletal risk. The findings recommended that the office ergonomics training and an adjustable chair were able to appropriate increased knowledge and decreased musculoskeletal risk.

2.7 Conceptual Framework

According to a review of related literature, this can be contributed to occur of musculoskeletal discomfort which included three factors: socio-demographic factors; personal factors; and working factors. Fujishiro et al., recommended that the multidimensional ergonomic intervention model was more effective than single interventions (Fujishiro et al., 2005).

Figure 13 Conceptual Framework of the Study



CHAPTER III
METHODOLOGY

This chapter was focused on the methodology which involves the effectiveness of the multidimensional ergonomic intervention (MEI) model on reducing of musculoskeletal discomfort, improving of muscular strength and endurance, and increasing of awareness of safe work practice among street sweepers. The research was divided into 12 parts as follows;

3.1 Research Design

3.2 Study Area

3.3 Study Period

3.4 Study Population

3.4.1 Population

3.4.2 Inclusion Criteria

3.4.3 Exclusion Criteria

3.4.4 Sample Size and Sampling Technique

3.5 Intervention Program

3.6 Measurement Tools

3.6.1 Musculoskeletal Discomfort Assessment (MSDA)

3.6.2 Rapid Entire Body Assessment (REBA)

3.6.3 Awareness Safety Practice of MSD (ASPMSD)

3.6.4 Physical exam

3.6.5 Physical performance

3.6.6 Reliability and Validity Test

3.7 Data Collection

3.8 Data Analysis

3.9 Ethical Consideration

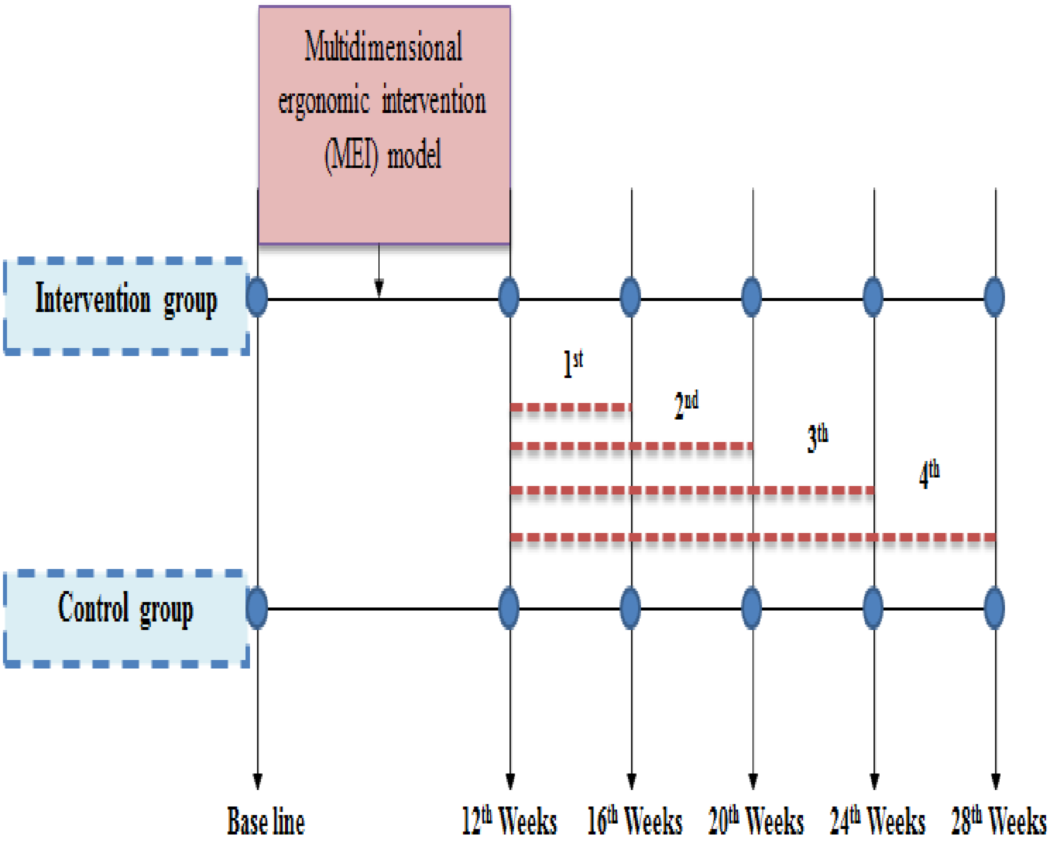
3.10 Limitation

3.11 Generalizability

3.1 Research design

The research design was conducted a quasi-experiment, pre- test and post-test. The study was divided similarly into 2 groups: intervention; and control group. An intervention group where the multidimensional ergonomic intervention (MEI) model was implemented, in contrast the control group where the multidimensional ergonomic intervention (MEI) model was not implemented. Assessment was conducted at baseline, at the end of the model (12th weeks) and 1st follow up (16th weeks), 2nd follow up (20th weeks), 3th follow up (24th weeks) and 4th follow up (28th weeks) as follows in figure 14;

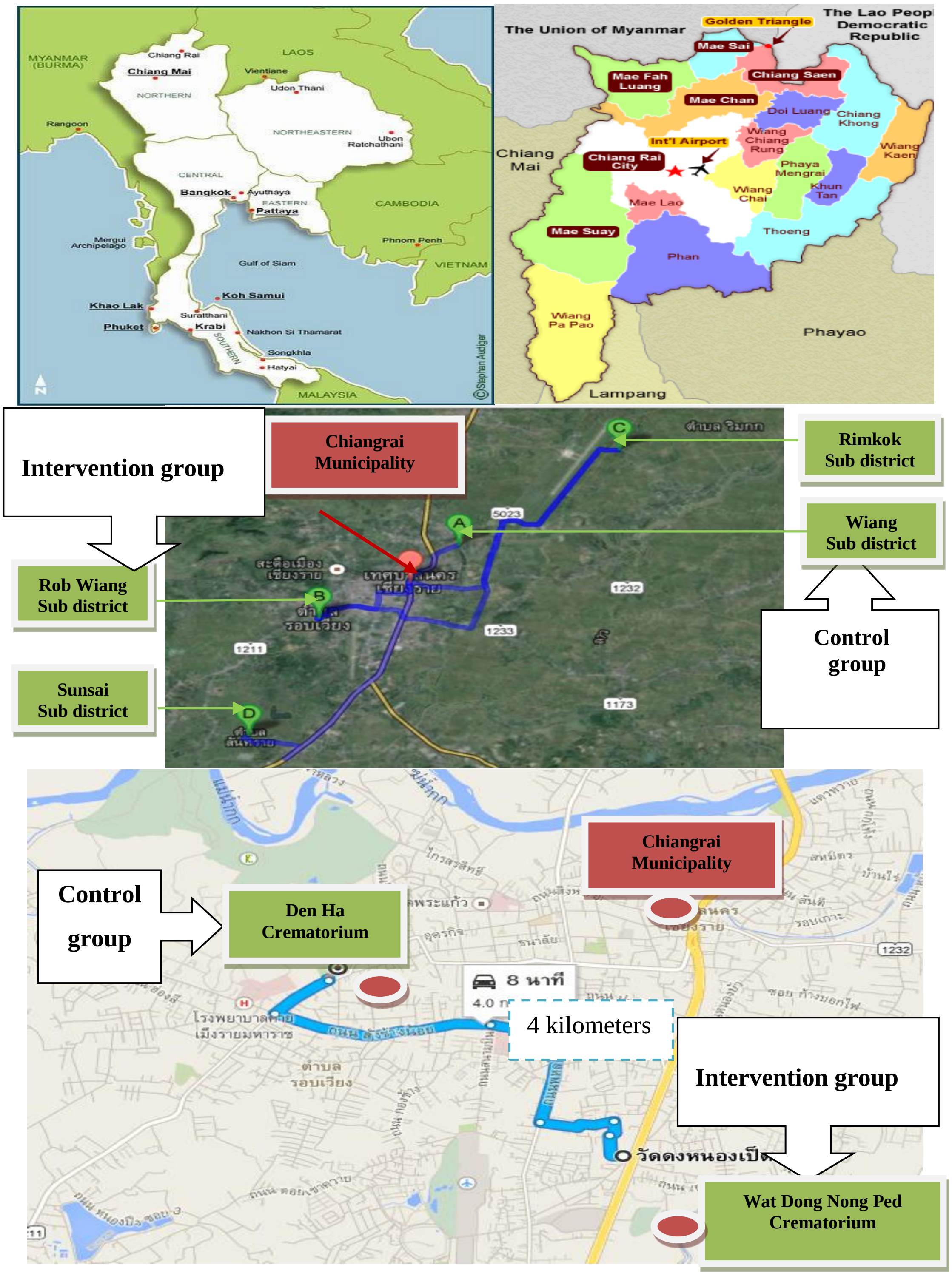
Figure 14 Diagram of research design



3.2 Study Area

The study area was Chiang Rai province which was located in the northern Thailand. The study setting was in Chiang Rai municipality which encompasses-4 sub-districts including Wiang, Robe Wiang, Rimkok and Sansai. Chiang Rai municipality was selected for four reasons: first reason as it has high prevalence rate of musculoskeletal discomforts among street sweepers, the second reason it is the most biggest in size in Chiang Rai province and among street sweepers who received income under municipality, the third it lacks ergonomics training prevent health risk among sweepers and the fourth there is a feasibility to do a research. Therefore, the study was expected to test a role model and develop the model that lead to reduce and prevent musculoskeletal health problems among street sweepers in Thailand. The study was conducted into two groups: an intervention group; and a control group by geographic areas. Therefore, simple random was divided into two group, an intervention and control groups. The intervention group was Robe Wiang and Sansai sub –districts. The control group was Wiang and Rimkok sub–districts. Moreover, this study was separated part of activity and meeting among street sweepers, intervention group was conducted at Wat Dong Nong Ped crematorium and control group was conducted at Den Ha crematorium. The both area were approximately 4 kilometers apart which would prevent an interaction between intervention and control groups. The place of this study was supported and suggested from Chiang Rai municipality. The areas of this study are shown in table 15 below.

Figure 15 Map of study areas



3.3 Study Period

In this study, the total time period of conducting the multidimensional ergonomic intervention (MEI) model was 7 months (28^{th} weeks), provide of model at 3 months (12 weeks) and follow up of post intervention model every month at 16^{th} weeks, 20^{th} weeks, 24^{th} weeks and 28^{th} weeks. The research study was started on September, 2014 until April, 2015.

3.4 Study Population and sample size

3.4.1 Population and sample size

The populations in this study were street sweepers who are working full time at Chiang Rai municipality in Chiang Rai province. Eligible target populations were selected to participate in the total of 75 street sweepers and they are voluntary participants in the study. Hence, no sample size calculation require in this study due to conduct all 75 street sweepers in this study area was participated. The volunteers were assessed musculoskeletal discomfort by physiotherapist; result of assessing was come out as musculoskeletal discomfort scores.

Table 1 Population in Chiang Rai municipality

Sub district	Wiang	Robe Wiang	Rimkok	Sansai
Street sweepers	20	20	18	17

3.4.2 Inclusion criteria

1. Both male and female aged 18-60 years
2. Working full time
3. Work experience at least one year.
4. Having musculoskeletal discomfort score ≥ 4 based on physiotherapist
5. No medical history of prohibition of the stretching exercise
6. Willing to participate in study

3.4.3 Exclusion criteria

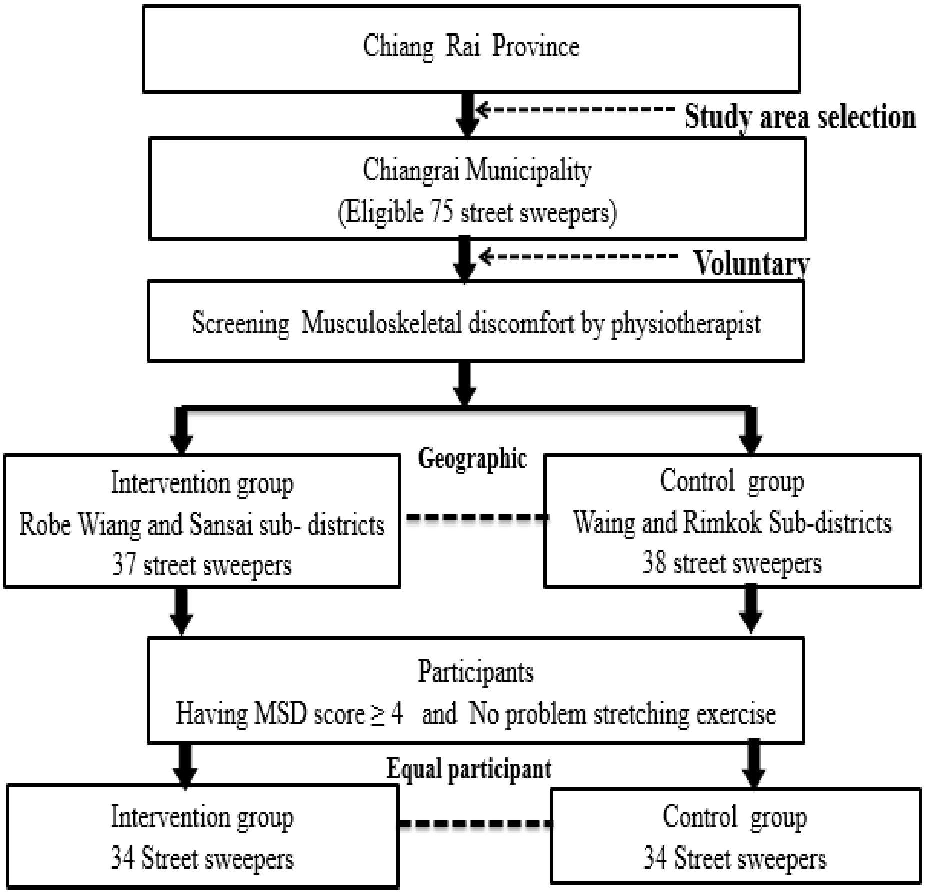
1. Having history of musculoskeletal during the study, such as arm or leg broken, etc.
2. Cannot participate throughout the study

3.4.4 Participants and sampling technique

In this study, the eligible participants were 75 street sweepers from Chiang Rai municipality. These voluntary participants were conducted a screening process on musculoskeletal discomfort of having level score ≥ 4 by physiotherapist. The participants were recruited with inclusion and exclusion criteria and get the program information from staff of municipality. After that the researcher was provide information and consent form before taking part in this program. The participants were in separated zone for activities, the intervention group was implemented at Wat Dong Nong Ped crematorium and the control group was conducted at Den Ha crematorium. Generally, the nature of street sweepers was required to work in the area that responsible for in the morning and afternoon. They were decided time of working by themselves with condition that their responsible area must be clean and completed. Therefore, it was very few opportunities for them to meet and discuss about the program of this study due to distance and work-time.

The participants were participated in the multidimensional ergonomic intervention (MEI) model for the period of 7 months (28^{th} weeks). The researcher had consulted that drop-out rate with municipality staffs and found that there was a very minimum chance for drop-out rate due to working nature of street sweepers who have time and are willing to participate throughout the study. Moreover, this study was conducted the activities which was not interfere with their daily life work of participants and the model was being supervised and controlled by municipality staff. However, the researcher was expected to have a drop-out rate less than 10% of accidence due to illness or inevitable incident. Participant chart was drawing in the Figure 16 below:

Figure 16 Participants and sampling technique



3.5 Intervention Program

The multidimensional ergonomic intervention (MEI) model was created from above literature review suggesting that combination technique intervention can be effective more than single interventions (Fujishiro et al., 2005). The study was integrated the cognitive behavior therapy, ergonomic education training, stretching exercise and add foam sleeve handle grip in this model. Expect benefits to reduce musculoskeletal discomfort, improve muscular strength and endurance, and increase awareness safe work practice related occupational musculoskeletal discomfort among street sweepers. In addition, the duration of times in implementing the multidimensional interventions is shorter than the single intervention, as described in Figure 17 and 18 below:

Figure 17 Multidimensional Ergonomic Intervention (MEI) model

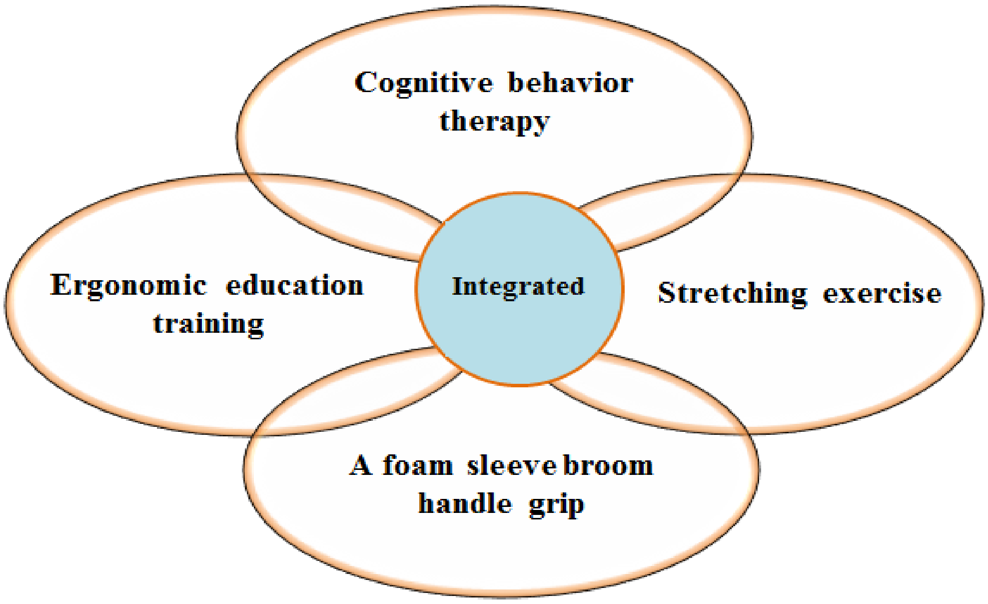
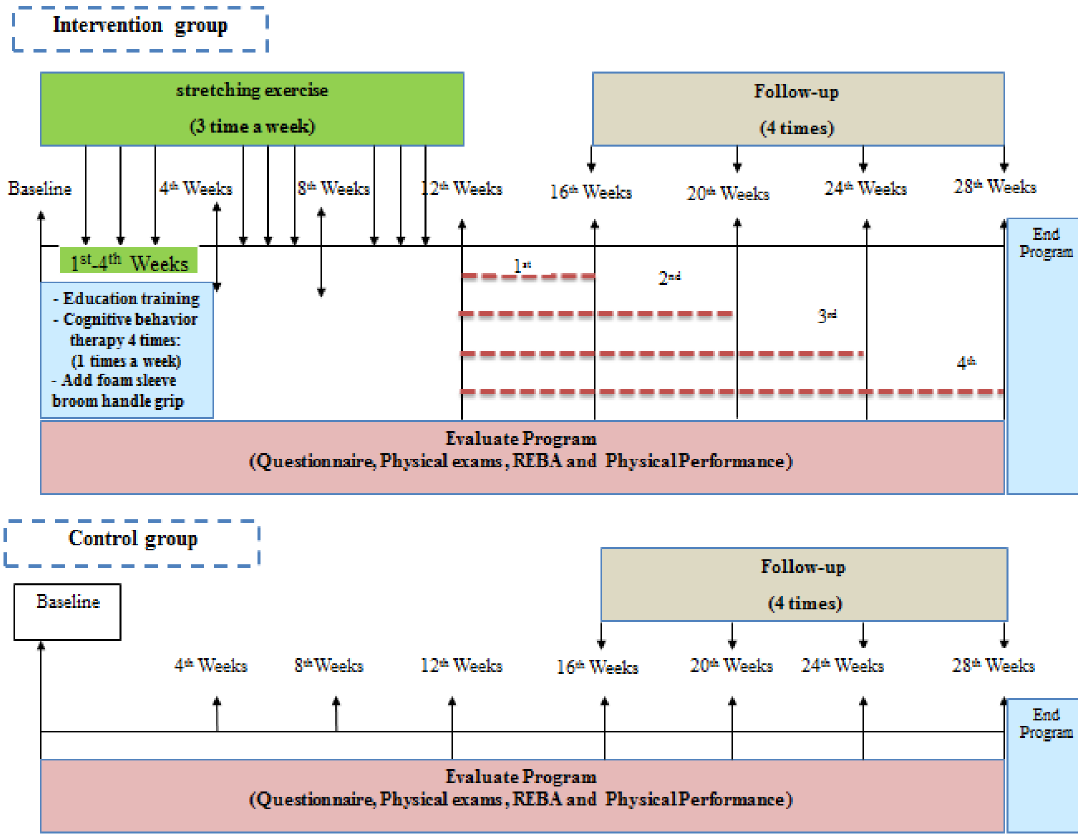


Figure 18 Diagram of intervention model



The MEI model was conducted in four domains as follows;

1. Training

The training or education model can help a long way to increase safety awareness on worker to perform on their jobs and can protect or improve risk factors of MSD (Dudley & Delong, 2001). This study was designed into two groups; staff and participants group. The staff team includes the psychiatric nurse, physiotherapist, sports scientist, team from Chiang Rai municipality and students on bachelor degree of occupational health. The participants are recruited with inclusion and exclusion criteria of street sweepers in Chiang Rai municipality. The participants were conducted to train approximately one hour, stretching exercise approximately 30 minute at Wat Dong Nong Ped crematorium supported by municipality staff. The training was use the cognitive behavior theory to change thought that lead to prevent and increase awareness on health among street sweepers. Details of provided training participants will receive include three components as below;

1. Cognitive behavior therapy by psychiatric nurse.

1.1 Cognitive behavior therapy related to self-practice MSD.

1.2 Concept of thinking, self-esteem and coping skill related MSD.

1.3 The effect to changes you though related ergonomic safety practice MSD.

2. Ergonomics education training by occupational nurse.

2.1 Health risk among street sweepers

2.2 Hazardous street sweeping affects the musculoskeletal discomfort

2.3 Consequences of musculoskeletal discomfort

2.4 Musculoskeletal discomfort can be prevented

2.5 Ergonomic safety practice such as safety working practice, posture of work and measurement tool for working condition.

3. Stretching exercise by sports scientist.

3.1 Benefits of stretching exercise.

3.2 Safety consideration of stretching exercise.

3.3 Step of stretching exercise

2. Demonstrate

This study was demonstrated to complement training on correct working posture and stretching exercise. The demonstration was taking step by step to allow greater understanding for participated workers. Moreover, the demonstration was helped to increase correct practice which they could apply to their daily work practice (Torma-Krajewski, Steiner, Unger, & Wiehagen, 2011). The information in each demonstration includes as follows;

2.1 Purpose of the demonstration

2.2 List of suggested supplies needed to conduct the demonstration

2.3 Step-by-step demonstration for safe work practice and stretching exercise.

2.4 Take messages that should be emphasized during the demonstration

3. Booklet

This study was designed a booklet to review and understand on street sweepers. The information of training was involved an ergonomic safety practice such as measurement tool for working condition, safety working practice, posture of work, and stretching exercise to reduce musculoskeletal discomfort in workplace and provide easy language that all workers can understand. Moreover, the booklet was used pictures to provide the activities due to limit education on street sweepers in Chiang rai municipality. The detail was provided in the booklet as follows;

1. Measurement tool for working condition includes booms and dustpan.

2. Safety working practice includes repetitive movement by sweeping stand and walks for responsibility sweeping area and bends down position)

3. Stretching exercise related to work condition includes;

- Wrist and hand: Repetitive movement by sweeping
- Shoulder and arm: Repetitive movement by sweeping
- Back pain: Bends down position
- Leg and feet: Stand and walks for responsibility sweeping area in daily working.

4. Foam sleeve on broom handle

This study was received free foam sleeve for adding on broom handle. The 45 centimeter length of smooth foam tube was provided. The researcher was supported foam sleeve broom handle grip for conducting the experiment in this study.

The intervention MEI model

This study was divided into 2 groups, staff and participants. The staff was provided the information about the MEI model as they were helped to the success and sustainability of the model. The participants were provided and conduct the MEI model as follows;

1. Staff

In the beginning of conducting the study model, a researcher was provided the staff the overall information for their understanding of the intervention activities by introducing the model such as objective, reasons of this study, selecting participants, and inclusion and exclusion criteria of participants. Then, each of them was assigned to take responsibilities on different part of the intervention.

The purpose of information the staff;

To understand and corresponding of activities.

The staffs of this study are;

1. Psychiatric nurse

The researcher was provided the objective of model for training to street sweepers. The psychiatric nurse was integrated between the cognitive behavior theory and ergonomic safety practice for motivating on street sweeper to reduce and protect of musculoskeletal discomfort. Moreover, they were helped to change beliefs, behavior thinking patterns, and awareness safety practice on workers.

2. Physiotherapist

The researcher was provided the objective model for screening musculoskeletal discomfort on the physiotherapist. Physiotherapist was screened the participants by using physical exam technique and interview to test musculoskeletal discomfort score.

3. Sports scientist

The researcher was provided the objective model for testing physical performance and training stretch exercise by sports scientist. Sports scientist was demonstrated stretching exercise and take -care the street sweepers before and after the intervention. The sports scientist was helped to test the physical performance on workers.

4. Team from Chiang Rai municipality

The researcher was provided introduction and overview of research study. They are assistance observer on any activities for training and demonstration to street sweepers. However, they are leaders within group for stretching exercise training and maintenance the activities on street sweepers. They were helped to provide the model for sustainability on the workplace and resolved any the problem during the intervention until the end of the study.

5. Students on bachelor degree of occupational health who are the researcher assistant for recording video among street sweepers are working on field and stretching exercise training.

2. Participants

The participants group was received the multidimensional ergonomics intervention model. The model was integrated the education training, cognitive behavior therapy, stretching exercise and add foam sleeve over broom handle for improving work-related musculoskeletal discomfort among street sweepers. The foam sleeve handle grip was supported for free for the participants. The model was taken approximately 28^{th} week by providing the intervention model at 12^{th} weeks and follow up four times at 16^{th} weeks, 20^{th} weeks, 24^{th} weeks and 28^{th} weeks. Moreover, the model was designed to follow up every month after intervention as at 1^{st} month, 2^{nd} months, 3^{th} months and 4^{th} months. The evaluation was showed that the periods of time and trend musculoskeletal change. This study was conducted the activities without interfering street sweepers' daily work as they work for a period of time in the morning and afternoon. The intervention was conducted on free time of street sweepers between 10.00-11.00 am. at Wat Dong Nong Ped crematorium.

This place was supported by municipality, it was conducted the convenience to travel, spacious to conduct activities and have facilities for participants.

The intervention for participants in this study

The purposes of training course:

1. To motivate the knowledge and practice for cognitive behavior therapy to reduce musculoskeletal discomfort and improve physical performance.

2. To motivate positive feeling and increase awareness on self-practices and safety behavior ergonomic related occupational health among street sweepers.

3. To evaluate the model to reduce musculoskeletal discomfort, improve physical performance, and increase awareness self-practices among street sweepers.

At the beginning of program, the voluntary participants were described the intervention model: introduction and overview of the model such as objective, reasons of this study, inclusion and exclusion criteria of participants. The intervention model was presented as follows;

Table 2 The intervention information and training model for participants

Session/ Week	Purpose	Learning process, Methods, Material and Duration time	Lecturer/ Trainer/ Evaluation
1 (1^{st} Week) Start baseline	-To motivate the knowledge and practice for cognitive behavior therapy to reduce musculoskeletal discomfort and improve physical performance. - To motivate positive feeling and increase awareness on self-practices and safety behavior ergonomic related occupational health among street sweepers.	**Learning process** - Introduction and overview of model for activities - Health risk among street sweepers. - Hazardous street sweeping affects the MSD. - Consequences of MSD. - MSD can be prevented - Ergonomic safety practice such as safety working practice, posture of work and measurement tool for working condition. - Provide foam sleeve handle grip free **Methods, Material** - Power point - Guideline book - Sharing experience. - Discussion and question **Duration time** - 1 hours. (10.00-11.00 am.)	**Lecturer/ Trainer/** - Researcher **Evaluation** - Question and answer. - Describe. - Discussion.

Session/ Week	Purpose	Learning process, Methods, Material and Duration time	Evaluation
2 (2nd Weeks)	-To evaluate the model to reduce musculoskeletal discomfort, improve physical performance, and increase awareness self-practices among street sweepers	<u>**Learning process**</u> - Cognitive behavior therapy related to self-practice of MSD. - Concept of thinking, self-esteem and coping skill related MSD. - The effect to changes you though related ergonomic safety practice of MSD. - Stretching exercise related to work condition includes; - Wrist and hand - Shoulder and - Back pain - Leg and feet <u>**Methods, Material**</u> - Power point - Guideline book - Sharing experience. - Demonstrate - Booklet <u>**Duration time**</u> - Training of 1 hours (10.00-11.00 am.) - Stretching exercise of 30 minute. (11.00-11.30 am.)(3 times a week)	**Lecturer/ Trainer/** - Psychiatric nurse -Sport scientist **Evaluation** - Question and answer. - Describe. - Discussion. -Demonstrate

Session/ Week	Purpose	Learning process, Methods, Material and Duration time	Evaluation
3 (3th Weeks)	-To motivate the knowledge and practice for cognitive behavior therapy to reduce MSD and improve physical performance. - To motivate positive feeling and increase awareness on self-practices and safety behavior ergonomic related occupational health among street sweepers. - To evaluate the model to reduce MSD, improve physical performance, and increase awareness self-practices among street sweepers.	**Learning process** - Safe work practice includes repetitive movement by sweeping stand and walks for responsibility sweeping area and bends down position (theory and demonstrate) - Measurement tool for working condition(theory and demonstrate) - Stretching exercise related to work condition (theory and demonstrate) **Methods, Material** - Power point - Guideline book, Booklet - Sharing experience. - Discussion and question - Demonstrate **Duration time** - Training of 1 hours (10.00-11.00 am.) - Stretching exercise of 30 minute. (11.00-11.30 am.) (3 times a week)	**Lecturer/ Trainer/** - Researcher -Sport scientist **Evaluation** - Question and answer. - Describe. - Discussion. -Demonstrate

Session/ Week	Purpose	Learning process, Methods, Material and Duration time	Evaluation
4 (4th Weeks)	-To motivate the knowledge and practice for cognitive behavior therapy to reduce musculoskeletal discomfort and improve physical performance. - To motivate positive feeling and increase awareness on self-practices and safety behavior ergonomic related occupational health among street sweepers.	**Learning process** - Review of safety working practice (demonstrate) includes repetitive movement by sweeping stand and walks for responsibility sweeping area and bends down position - Stretching exercise related to work condition (theory and demonstrate). **Methods, Material** - Power point - Booklet - Sharing experience. - Brainstorming - Discussion and question **Duration time** - Training of 1 hours (10.00-11.00 am.) - Stretching exercise of 30 minute. (11.00-11.30 am.)(3 times a week)	**Lecturer/ Trainer/** - Researcher -Sport scientist **Evaluation** -Question and answer -Describe -Discussion -Demonstrate - pre-test and post test

Session/ Week	Purpose	Learning process, Methods, Material and Duration time	Evaluation
5 (5^{th} -11^{th} Weeks) (3 times a week)	- To evaluate the model to reduce musculoskeletal discomfort, improve physical performance, and increase awareness self-practices among street sweepers.	<u>Learning process</u> -Stretching exercise related to work condition includes; (theory and demonstrate) ● Wrist and hand ● Shoulder and ● Back pain ● Leg and feet <u>Methods, Material</u> - Demonstrate - Booklet - Sharing experience. <u>Duration time</u> - 30 minute. (10.00-10.30 am.) (3 times a week)	**Lecturer/ Trainer/** -Sport scientist **Evaluation** - Question and answer. - Describe. - Discussion. -Demonstrate

Session/ Week	Purpose	Learning process, Methods, Material and Duration time	Evaluation
6 (12th Weeks)	-To motivate the knowledge and practice for cognitive behavior therapy to reduce musculoskeletal discomfort and improve physical performance. - To motivate positive feeling and increase awareness on self-practices and safety behavior ergonomic related occupational health among street sweepers. - To evaluate the model to reduce MSD, improve physical performance, and increase awareness self-practices among street sweepers.	**<u>Learning process</u>** - Summarize intervention for sustainability (Safe work practice, measurement tool for working condition and Stretching exercise) -Stretching exercise related to work condition includes; (theory and demonstrate) • Wrist and hand • Shoulder and • Back pain • Leg and feet **<u>Methods, Material</u>** - Power point - Booklet - Sharing experience. - Brainstorming - Discussion and question - Demonstrate **<u>Duration time</u>** - 1 hours. (10.00-11.00 am.)	**Lecturer/ Trainer/** - Researcher -Sport scientist **Evaluation** -Question and answer -Describe -Discussion -Demonstrate - pre-test and post test

For control group

In this study, the inclusion and exclusion criteria of participants were provided the data information and consent form to participate in the model. The participants in control group where the multidimensional ergonomic intervention (MEI) model was not implemented. Assessment was conducted at baseline, 12th weeks, 16th weeks, 20th weeks, 24th weeks and 28th weeks as follows;

1. Interview the questionnaire approximately 15-20 minute
2. Physical exam approximately 10 minute by physiotherapist
3. Physical performance approximately 10 minute by sport scientist
4. Record VDO approximately 10 minute at baseline, 12th weeks and 24th weeks.

The time of participation was between 10.00-11.00 am. at the Den Ha crematorium that was not interfered with their work. The place was supported by municipality which had easy access and is spacious to conduct the activities.

The participants were expected benefits and application are;

1. The physiotherapist was investigated musculoskeletal discomfort that to test a discomfort on movement and test of muscle strength can prevent or reduce musculoskeletal discomfort.

2. The sports scientist was tested muscular strength and endurance that they will be aware of their health in the future.

After successful model, the researcher was provided the multidimensional ergonomic intervention (MEI) model to this group. Moreover, the participants were got the booklet of an ergonomic safety practice and given to staff municipality for implements on the further.

3.6 Measurement instruments

This study was used measurement tool which consists of three parts as follows:

Parts 1: Questionnaire

The questionnaire was collected by interview and divided into three components including personal factors, working factors, musculoskeletal discomfort, and awareness safe work practice of musculoskeletal discomfort.

1. **Personal factors and work factors**

The questionnaire was interviewed the participants consist two factors, Personal factors include gender, age, education, marital status, BMI, history of illness, exercise, smoking, alcohol drinking, energetic drink, self- reduction of MSD. Work factors include working years, take a short break, walking distance, number of broom changing per month, length of broom, weight of broom, weight broom and dustpan, proportion(chin height and broom) and proportion(tall and broom).

2. **Musculoskeletal Discomfort Assessment (MSDA)**

Musculoskeletal Discomfort Assessment was modified base on Standardized Nordic questionnaire (SNQ) from Kilbom et al. (1986) and Kuorinka et al. (1987). The SMQ was one of the standard questionnaires to define musculoskeletal symptom and involvement to work factors (Kuorinka et al., 1987). The structure of SMQ divided in to two components: general questionnaire and special questionnaires. The general questionnaire was indicated that screening to signs and symptom of musculoskeletal troubles occur on body parts. The questionnaire was created with anatomical regions the human body and the map diagram of the body divided into nine regions (Kilbom et al., 1986; Kuorinka et al., 1987). The questionnaire was presented of severity on physical condition including pain, discomfort, numberless, etc., for the after 12 months and after 7 days in each areas of the body (Kaewboonchoo et al., 1998). The special questionnaire was designed for the occupational to concentrate on anatomical areas on neck, shoulder and low back symptom. The respective questionnaire can analyze severity of symptoms on the duration past 12 months, and past 7 days (Kilbom et al., 1986; Kuorinka et al., 1987).

In this study was developed questionnaire from a literature review occupational related musculoskeletal discomfort among street sweepers and conceptual framework. The MSDA was presented by body map and divided into 9 body region include neck, shoulders, upper back, elbows, low back, wrists and hands, hip and thighs, knees, and Ankles and Feet in the last week and part month as follows;

1. The prevalence rate of musculoskeletal discomfort will be computed as follows;

$$\text{MSD rate} = \frac{\text{all new and pre-existing MSD cases during a time period}}{\text{Population during the same time period}} \times 100$$

2. Musculoskeletal discomfort was asked severity on physical condition by physiotherapist that followed physical exam on range of motion to test a discomfort on movement, it was modified discomfort by numeric rating scale, a scale from 0 to 10 where 0 is the no musculoskeletal discomfort and 10 is more musculoskeletal discomfort as follows;

No discomfort-- More discomfort

0 1 2 3 4 5 6 7 8 9 10

The musculoskeletal discomfort cut off score ≥ 4, the data was indicated mean score of musculoskeletal discomfort and it was indicated risk levels as follows;

Levels	**Severity musculoskeletal discomfort levels**
0	No musculoskeletal discomfort
1-3	Slight musculoskeletal discomfort
4-6	Moderate musculoskeletal discomfort
7-9	Highs musculoskeletal discomfort
10	Severe musculoskeletal discomfort

3. Awareness Safe Work Practice of Musculoskeletal Discomfort (ASWP-MSD)

According to Genaiyt et al, awareness safe work practice was developed from workplace guidelines for the prevention of musculoskeletal injuries (Genaidy, Al-Shedi, & Shell, 1993). The questionnaires were involved the type of safety ergonomic occupational related musculoskeletal discomfort among street sweepers such as safety practice of working condition, equipment tool use sweeping and stretching exercise. In addition, the ASPMSD questionnaire was divided into 4 levels as follows;

Scores	Levels
1	Disagree
2	Slightly agree
3	Agree
4	Strongly agree

The interpret awareness safety practice analysis by mean score of awareness (continuous variable) and evaluate will be defined the total score awareness not more than 80 scores as follows;

Scores	Awareness Level
0-20	Mild awareness
21-40	Moderate awareness
41-60	High awareness
61-80	Very high awareness

Parts2. Rapid Entire Body Assessment (REBA)

Rapid entire body assessment (REBA) was one form designed to assess the unpredictable whole body postures of working and used collected data of the body posture for movement, action, coupling and repetition. The analysis of REBA scores was generated in order to an indication of the risk level and urgency with which should be taken action (Hignett & McAtamney, 2000). Moreover, REBA was developed for used an event-driven tool due to the complexity of data collection (Janik, Munzberger, & Schultz, 2002). The REBA is one type of ergonomic assessment tool for using a systematic process and evaluates required whole body posture of MSD related to job tasks. According to Window indicated that the REBA was easy designed for use the evaluator a score for each body regions include neck, back, trunk, shoulders, elbows, forearms wrists, legs and knees (Window, 2006). The data scores was collected for each region and put in the form of tables that used to compile the risk factor variables and generating the score that represents the MSD risk level (Hignett & McAtamney, 2000). However, in the U.K has been also used for assessments the body posture related to the Manual Handling Operations regulations (Steinberg, Caffier, & Liebers, 2006). It has been widely used internationally and was provided in the draft U.S. Ergonomic Program Standard (Reese & Eidson, 2006).

The principles of REBA as follows;(Hignett & McAtamney, 2000; McAtamney & Hignett, 2005)

REBA can be used when an ergonomic workplace assessment identifies that further postural analysis is required and:

1. Better tool for whole body and used for both static, dynamic postures unstable and rapidly changing postures

2. User-friendly

3. Uses tables to compute scores

4. Perfectly matches the selection criteria (quantitative, subjective, self-reporting potential, posture- based)

5. Inanimate or animate loads are handled either frequently or infrequently.

6. Modifications to the workplace, equipment, training, or risk-taking behavior of the worker are being monitored pre/post changes.

Procedure of REBA

The REBA can be follows step-by-step, REBA has six steps as follows; (Marras & Karwowski, 2006)

1. Observe the task

Observe the task was conducted to formulate a general ergonomic workplace assessment include use of equipment, the impact of the work layout and environment, and behavior of the worker with respect to risk taking. This step is record data by using a video camera or photographs. However, the observe technique was recommended as multiple views should be control for any confounding and bias on the field

2. Select the postures for assessment

This step was follow in step one from the observations on working condition postures and analyze to decide which posture which can be used criteria as follows;

1. Posture require the most frequency movement and repeated
2. Posture prolonged maintained
3. Posture requiring the greatest forces or the most muscular activity
4. Posture has been known to cause discomfort
5. Posture are awkward, extreme, unstable and force is exerted
6. Posture the most to be improved from interventions, control measures, or other changes

From above criteria can be decision which postures based on one or more criteria to analyze should be reported with the results and recommendations.

3. Score the postures.

Record by use the scoring sheet and body-part to score the posture by groups as follows;

a. Group A: trunk, neck, legs
b. Group B: upper arms, lower arms, wrists
c. Group B postures are divided into 2 sides, right and left sides of the body are indicated on the scoring sheet

4. Process the scores.

This process was use in Table A to generate a single score from the neck, trunk, and legs scores. The scoring A was recorded in the box and added to the load/force score and table B was used to generate the single score are the upper arms, lower arms and wrist scores using. This scores are different can be repeated the musculoskeletal risk. The score was then added to the coupling score to produce score B. Scores A and B are entered into Table C and a single score is read off.

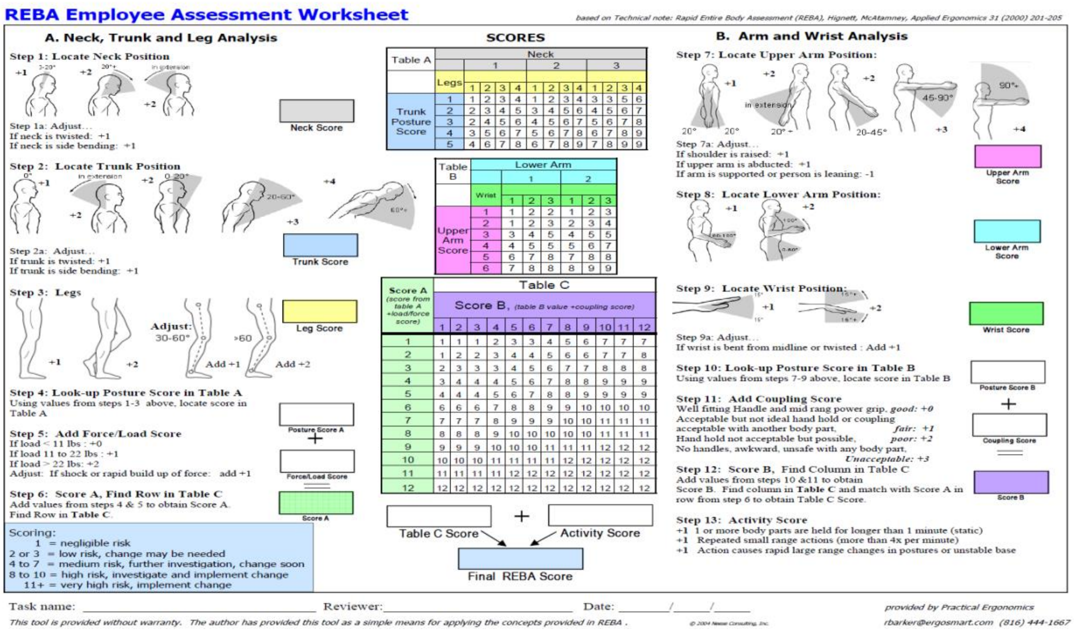
5. Establish the REBA score

The type of muscle activity to be performed for represented the total score by an activity that is added to give the final REBA score.

6. Confirm the action level with respect to the urgency for control measures.

The REBA score can be rechecked the action levels. These are scores bands of corresponding to increase urgency for the need to make changes.

Figure 19 REBA sheet



Source:(Hignett & McAtamney, 2000; McAtamney & Hignett, 2005)

Table 3 REBA Score risk level

Action Level	REBA Score	Risk Level	Action (including further assessment)
0	1	Negligible	None necessary
1	2-3	Low	Maybe necessary
2	4-7	Medium	Necessary
3	8-10	High	Necessary Soon
4	11-15	Very High	Necessary NOW

Source: (McAtamney & Hignett, 2005)

Reliability and Validity (Hignett & McAtamney, 2000)

Reliability of REBA was established into 2 stages. The first stage involved 144 posture combinations three physiotherapists or ergonomists independent. They resolved and discussed any conflicts in the scores then incorporated the additional risk scores for load, coupling, and activity to generate the final REBA score on a range of 1 to 15. The second stage involved two workshops with 14 health professionals using REBA to code over 600 examples of work postures from the health-care, manufacturing, and electricity industries. This established good face validity, and REBA has continued to be widely used, particularly in the health-care industry. However, that small changes were made to the upper-arm code introduction of the during the validation process, so additional work is planned to undertake more-detailed reliability and validity testing.

Parts 3: Physical Exam

1. Discomfort on movement

The discomfort on movement was designed for testing physical on workers by physiotherapist. The activities were developed from health assessment for nursing practice by Wilson and Giddens (Wilson & Giddens, 2014) and Polnok to assessment of musculoskeletal (Polnok, 2009). This physical exam can help to confirm musculoskeletal discomfort with questionnaire due to test passive movement by physiotherapist. The exam was tested 7 part of body include neck, hands/shoulders/scapular, wrists, fingers, hips, knees and feet. The score test was find that frequency of discomfort and no discomfort on body part among street sweepers.

2. Muscle strength

The muscle strength was designed to test physical on workers by physiotherapist. The exam was tested 14 postures on body part related musculoskeletal discomfort street sweepers. The activities were developed from health assessment for nursing practice by Wilson and Giddens and assessment of musculoskeletal by Polnok (Polnok, 2009; Wilson & Giddens, 2014). The score test was finding that frequency of resistance and no resistance on body part among street sweepers.

Parts 4: Physical Performance

1. Arm curl test (dumbbell)

The study was selected test of the physical performance by using dumbbell that arm curl test due to assessment muscular strength and endurance on upper body strength which appropriate among street sweepers by sports scientist. According to Jones and Rikli, the Arm curl test is significant to assess upper body strength and needed for performing household and other activities involving lifting and carrying things such as groceries, suitcases and grandchildren (Jones & Rikli, 2002). The participants age range 18-60 years old that will be evaluated by age range such as 18-29 years old, 30-41 years old, 42-53 years old and ≥ 54 years old.

The purpose

To test muscular strength and endurance to do as many arm curls as possible in 30 seconds.

Equipment

1. Chair or backrest folding chair without armrest
2. Stopwatch
3. A dumbbell, 5 pounds weight (2.27 kilograms) for women and 8 pounds weight (3.63 kilograms) for men.

Procedure (Jones & Rikli, 2002; Panti, 2007)

1. The participant sits on the chair, back straight, feet on the floor, conducted on dominant arm side, holding the weight in the hand using a dumbbell either edge of the chair to sit on that side.

2. The participant to test with the arm in a vertically holding down position beside the chair and brace the upper arm against the body so that only the lower arm is moving. Curl the arm up through a full range of motion, gradually turning the palm up (flexion with supination). As the arm is lowered through the full range of motion, gradually return to the starting position.

3. The arm must be fully bent and then fully straightened at the elbow. The protocol is use of test describes the administrator's hand being placed on the biceps,

and the lower arm must touch the tester's hand for a full bicep curl to be counted. Repeat this action as many times as possible within 30 seconds.

4. Counting the number of times that can be implemented completely in 30 seconds.

5. Before actually giving the participant to tests articulated elbow flexion without weight training 1-2 times to check for correct posture but if real test is a only one way

Figure 20 Arm curl test

Score: The score is the total number of controlled arm curls performed in 30 seconds. Criterion performance scores of arm curl test less than 11 times in the both male and female that mean risk of upper body strength (Jones & Rikli, 2002).

2. A 30- second chair stand

The study was selected test of the physical performance by using a 30-second chair stand due to assessment muscular strength and endurance on lower body strength which appropriate among street sweepers by sports scientist (Panti, 2007).

The purpose

To test muscular strength and endurance to do as a 30- second chair stand due to assessment muscular strength and endurance on lower body strength

Equipment

1. Chair or backrest folding chair without armrest as height 43.18 centimeter.

2. Stopwatch

Procedure (Jones & Rikli, 2002; Panti, 2007)

1. The participant sits on the chair, back straight, feet on the floor, conducted right and left arm holding on chest that side.

2. The participant to test with sit and stand on the chair. Repeat this action as many times as possible within 30 seconds.

3. Counting the number of times that can be implemented completely in 30 seconds.

4. Before actually giving the participant to tests articulated elbow flexion without weight training 1-2 times to check for correct posture but if real test is a only one way

Figure 21 A 30- second chair stand test

Score: The score is the total number of controlled arm curls performed in 30 seconds. Criterion performance scores of a 30- second chair stand test less than 8 times in the both male and female that means risk of upper body strength.

3.7 Reliability and validity test

3.7.1 Validity

The questionnaire was assessed the content validity by 3 experts: one ergonomic educator, one physiotherapist and one sports scientist who know well Thai language (process of back translation) to check appropriate in terms of concepts, language and suggestions. The opinions from experts are quite high congruence with IOC, Accept ≥ 0.50 (Rovinelli & Hambleton, 1976). After that the questionnaires were revised based on the expert's recommendation.

Results in this study was showed item objective congruence (IOC), the questionnaire was divided into 3 part included; 1.00 of musculoskeletal discomfort assessment, 0.81 of awareness safe work practice of musculoskeletal discomfort that indicated in the appendix part.

3.7.2 Reliability

The questionnaires were tested with 30 street sweepers who are working in Phayao municipality in Phayao province, and they have similar characteristics with street sweepers in intervention municipality. The experimental tools are revised based on the expert's recommendation, the tools are tested among 30 street sweepers who are similar characteristic with sampling street sweepers in others municipality. A Cronbach alpha coefficient in this study was showed 0.93 of musculoskeletal discomfort assessment and 0.85 of awareness safe work practice of musculoskeletal discomfort that indicated in the appendix part.

3.8 Data Collection

The study was conducted the data collection as follows;

1. Questionnaire: there are 3 parts as follows;

Part I: Personal factors and work factors

Part II: Musculoskeletal Discomfort Assessment (MSDA)

Part III: Awareness safe work practice of musculoskeletal discomfort

The questionnaire was conducted to interview by research.

2. Video record for working posture based on Rapid Entire Body Assessment (REBA). This study was conducted 10 minute times per person at baseline, 12^{th} weeks and 24^{th} weeks. The students on bachelor degree of occupational health were recorded on field.

3. Physical exam: The assessment discomfort on movement and muscle strength by physiotherapist.

4. Physical Performance: The activity was used arm curl test that dumbbell by Sports scientist.

5. Physical Performance form: The tool was collected from the muscular strength and endurance.

3.9 Data analysis

1. Using SPSS version 17 licenses for Chulalongkorn University.

2. Descriptive statistics was used to describe the demographic data and prevalence of MSDs.

- Frequencies and percentages (Categorical variable).

- Mean and standard deviation (Continuous variable).

3. Chi-square and independent T-test were used to compare the differences of demographic data between the intervention and control group.

4. Repeated measurement ANOVA was used to assess effectiveness of MEI model across (baseline, exit the model (12^{th} weeks) and 1^{st} follow up (16^{th} weeks), 2^{nd} follow up (20^{th} weeks), 3^{th} follow up (24^{th} weeks) and 4^{th} follow up (28^{th} weeks).

3.10 Ethical consideration

The study was approved by the Ethics Review Committee for Research involving Human Research Subjects group, Chulalongkorn University, Thailand. The certificate of approval number was COA 135/2557.

Interviewees were received full explanation about the study including the purpose, process and the benefits of this study. Information sign consent form was taken by the interviewee's considering. The ethical consideration would provide the multidimensional ergonomic intervention model for the control group after finished and evaluation of the model.

CHAPTER IV
RESULTS

This chapter was gathered the findings which aimed to demonstrate the effectiveness of the multidimensional ergonomic intervention (MEI) model on reduce musculoskeletal discomfort, improve physical performance and increase awareness of safe work practices among street sweepers. The participants in this study were streets sweepers from four sub-districts in Chiang Rai municipality, Chiang Rai province.

The study was conducted into intervention group and control group by geographic areas; the intervention group was Robe Wiang and Sansai sub –districts; the control group was Wiang and Rimkok sub–districts. The participants were eligible totally 75 street sweepers by voluntary; intervention n=37; and control n=38. After screening musculoskeletal discomfort score ≥4 by physiotherapist at baseline, there were 68 eligible street sweepers; intervention n=34; and control n=34. The MEI model was started on September until December, 2014 and follow-up in January, February, March and April 2015.

The results include 4 components as follows;

4.1 Demographic characteristic and work factors.

4.2 Effectiveness of MEI model to reduce musculoskeletal discomfort (MSD).

4.3 Effectiveness of MEI model to improve physical performance.

4.4 Effectiveness of MEI model to increase awareness of safe work practice.

4.1 Demographic characteristic and work factors

The participants were eligible totally 75 street sweepers, only 68 street sweepers met inclusion criteria. The intervention group was 34 street sweepers at Robe Wiang and Sansai sub –districts. The control group was 34 street sweepers at Wiang and Rimkok sub–districts. The participants in this study were not dropped-out and lost to follow – up on the model. The variables data were presented intervention group, control group and comparable between intervention and control group.

In table 4 shows the demographic characteristic, the participants in the both group had higher numbers of female than male and most of them were primary school. Majority of both participants were together with parent; intervention group was 91.18% and control group was 97.06%. There were more number of their street sweepers no smoking and never drinking. Street sweepers, most of them were not taking a break during their sweeping on field. Both groups were never exercise.

In table 5 shows the working factors, the average age in the intervention group was 47.59 years (SD=7.25) and ranged from 28-59 years. The working years ranged from 1-37 years and mean was 14.74 years (SD=7.57). Body mass index of street sweepers were 25.10 kg/m^2 (SD=4.38). Street sweepers in both groups were similar of walking distance approximately 1-3 kilometers and using 1-3 brooms per month. Their length and weight of broom ranged from 140-200 centimeters and 550-1000 grams. The total weight broom and dustpan was ranged from 1300-2000 grams. The average proportion between height of the chin among street sweepers and height of the boom were 123.56 centimeters (SD=11.80). The average proportion between height of street sweepers and height of the boom were 106.98 centimeters (SD=10.08). Control group, the average age was 47.71 years (SD=8.01) and ranged from 26-60 years. The working years ranged from 1-38 years and mean was 15.03 years (SD=8.94). Body mass index of street sweepers were 24.83 kg/m2 (SD=3.96). Their length and weight of broom ranged from 145-182 centimeters and 600-1000 grams. The total weight broom and dustpan was ranged from 1350-2000 grams. The average proportion between height of the chin among street sweepers and height of the boom was 121.85 centimeters (SD=10.17). The average proportion between height of street sweepers and height of the boom was 105.83 centimeters (SD=8.44).

Comparing demographic characteristics among street sweepers between intervention and control groups were shown no statistically associated most of characteristics. Similarly to characteristics of street sweepers were comparable between intervention and control groups at the baseline.

Table 4 Demographic characteristic among street sweepers (n=68)

Categorical variables	Intervention (*n*=34)		Control (*n*=34)		*p*-value
	n	Percent	n	Percent	
Gender					0.377
Male	5	14.71	4	11.76	
Female	29	85.29	30	88.24	
Education					0.111
Primary school	27	79.41	31	91.18	
Secondary school	7	20.59	3	8.82	
Marital status					0.752
Married	31	91.18	33	97.06	
Widowed/Divorce / Separate	3	8.82	1	2.94	
Smoking					0.595
No	30	88.23	32	94.12	
Yes	4	11.77	2	5.88	
Drinking					0.650
Never	32	94.12	31	91.18	
Sometime	2	5.88	3	8.82	
Take a short break					0.169
No	27	79.41	28	82.35	
Yes	7	20.59	6	17.65	
Exercise					0.595
Never	30	88.24	32	94.12	
Work out 1-2 times/week	4	11.76	2	5.88	

*Significant at p-value < 0.05, (χ^2) = Chi-square, (t) = T-test

Table 5 work factors among street sweepers (n=68)

Continuous variables	Intervention (*n*=34)		Control (*n*=34)		*p*-value
	Mean	± SD	Mean	± SD	
Age (years)	47.59	7.25	47.71	8.01	0.337
Range	28-59		26-60		
Working years	14.74	7.57	15.03	8.94	0.824
Range	1-37		1-38		
Body mass Index (Kg/m^2)	25.10	4.38	24.83	3.96	0.237
Range	17.50-34.90		18.60-39.80		
Walking distance(Kilometer)	2.15	0.61	2.12	0.69	0.209
Range	1-3		1-3		
Number of broom changed per month	2.00	0.74	2.00	0.67	0.150
Range	1-3		1-3		
Length of broom(Centimeter)	162.88	13.01	161.46	9.32	0.662
Range	140-200		145-182		
Weight of broom(Grams)	798.53	152.99	838.24	34.87	0.393
Range	550-1000		600-1000		
Weight broom and dustpan	1725	205.33	1750	192.27	0.562
Range (Grams)	1300-2000		1350-2000		
Proportion(chin height and broom)	123.56	11.80	121.85	10.17	0.262
Range (centimeter)	101.96-153.85		106.67-146.34		
Proportion(tall and broom)	106.98	10.08	105.83	8.44	0.281
Range	90.70-134.23		93.54-126.76		

*Significant at p-value < 0.05, (χ^2) = Chi-square, (t) = T-test.

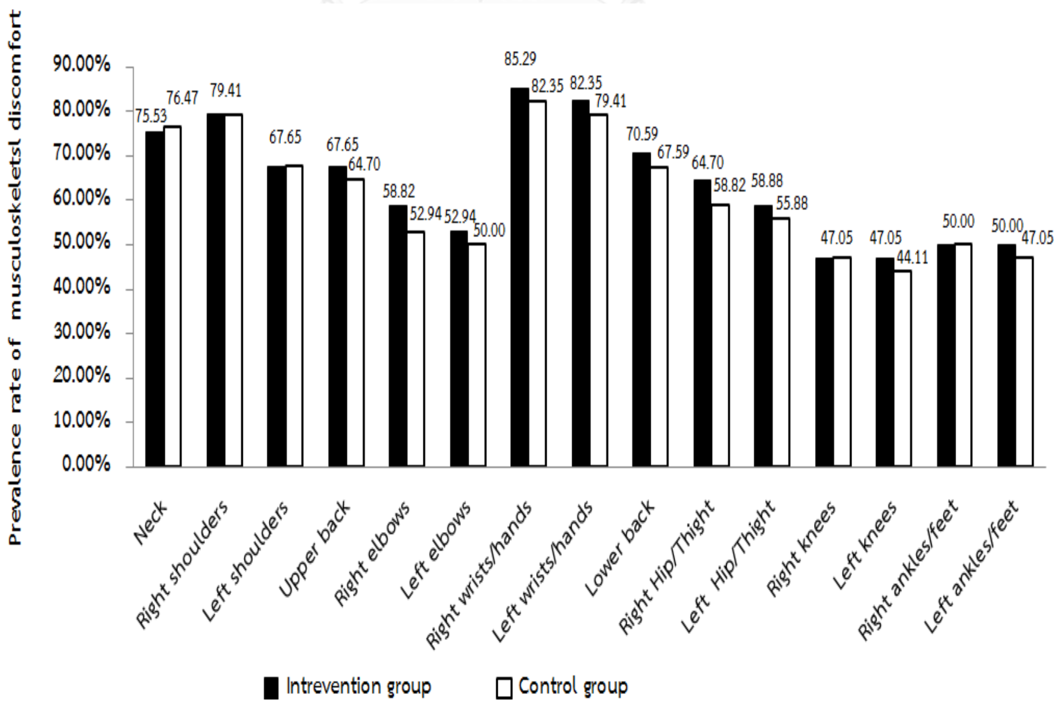
4.2 Effectiveness of MEI model to reduce musculoskeletal discomfort.

Main outcome of this study is to the effectiveness of MEI model to reduce musculoskeletal discomfort among street sweepers. The results included musculoskeletal discomfort assessment, and musculoskeletal discomfort score by physiotherapist.

4.2.1 Musculoskeletal discomfort assessment

In figure 22 shows the baseline prevalence rate of musculoskeletal discomfort in past 1 month between intervention and control group. Intervention group, majority was 85.29% of street sweepers had musculoskeletal discomfort in the right wrists/hands, 82.35% in the left wrists/hands, 79.41% in shoulders and 73.53% in neck respectively. Control group, majority was 82.35% of street sweepers had musculoskeletal discomfort in the right wrists/hands, 79.41% in the left wrists/hands and shoulders, and 76.47% in neck, respectively.

Figure 22 Baseline prevalence rate of musculoskeletal discomfort in the past 1 month among street sweepers between intervention and control group



In figure 23 shows the baseline prevalence rate of musculoskeletal discomfort in past 7 days between intervention and control group. Intervention group, majority was 82.35% of street sweepers had musculoskeletal discomfort in the right wrists/hands, 76.47% in the left wrists/hands, 70.59% in shoulders, 67.64% in neck respectively. Control group, majority was 79.41% of street sweepers had musculoskeletal discomfort in the right wrists/hands, 76.47% in shoulders and 73.53% in neck respectively.

Figure 23 Baseline prevalence rate of musculoskeletal discomfort in the past 7 days among street sweepers between intervention and control group

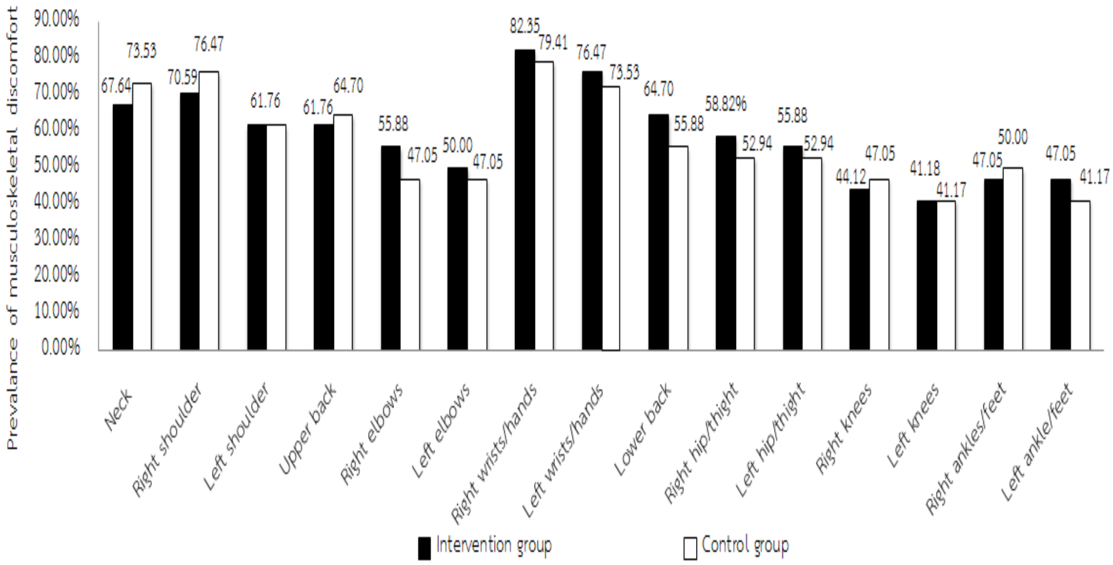


Figure 24 shows the comparison of prevalence rate of musculoskeletal discomfort in the past 1 month between intervention and control group at baseline, exit model, 1st, 2nd, 3rd and 4th follow-up. At baseline, the prevalence rate of musculoskeletal discomfort reported that 63.72% of street sweepers had musculoskeletal discomfort in the intervention group, 61.57% in the control group. Prevalence rate of musculoskeletal discomfort indicated that 50.00% in the intervention group and 69.80% in the control group at exit model. The both group, increased the prevalence rate of musculoskeletal discomfort after exit model (4 times follow-up).

Figure 24 Comparing prevalence rate of musculoskeletal discomfort in the past 1 month between intervention (n=34) and control group (n=34) at the baseline, exit model, 1st, 2nd, 3rd and 4th follow-up

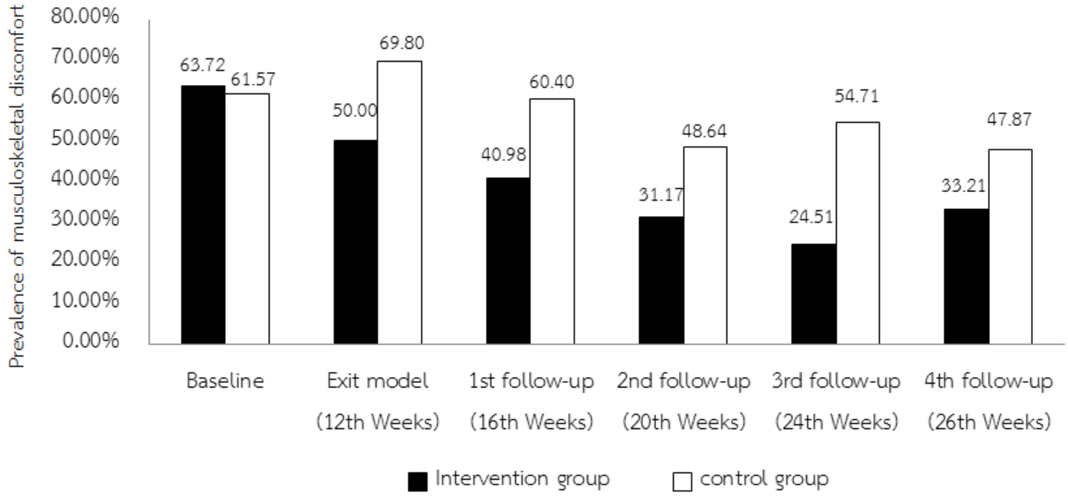


Figure 25 shows the trend of prevalence rate of musculoskeletal discomfort in the past 1 month between intervention and control group. Intervention group, it was decreased at exit model, 1st, 2nd and 3rd follow-up but it was increased at 4th follow-up. Control group, it was slightly increased at exit model and 3rd follow-up except 1st, 2nd and 4th follow-up were trendily decreased to the prevalence rate of musculoskeletal discomfort.

Figure 25 Trend in prevalence rate of musculoskeletal discomfort in the past 1 month between intervention and control group at time point

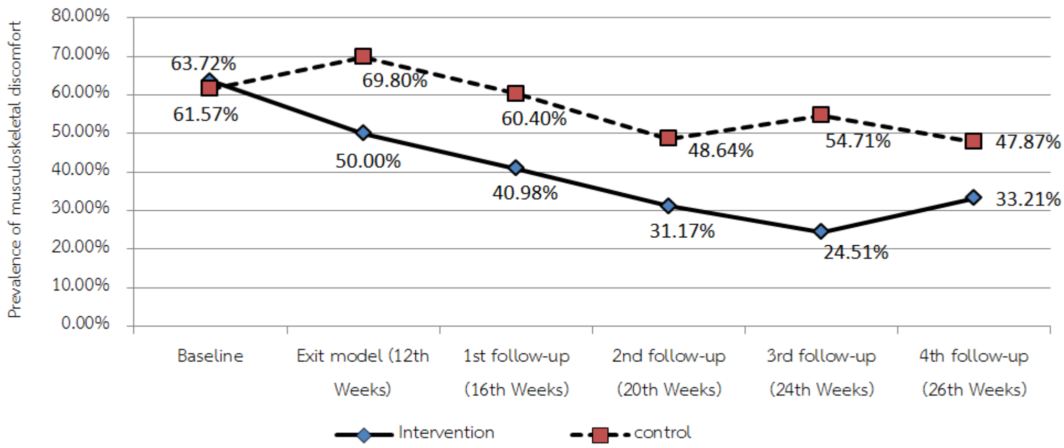
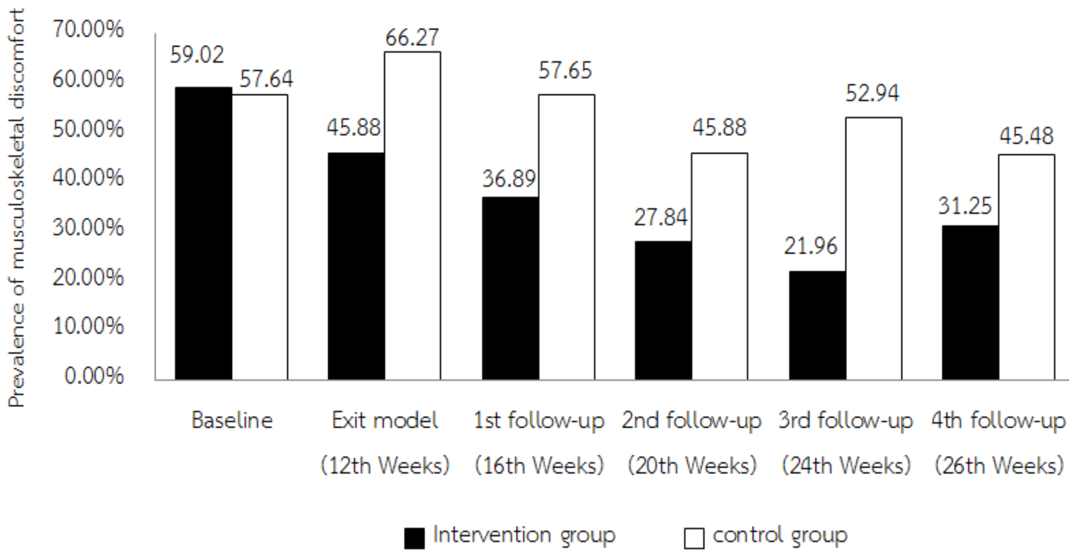


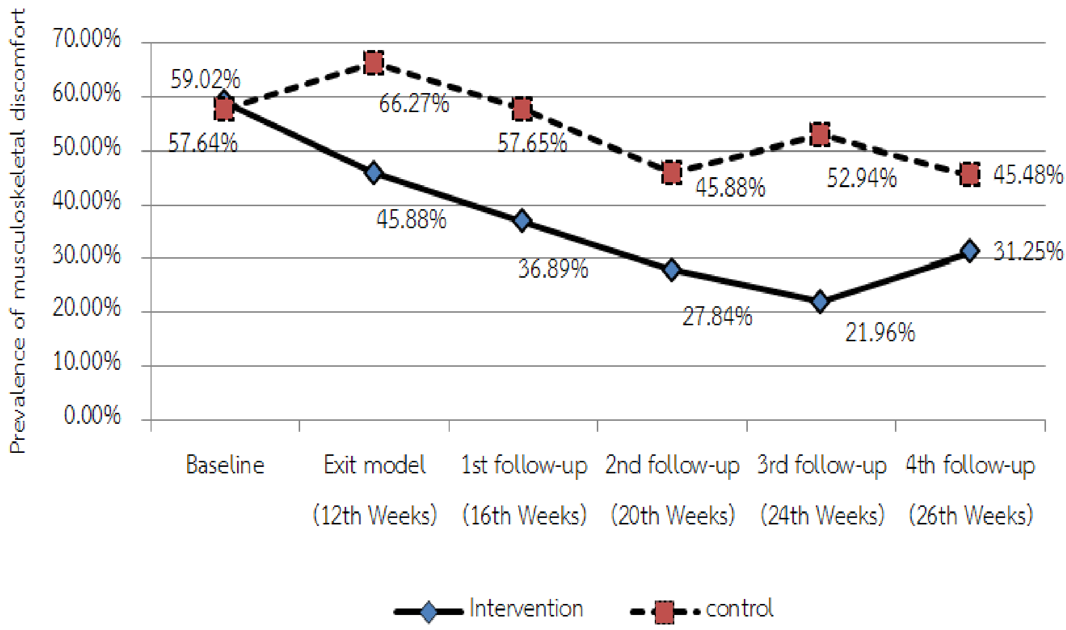
Figure 26 shows the prevalence rate of musculoskeletal discomfort in the past 7 days between intervention and control group at baseline, exit model, 1^{st}, 2^{nd}, 3^{rd} and 4^{th} follow-up. The prevalence rate musculoskeletal discomfort at baseline was reported 59.02% of street sweepers had musculoskeletal discomfort in the intervention group, 56.64% in the control group. Prevalence rate of musculoskeletal discomfort indicated that 45.88% in the intervention group and 66.27% in the control group at exit model. The both group, increased the prevalence rate of musculoskeletal discomfort after exit model (4 times follow-up).

Figure 26 Comparing prevalence rate of musculoskeletal discomfort in the past 7 days between intervention (n=34) and control group (n=34) at the baseline, exit model, 1st, 2nd, 3rd and 4th follow-up



In figure 27, it shows the prevalence rate of musculoskeletal discomfort in the past 7 days between intervention and control group at baseline, exit model, 1^{st}, 2^{nd}, 3^{rd} and 4^{th} follow-up. Intervention group, it was decreased at exit model, 1^{st}, 2^{nd} and 3^{rd} follow-up but it was increased at 4^{th} follow-up. Control group, it was slightly increased at exit model and 3^{rd} follow-up except 1^{st}, 2^{nd} and 4^{th} follow-up were trendily decreased to the prevalence rate of musculoskeletal discomfort.

Figure 27 Trend in prevalence of musculoskeletal discomfort in the past 7 days between intervention and control group at time point



4.2.2 Musculoskeletal discomfort score by physiotherapist

In table 6 shows comparing musculoskeletal discomfort score by physiotherapist between intervention and control group at the baseline, exit model, 1st, 2nd, 3rd and 4th follow-up. At baseline point, there was no difference of musculoskeletal discomfort score between intervention (Mean= 7.21, SD=0.98) and control group (Mean= 7.24, SD=0.92), mean score of differences was -0.06. However, there were significantly different in mean musculoskeletal discomfort score from exit model, 1st, 2nd, 3rd and 4th follow-up.

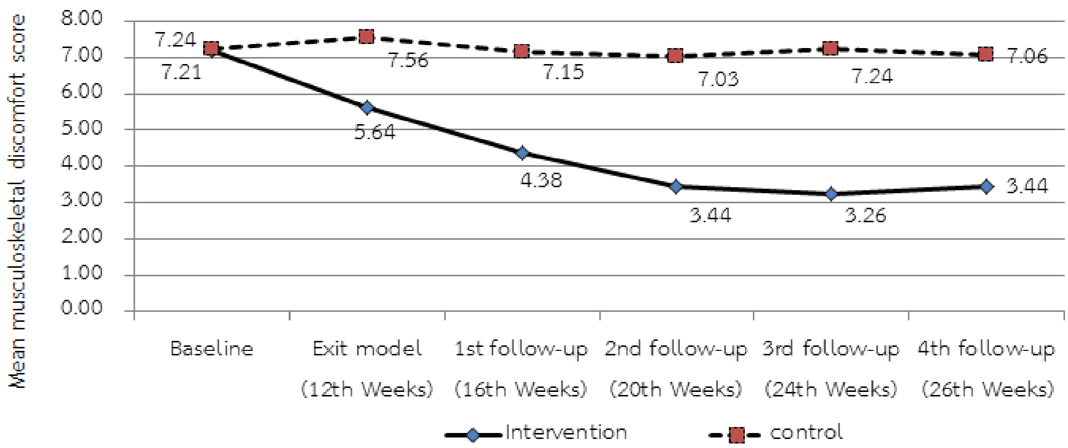
Table 6 Comparing musculoskeletal discomfort score by physiotherapist between intervention (n=34) and control group (n=34) at the baseline, exit model, 1^{st}, 2^{nd}, 3^{rd} and 4^{th} follow-up

Time of data collection	Musculoskeletal strength (score)		Mean Difference	95% CI
	Intervention mean ± SD.	Control mean ± SD.		
Baseline	7.21 ± 0.98	7.21 ± 0.87	-0.06	0.49 – 0.43
Exit model (12^{th} Weeks)	5.62 ± 0.85	7.53 ± 0.73	-1.92	-2.33 – (-1.55)*
1st follow-up (16^{th} Weeks)	4.38 ± 0.78	7.15 ± 0.77	-2.75	-3.13 – (- 2.40)*
2nd follow-up (20^{th} Weeks)	3.44 ± 0.79	7.03 ± 0.80	-3.59	-3.97– (-3.21)*
3rd follow-up (24^{th} Weeks)	3.26 ± 0.79	7.24 ± 0.70	-3.97	-4.36 – (-3.61)*
4th follow-up (26^{th} Weeks)	3.44 ± 0.71	7.06 ± 0.78	-3.62	-4.00 – (-3.30)*

* Significant at p-value < 0.05, using independent t-test

In figure 28 shows similarly between intervention and control group at the baseline point. Intervention, there were decreased mean musculoskeletal discomfort score from exit model, 1^{st}, 2^{nd}, 3^{rd} follow-up except from 4th follow-up was slightly increased. Control group, it was slightly increased at exit model and 3rd follow-up except 1st, 2nd and 4th follow-up were decreased to mean musculoskeletal discomfort score.

Figure 28 Trend in musculoskeletal discomfort score by physiotherapist between intervention (n=34) and control school (n=34)



Testing the effect of the MEI model

In table 7 shows significantly different effect of MEI model to reduce musculoskeletal discomfort among street sweepers on changes in mean musculoskeletal discomfort score between intervention and control group at baseline, exit model, 1st, 2nd, 3rd and 4th follow-up (F=474.73, p-value=<0.001). Similarly, the within subjects testing showed significantly different effect of MEI model on changes in mean musculoskeletal discomfort score over 6 time points (F=79.22, p-value=<0.001). There were significant the mean musculoskeletal discomfort score by time interaction, p-value=<0.001).

Table 7 Effectiveness of the MEI model for musculoskeletal discomfort score of street sweepers (n =68)

Source	SS	df	MS	F	P-value
Between subjects					
Intervention	717.35	1	717.35	474.73	<0.001**
Error	99.73	66	1.51		
Within subjects*					
Time	239.45	2.47	96.82	101.96	<0.001**
Intervention* time	186.04	2.47	75.22	79.22	<0.001**
Error	155.01	163.23	0.95		

* Greenhouse-Geisser, ** Significant at p-value < 0.01

In table 8 shows the pairwise comparisons of the different measurements of musculoskeletal discomfort score in intervention and control. The results reported time in 2^{nd} follow-up with 3^{rd} follow-up (24th Weeks), 2^{nd} follow-up with 4^{th} follow-up (26th Weeks), 3^{rd} follow-up (24th Weeks) with 2^{nd} follow-up, 3^{rd} follow-up (24th Weeks) with 4^{th} follow-up (26th Weeks), 4^{th} follow-up (26th Weeks) with 2^{nd} follow-up and 4^{th} follow-up (26th Weeks) with3^{rd} follow-up (24th Weeks) were no significantly different in time point.

Table 8 Pairwise Comparisons of the different measurements of musculoskeletal discomfort score in intervention and control group (n=68)

Time	Time	Mean Difference	Std. Error	Sig.[a]	95% Confidence Interval	
					Lower	Upper
Baseline	Exit model (12th Weeks)	.632*	.103	<.001	.427	.838
	1st follow-up(16th Weeks)	1.456*	.137	<.001	1.183	1.729
	2nd follow-up (20th Weeks)	1.985*	.152	<.001	1.682	2.289
	3rd follow-up (24th Weeks)	1.971*	.149	<.001	1.673	2.268
	4th follow-up (26th Weeks)	1.971*	.152	<.001	1.668	2.273
Exit model	Baseline	-.632*	.103	<.001	-.838	-.427
	1st follow-up(16th Weeks)	.824*	.122	<.001	.581	1.066
	2nd follow-up (20th Weeks)	1.353*	.140	<.001	1.074	1.632
	3rd follow-up (24th Weeks)	1.338*	.141	<.001	1.057	1.620
	4th follow-up (26th Weeks)	1.338*	.136	<.001	1.066	1.610
1st follow-up	Baseline	-1.456*	.137	<.001	-1.729	-1.183
	Exit model (12th Weeks)	-.824*	.122	<.001	-1.066	-.581
	2nd follow-up (20th Weeks)	.529*	.066	<.001	.398	.661
	3rd follow-up (24th Weeks)	.515*	.082	<.001	.351	.679
	4th follow-up (26th Weeks)	.515*	.097	<.001	.320	.709
2ndfollow-up	Baseline	-1.985*	.152	<.001	-2.289	-1.682
	Exit model (12th Weeks)	-1.353*	.140	<.001	-1.632	-1.074
	1st follow-up(16th Weeks)	-.529*	.066	<.001	-.661	-.398
	3rd follow-up (24th Weeks)	-.015	.061	.809	-.136	.106
	4th follow-up (26th Weeks)	-.015	.083	.860	-.181	.151
3rd follow-up	Baseline	-1.971*	.149	<.001	-2.268	-1.673
	Exit model (12th Weeks)	-1.338*	.141	<.001	-1.620	-1.057
	1st follow-up(16th Weeks)	-.515*	.082	<.001	-.679	-.351
	2nd follow-up (20th Weeks)	.015	.061	.809	-.106	.136
	4th follow-up (26th Weeks)	.000	.076	1.000	-.152	.152
4th follow-up	Baseline	-1.971*	.152	<.001	-2.273	-1.668
	Exit model (12th Weeks)	-1.338*	.136	<.001	-1.610	-1.066
	1st follow-up(16th Weeks)	-.515*	.097	<.001	-.709	-.320
	2nd follow-up (20th Weeks)	.015	.083	.860	-.151	.181
	3rd follow-up (24th Weeks)	.000	.076	1.000	-.152	.152

Based on estimated marginal means, the mean * difference is significant at p-value < 0.05.

a. Adjustment for multiple comparisons: Bonferroni.

4.3 The effectiveness of MEI model to improve physical performance.

4.3.1 Musculoskeletal strength score

In table 9 shows comparing musculoskeletal strength score by physiotherapist between intervention and control group. At baseline point, there was no difference of musculoskeletal strength score between intervention (Mean= 10.12, SD=1.51) and control group (Mean= 10.18, SD=1.03), mean score of differences was -0.05. However, there were significantly different in mean musculoskeletal strength score from exit model, 1st, 2nd, 3rd and 4th follow-up.

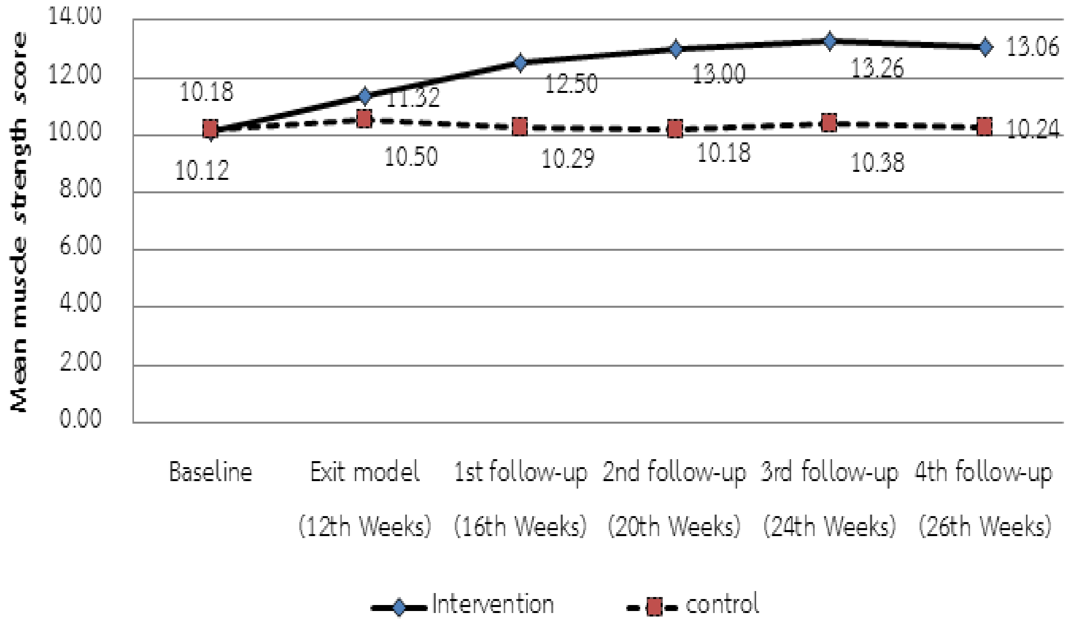
Table 9 Comparing musculoskeletal strength score by physiotherapist between intervention (n=34) and control school (n=34) at the baseline, exit model, 1st, 2nd, 3rd and 4th follow-up

Time of data collection	Musculoskeletal strength (score)		Mean Difference	95% CI
	Intervention mean ± SD.	Control mean ± SD.		
Baseline	10.12 ± 1.51	10.18 ± 1.03	-0.05	-0.69 – 0.57
Exit model (12th Weeks)	11.32 ± 1.27	10.50 ± 1.42	0.82	0.17 – 1.48*
1st follow-up (16th Weeks)	12.50 ± 0.93	10.29 ± 1.22	2.21	1.68 – 2.73*
2nd follow-up (20th Weeks)	13.00 ± 0.78	10.18 ± 1.03	2.82	2.38 – 3.27*
3rd follow-up (24th Weeks)	13.26 ± 0.67	10.38 ± 1.18	2.88	2.42 – 3.35*
4th follow-up (26th Weeks)	13.06 ± 0.65	10.24 ± 0.89	2.82	2.45 – 3.20*

* Significant at p-value < 0.05, using independent t-test

In figure 29 shows similarly between intervention and control group at the baseline point. Intervention, there were decreased mean musculoskeletal strength score from exit model, 1st, 2nd, 3rd follow-up except from 4th follow-up was slightly increased. Control group, it was slightly increased at exit model and 3rd follow-up except 1st, 2nd and 4th follow-up were decreased to mean musculoskeletal strength score.

Figure 29 Trend in musculoskeletal strength score between intervention (n=34) and control school (n=34)



Testing the effect of the MEI model

In table 10 shows significantly different effect of MEI model to reduce musculoskeletal discomfort among street sweepers on changes in mean musculoskeletal strength score between intervention and control group at baseline, exit model, 1st, 2nd, 3rd and 4th follow-up (F=77.90, p-value=<0.001). Similarly, the within subjects testing showed significantly different effect of MEI model on changes in mean musculoskeletal strength score over 6 time points (F=55.58, p-value=<0.001). There were significant the mean musculoskeletal strength score by time interaction, p-value=<0.001).

Table 10 Effectiveness of the MEI model for musculoskeletal strength score of street sweepers (n =68)

Source	SS	df	MS	F	P-value
Between subjects					
Intervention	374.71	1	374.71	77.90	<0.001**
Error	317.46	66	4.81		
Within subjects*					
Time	132.84	3.38	39.28	60.01	<0.001**
Intervention* time	131.89	3.38	39.00	59.58	<0.001**
Error	146.10	223.19	0.66		

* Greenhouse-Geisser, ** Significant at p-value < 0.01

In table 11 shows the pairwise comparisons of the different measurements of musculoskeletal strength score in intervention and control. The results reported time in1st follow-up with 2nd follow-up, 2nd follow-up with 1st follow-up, 2nd follow-up with 4th follow-up (26th Weeks), 3rd follow-up (24th Weeks) with 4th follow-up (26th Weeks), 4th follow-up (26th Weeks) with 2nd follow-up and 4th follow-up (26th Weeks) with 3rd follow-up (24th Weeks) were no significantly different in time point.

Table 11 Pairwise comparisons of the different measurements of musculoskeletal strength score in intervention and control group (n=68)

Time	Time	Mean Difference	Std. Error	Sig.[a]	95% Confidence Interval	
					Lower	Upper
Baseline	Exit model (12th Weeks)	-.765*	.102	<.001	-.969	-.560
	1st follow-up(16th Weeks)	-1.250*	.126	<.001	-1.502	-.998
	2nd follow-up (20th Weeks)	-1.441*	.091	<.001	-1.624	-1.259
	3rd follow-up (24th Weeks)	-1.676*	.143	<.001	-1.962	-1.391
	4th follow-up (26th Weeks)	-1.500*	.126	<.001	-1.752	-1.248
Exit model	Baseline	.765*	.102	<.001	.560	.969
	1st follow-up(16th Weeks)	-.485*	.102	<.001	-.689	-.282
	2nd follow-up (20th Weeks)	-.676*	.118	<.001	-.913	-.440
	3rd follow-up (24th Weeks)	-.912*	.107	<.001	-1.125	-.698
	4th follow-up (26th Weeks)	-.735*	.149	<.001	-1.032	-.438
1st follow-up	Baseline	1.250*	.126	<.001	.998	1.502
	Exit model (12th Weeks)	.485*	.102	<.001	.282	.689
	2nd follow-up (20th Weeks)	-.191	.101	.063	-.393	.011
	3rd follow-up (24th Weeks)	-.426*	.104	<.001	-.635	-.218
	4th follow-up (26th Weeks)	-.250*	.114	.032	-.477	-.023
2ndfollow-up	Baseline	1.441*	.091	<.001	1.259	1.624
	Exit model (12th Weeks)	.676*	.118	<.001	.440	.913
	1st follow-up(16th Weeks)	.191	.101	.063	-.011	.393
	3rd follow-up (24th Weeks)	-.235*	.112	.039	-.459	-.012
	4th follow-up (26th Weeks)	-.059	.079	.457	-.216	.098
3rd follow-up	Baseline	1.676*	.143	<.001	1.391	1.962
	Exit model (12th Weeks)	.912*	.107	<.001	.698	1.125
	1st follow-up(16th Weeks)	.426*	.104	<.001	.218	.635
	2nd follow-up (20th Weeks)	.235*	.112	.039	.012	.459
	4th follow-up (26th Weeks)	.176	.115	.131	-.054	.407
4th follow-up	Baseline	1.500*	.126	<.001	1.248	1.752
	Exit model (12th Weeks)	.735*	.149	<.001	.438	1.032
	1st follow-up(16th Weeks)	.250*	.114	.032	.023	.477
	2nd follow-up (20th Weeks)	.059	.079	.457	-.098	.216
	3rd follow-up (24th Weeks)	-.176	.115	.131	-.407	.054

Based on estimated marginal means, the mean * difference is significant at p-value < 0.05.

a. Adjustment for multiple comparisons: Bonferroni.

4.3.2 Upper body strength

In table 12 shows comparing upper body strength score by sport scientist between intervention and control group at the baseline, exit model, 1^{st}, 2^{nd}, 3^{rd} and 4^{th} follow-up. At baseline point, there was no difference of upper body strength score between intervention (Mean= 9.65, SD=1.04) and control group (Mean= 9.62, SD=1.30), mean score of differences was 0.02. However, there were significantly different in mean upper body strength score from exit model, 1st, 2nd, 3rd and 4th follow-up.

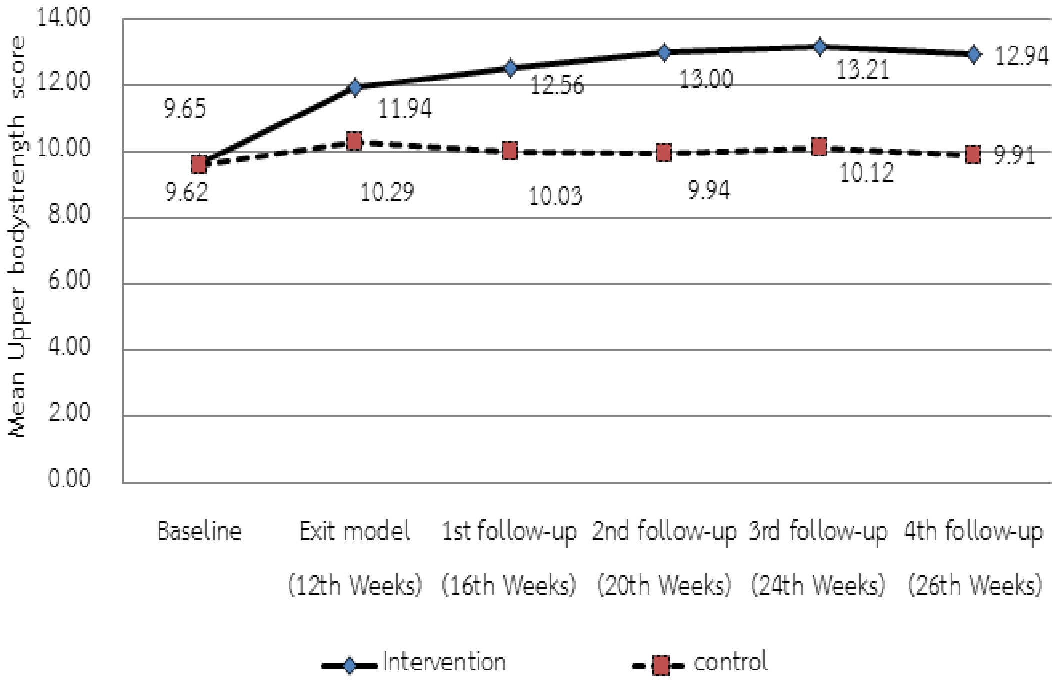
Table 12 Comparing upper body strength score by sport scientist between intervention (n=34) and control school (n=34) at the baseline, exit model, 1^{st}, 2^{nd}, 3^{rd} and 4^{th} follow-up

Time of data collection	Musculoskeletal strength (score)		Mean Difference	95% CI
	Intervention mean ± SD.	Control mean ± SD.		
Baseline	9.65 ± 1.04	9.62 ± 1.30	0.02	-0.54 -0.60
Exit model (12^{th} Weeks)	11.94 ± 1.18	10.29 ± 1.00	1.65	1.12 – 2.18*
1st follow-up (16^{th} Weeks)	12.56 ± 1.02	10.03 ± 1.09	2.53	2.02 – 3.04*
2nd follow-up (20^{th} Weeks)	13.00 ± 0.92	9.94 ± 0.98	3.06	2.60 – 3.52*
3rd follow-up (24^{th} Weeks)	13.21 ± 0.91	10.12 ± 0.81	3.09	2.67 – 3.51*
4th follow-up (26^{th} Weeks)	12.94 ± 0.78	9.91 ± 1.08	3.03	2.57 – 3.49*

* Significant at p-value < 0.05, using independent t-test

In figure 30 shows similarly between intervention and control group at the baseline point. Intervention, there were decreased mean upper body strength score from exit model, 1^{st}, 2^{nd}, 3^{rd} follow-up except from 4^{th} follow-up was slightly increased. Control group, it was slightly increased at exit model and 3^{rd} follow-up except 1^{st}, 2^{nd} and 4^{th} follow-up were decreased to mean upper body strength score.

Figure 30 Trend in upper body strength scores (Arm curl test by sport scientist) between intervention (n=34) and control school (n=34)



Testing the effect of the MEI model

In table 13 shows significantly different effect of MEI model to reduce musculoskeletal discomfort among street sweepers on changes in mean upper body strength score between intervention and control group at baseline, exit model, 1st, 2nd, 3rd and 4th follow-up (F=124.51, p-value=<0.001). Similarly, the within subjects testing showed significantly different effect of MEI model on changes in mean upper body strength score over 6 time points (F=57.67, p-value=<0.001). There were significant the mean upper body strength score by time interaction, p-value=<0.001).

Table 13 Effectiveness of the MEI model for upper body strength scores of street sweepers (n =68)

Source	SS	df	MS	F	P-value
Between subjects					
Intervention	507.41	1	507.41	124.51	<0.001**
Error	268.97	66	4.08		
Within subjects*					
Time	187.10	3.05	61.34	86.53	<0.001**
Intervention* time	124.69	3.05	40.88	57.67	<0.001**
Error	142.71	201.33	0.71		

* Greenhouse-Geisser, ** Significant at p-value < 0.01

In table 14 shows the pairwise comparisons of the different measurements of upper body strength score in intervention and control. The results reported time in exit model with 1^{st} follow-up, exit model with 4^{th} follow-up (26th Weeks), 2^{nd} follow-up with 4^{th} follow-up (26th Weeks), 4^{th} follow-up (26th Weeks) with 1^{st} follow-up, 4^{th} follow-up (26th Weeks) with 2^{nd} follow-up and 4^{th} follow-up (26th Weeks) with 3^{rd} follow-up (24th Weeks) were no significantly different in time point.

Table 14 Pairwise Comparisons of the different measurements of upper body strength scores in intervention and control group (n=68)

Time	Time	Mean Difference	Std. Error	Sig.[a]	95% Confidence Interval	
					Lower	Upper
Baseline	Exit model (12th Weeks)	-1.485*	.148	<.001	-1.781	-1.190
	1st follow-up(16th Weeks)	-1.662*	.133	<.001	-1.927	-1.397
	2nd follow-up (20th Weeks)	-1.838*	.143	<.001	-2.123	-1.554
	3rd follow-up (24th Weeks)	-2.029*	.160	<.001	-2.349	-1.710
	4th follow-up (26th Weeks)	-1.794*	.127	<.001	-2.047	-1.541
Exit model	Baseline	1.485*	.148	<.001	1.190	1.781
	1st follow-up(16th Weeks)	-.176*	.064	.008	-.305	-.048
	2nd follow-up (20th Weeks)	-.353*	.092	<.001	-.536	-.170
	3rd follow-up (24th Weeks)	-.544*	.124	<.001	-.793	-.296
	4th follow-up (26th Weeks)	-.309*	.114	.008	-.536	-.082
1st follow-up	Baseline	1.662*	.133	<.001	1.397	1.927
	Exit model (12th Weeks)	.176*	.064	.008	.048	.305
	2nd follow-up (20th Weeks)	-.176*	.065	.009	-.307	-.046
	3rd follow-up (24th Weeks)	-.368*	.110	.001	-.588	-.148
	4th follow-up (26th Weeks)	-.132	.091	.153	-.315	.050
2nd follow-up	Baseline	1.838*	.143	<.001	1.554	2.123
	Exit model (12th Weeks)	.353*	.092	<.001	.170	.536
	1st follow-up(16th Weeks)	.176*	.065	.009	.046	.307
	3rd follow-up (24th Weeks)	-.191*	.077	.015	-.345	-.038
	4th follow-up (26th Weeks)	.044	.083	.596	-.121	.210
3rd follow-up	Baseline	2.029*	.160	<.001	1.710	2.349
	Exit model (12th Weeks)	.544*	.124	<.001	.296	.793
	1st follow-up(16th Weeks)	.368*	.110	.001	.148	.588
	2nd follow-up (20th Weeks)	.191*	.077	.015	.038	.345
	4th follow-up (26th Weeks)	.235*	.104	.026	.028	.442
4th follow-up	Baseline	1.794*	.127	<.001	1.541	2.047
	Exit model (12th Weeks)	.309*	.114	.008	.082	.536
	1st follow-up(16th Weeks)	.132	.091	.153	-.050	.315
	2nd follow-up (20th Weeks)	-.044	.083	.596	-.210	.121
	3rd follow-up (24th Weeks)	-.235*	.104	.026	-.442	-.028

Based on estimated marginal means, the mean * difference is significant at p-value < 0.05.

a. Adjustment for multiple comparisons: Bonferroni

4.3.3 Lower body strength

In table 15 shows comparing lower body strength score by sport scientist between intervention and control group at the baseline, exit model, 1st, 2nd, 3rd and 4th follow-up. At baseline point, there was no difference of lower body strength score between intervention (Mean= 10.24, SD=1.46) and control group (Mean= 10.21, SD=1.37), mean score of difference was 0.02. However, there were significantly different in mean lower body strength score from exit model, 1st, 2nd, 3rd and 4th follow-up.

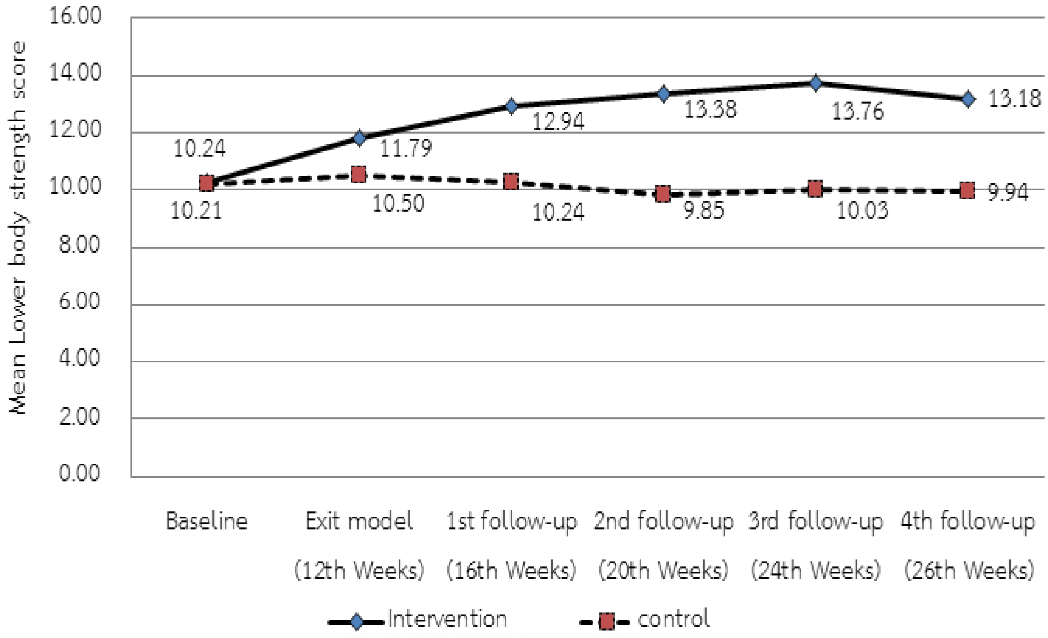
Table 15 Comparing lower body strength score by sport scientist between intervention (n=34) and control school (n=34) at the baseline, exit model, 1st, 2nd, 3rd and 4th follow-up

Time of data collection	Musculoskeletal strength (score)		Mean Difference	95% CI
	Intervention mean ± SD.	Control mean ± SD.		
Baseline	10.24 ± 1.46	10.21 ± 1.37	0.02	-0.66 -0.72
Exit model (12th Weeks)	11.79 ± 1.43	10.50 ± 0.93	1.29	0.71 – 1.88*
1st follow-up (16th Weeks)	12.94 ± 0.95	10.24 ± 0.86	2.71	2.27 – 3.14*
2nd follow-up (20th Weeks)	13.38 ± 0.78	9.85 ± 0.78	3.53	3.15 – 3.91*
3rd follow-up (24th Weeks)	13.76 ± 0.74	10.03 ± 0.72	3.73	3.38 – 4.09*
4th follow-up (26th Weeks)	13.18 ± 0.83	9.94 ± 0.81	3.23	2.84 – 3.62*

* Significant at p-value < 0.05, using independent t-test

In figure 31 shows similarly between intervention and control group at the baseline point. Intervention, there were decreased mean lower body strength score from exit model, 1st, 2nd, 3rd follow-up except from 4th follow-up was slightly increased. Control group, it was slightly increased at exit model and 3rd follow-up except 1st, 2nd and 4th follow-up were decreased to mean lower body strength score.

Figure 31 Trend in lower body strength scores between intervention (n=34) and control school (n=34)



Testing the effect of the MEI model

In table 16 shows significantly different effect of MEI model to reduce musculoskeletal discomfort among street sweepers on changes in mean lower body strength score between intervention and control group at baseline, exit model, 1st, 2nd, 3rd and 4th follow-up (F=180.65, p-value=<0.001). Similarly, the within subjects testing showed significantly different effect of MEI model on changes in mean lower body strength score over 6 time points (F=65.39, p-value=<0.001). There were significant the mean lower body strength score by time interaction, p-value=<0.001).

Table 16 Effectiveness of the MEI model for lower body strength scores of street sweepers (n =68)

Source	SS	df	MS	F	P-value
Between subjects					
Intervention	598.13	1	598.13	180.65	<0.001**
Error	218.53	66	3.31		
Within subjects*					
Time	121.53	2.92	41.67	43.73	<0.001**
Intervention* time	181.73	2.92	62.31	65.39	<0.001**
Error	183.41	192.48	0.95		

* Greenhouse-Geisser, ** Significant at p-value < 0.01

In table 17 shows the pairwise comparisons of the different measurements of lower body strength scores in intervention and control. The results reported time in 1st follow-up with 2nd follow-up, 1st follow-up with 4th follow-up (26th Weeks), 2nd follow-up with 1st follow-up, 2nd follow-up with 4th follow-up (26th Weeks), 4th follow-up (26th Weeks) with 1st follow-up and 4th follow-up (26th Weeks) with 2nd follow-up were no significantly different in time point.

Table 17 Pairwise Comparisons of the different measurements of lower body strength scores in intervention and control group (n=68)

Time	Time	Mean Difference	Std. Error	Sig.[a]	95% Confidence Interval	
					Lower	Upper
Baseline	Exit model (12th Weeks)	-.926*	.101	<.001	-1.127	-.726
	1st follow-up(16th Weeks)	-1.368*	.128	<.001	-1.624	-1.111
	2nd follow-up (20th Weeks)	-1.397*	.159	<.001	-1.715	-1.079
	3rd follow-up (24th Weeks)	-1.676*	.170	<.001	-2.016	-1.337
	4th follow-up (26th Weeks)	-1.338*	.158	<.001	-1.654	-1.022
Exit model	Baseline	.926*	.101	<.001	.726	1.127
	1st follow-up(16th Weeks)	-.441*	.095	<.001	-.632	-.251
	2nd follow-up (20th Weeks)	-.471*	.132	.001	-.734	-.207
	3rd follow-up (24th Weeks)	-.750*	.143	<.001	-1.035	-.465
	4th follow-up (26th Weeks)	-.412*	.154	.009	-.719	-.104
1st follow-up	Baseline	1.368*	.128	<.001	1.111	1.624
	Exit model (12th Weeks)	.441*	.095	<.001	.251	.632
	2nd follow-up (20th Weeks)	-.029	.085	.730	-.199	.140
	3rd follow-up (24th Weeks)	-.309*	.106	.005	-.521	-.097
	4th follow-up (26th Weeks)	.029	.126	.816	-.222	.281
2ndfollow-up	Baseline	1.397*	.159	<.001	1.079	1.715
	Exit model (12th Weeks)	.471*	.132	.001	.207	.734
	1st follow-up(16th Weeks)	.029	.085	.730	-.140	.199
	3rd follow-up (24th Weeks)	-.279*	.086	.002	-.451	-.108
	4th follow-up (26th Weeks)	.059	.122	.630	-.184	.301
3rd follow-up	Baseline	1.676*	.170	<.001	1.337	2.016
	Exit model (12th Weeks)	.750*	.143	<.001	.465	1.035
	1st follow-up(16th Weeks)	.309*	.106	.005	.097	.521
	2nd follow-up (20th Weeks)	.279*	.086	.002	.108	.451
	4th follow-up (26th Weeks)	.338*	.111	.003	.117	.559
4th follow-up	Baseline	1.338*	.158	<.001	1.022	1.654
	Exit model (12th Weeks)	.412*	.154	.009	.104	.719
	1st follow-up(16th Weeks)	-.029	.126	.816	-.281	.222
	2nd follow-up (20th Weeks)	-.059	.122	.630	-.301	.184
	3rd follow-up (24th Weeks)	-.338*	.111	.003	-.559	-.117

Based on estimated marginal means, the mean * difference is significant at p-value < 0.05.

a. Adjustment for multiple comparisons: Bonferroni.

4.4 Effectiveness of MEI model to increase awareness of safe work practice

4.4.1 Rapid entire body assessment (REBA)

In table 18 shows comparing mean REBA score between intervention and control group at the baseline, exit model (12 weeks), 1st follow-up (24 weeks). At baseline point, the REBA score was high risk level in both groups among street sweepers and there was no difference of REBA score between intervention (Mean= 10.41, SD=1.83) and control group (Mean= 10.06, SD=1.43), mean of difference was 0.35. However, there were significantly different in mean REBA score from exit model (12 weeks) and 1st follow-up (24th weeks).

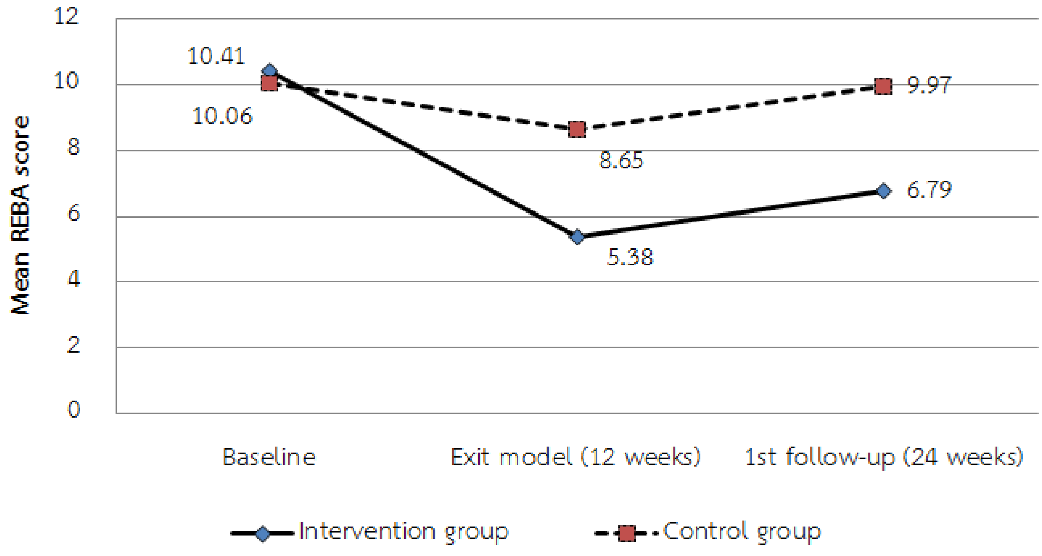
Table 18 Comparing the REBA score between intervention (n=34) and control school (n=34) at the baseline, exit model, 1st follow-up

Time of data collection	Musculoskeletal strength (score)		Mean Difference	95% CI
	Intervention mean ± SD.	Control mean ± SD.		
Baseline	10.41± 1.83	10.06 ± 1.43	0.35	-0.44 – 1.15
Exit model (12th Weeks)	5.38 ± 1.16	8.65 ± 1.99	-3.26	-4.06 – (-2.47)*
1st follow-up (16th Weeks)	6.79 ± 1.39	9.68 ± 2.01	-3.18	-4.03 – (-2.32)*

*Significant at p-value < 0.05, using independent t-test

In figure 32 shows the REBA score was high risk level in both groups among street sweepers at baseline, it was similarly between intervention and control group at the baseline point. Intervention group, the average of mean REBA score was decreased at exit model and 1st follow-up. Control group, the average of mean REBA score was slightly decreased at exit model and follow-up.

Figure 32 Trend in REBA score score between intervention and control group among street sweepers (n =34)



Testing the effect of the MEI model

In table 19 shows significantly different effect of MEI model to reduce musculoskeletal discomfort among street sweepers on changes in mean REBA score between intervention and control group at baseline, exit model, 1st follow-up (F=72.75, p-value=<0.001). Similarly, the within subjects testing showed significantly different effect of MEI model on changes in mean REBA score over 3 time points (F=63.75, p-value=<0.001). There were significant the mean REBA score by time interaction, p-value=<0.001).

Table 19 Effectiveness of the MEI model for REBA scores of street sweepers (n =68)

Source	SS	df	MS	F	P-value
Between subjects					
Intervention	210.04	1	219.04	72.75	<0.001**
Error	190.56	66	2.89		
Within subjects*					
Time	355.32	2	177.66	63.75	<0.001**
Intervention* time	144.79	2	72.39	25.98	<0.001**
Error	367.88	132	2.79		

* Sphericity assumed (p<0.066), ** Significant at p-value < 0.001

In table 20 shows the pairwise comparisons of the different measurements of REBA scores in intervention and control. The results reported time in baseline with exit model (12 weeks) and 1^{st} follow-up, exit model (12^{th} weeks) with baseline and 1^{st} follow-up, 1^{st} follow-up with baseline with exit model (12^{th}weeks) were significantly different in time point.

Table 20 Pairwise comparisons of the different measurements of REBA scores in intervention and control group (n=68)

Time	Time	Mean Difference	Std. Error	Sig[a]	95% Confidence Interval	
					Lower	Upper
Baseline	Exit model (12th Weeks)	3.221*	.300	<.001	2.484	3.957
	1st follow-up(16th Weeks)	1.853*	.308	<.001	1.097	2.609
Exit model	Baseline	-3.221*	.300	<.001	-3.957	-2.484
	1st follow-up(16th Weeks)	-1.368*	.248	<.001	-1.976	-.759
1st follow-up	Baseline	-1.853*	.308	<.001	-2.609	-1.097
	Exit model (12th Weeks)	1.368*	.248	<.001	.759	1.976

Based on estimated marginal means, the mean * difference is significant at p-value < 0.05.

a. Adjustment for multiple comparisons: Bonferroni.

4.4.2 Awareness score

In table 21 shows comparing awareness score between intervention and control group at the baseline, exit model, 1st, 2nd, 3rd and 4th follow-up. At baseline point, there was no difference of awareness score between intervention (Mean= 42.85, SD=5.87) and control group (Mean= 47.35, SD=6.14), mean of difference was -4.50. However, there were significantly different in mean awareness score from exit model, 1st, 2nd, 3rd and 4th follow-up.

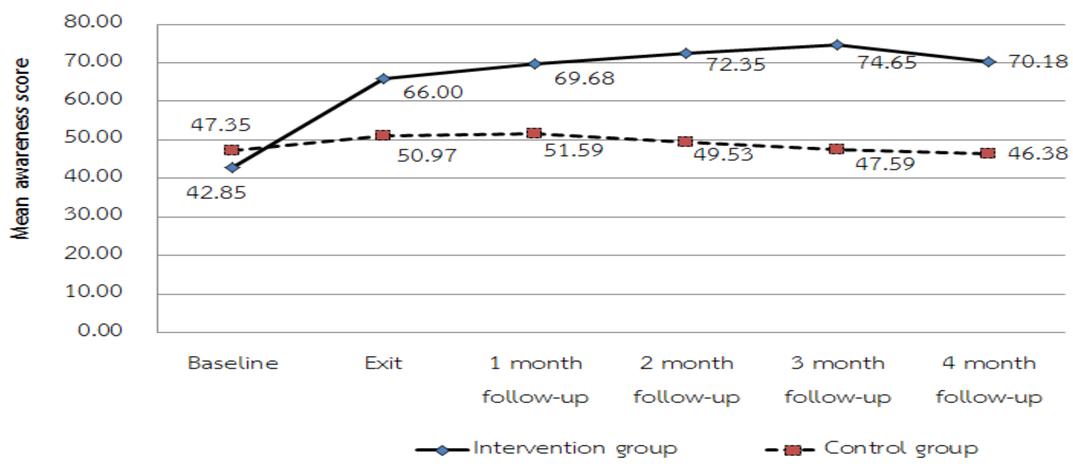
Table 21 Comparing the awareness safe work practice score between intervention (n=34) and control school (n=34) at the baseline, exit model, 1st, 2nd, 3rd and 4th follow-up

Time of data collection	Musculoskeletal strength (score)		Mean Difference	95% CI
	Intervention mean ± SD.	Control mean ± SD.		
Baseline	42.85 ± 5.87	47.35 ± 6.14	-4.50	-7.14 – (-1.59)
Exit model (12th Weeks)	66.00 ± 3.13	50.97 ± 5.14	15.02	12.96 – 17.10*
1st follow-up (16th Weeks)	69.68 ± 2.36	51.59 ± 2.97	18.08	16.79 – 19.40*
2nd follow-up (20th Weeks)	72.35 ± 2.64	49.53 ± 2.64	22.82	21.61 – 24.03*
3rd follow-up (24th Weeks)	74.65 ± 2.06	47.59 ± 2.32	27.06	25.99 – 28.12*
4th follow-up (26th Weeks)	70.18 ± 2.50	46.38 ± 1.59	23.79	22.77 – 24.81*

*Significant at p-value < 0.05, using independent t-test

In figure 33 shows similarly between intervention and control group at the baseline point. Intervention, there were decreased mean awareness score from exit model, 1st, 2nd, 3rd follow-up except from 4th follow-up was slightly increased. Control group, it was slightly increased at exit model and 1st follow-up except, 2nd 3rd and 4th follow-up were decreased to mean awareness score.

Figure 33 Trend in awareness safe work practice score between intervention and control group among street sweepers (n =34)



Testing the effect of the MEI model

In table 22 shows significantly different effect of MEI model to reduce musculoskeletal discomfort among street sweepers on changes in mean awareness score between intervention and control group at baseline, exit model, 1^{st}, 2^{nd}, 3^{rd} and 4^{th} follow-up (F=753.99, p-value=<0.001). Similarly, the within subjects testing showed significantly different effect of MEI model on changes in mean experience discomfort score over 6 time points (F=293.10, p-value=<0.001). There were significant the mean REBA score by time interaction, p-value=<0.001).

Table 22 Effectiveness of the MEI model for awareness scores of street sweepers (n =68)

Source	SS	df	MS	F	P-value
Between subjects					
Intervention	29648.24	1	29648.24	753.99	<0.001**
Error	2595.22	66	39.32		
Within subjects*					
Time	12918.21	1.85	6992.75	343.42	<0.001**
Intervention* time	11025.46	1.85	5968.19	293.10	<0.001**
Error	1115.33	56.88	19.61		

* Greenhouse-Geisser, ** Significant at p-value < 0.01

In table 23 shows the pairwise comparisons of the different measurements of awareness score in intervention and control. The results reported time in 1^{st} follow-up with 2^{nd} follow-up, 1^{st} follow-up with 4^{th} follow-up (26th Weeks), 2^{nd} follow-up with 1^{st} follow-up, 2^{nd} follow-up with 4^{th} follow-up (26th Weeks), 4^{th} follow-up (26th Weeks) with 1^{st} follow-up and 4^{th} follow-up (26th Weeks) with 2^{nd} follow-up were no significantly different in time point.

Table 23 Pairwise comparisons of the different measurements of awareness scores in intervention and control group (n=68)

Time	Time	Mean Difference	Std. Error	Sig.[a]	95% Confidence Interval	
					Lower	Upper
Baseline	Exit model (12th Weeks)	-13.382*	.429	<.001	-14.238	-12.527
	1^{st} follow-up(16th Weeks)	-15.529*	.586	<.001	-16.700	-14.359
	2^{nd} follow-up (20th Weeks)	-15.838*	.685	<.001	-17.205	-14.471
	3^{rd} follow-up (24th Weeks)	-16.015*	.729	<.001	-17.470	-14.559
	4^{th} follow-up (26th Weeks)	-13.176*	.715	<.001	-14.603	-11.750
Exit model	Baseline	.429	.000	12.527	14.238	.429
	1^{st} follow-up(16th Weeks)	.352	.000	-2.849	-1.445	.352
	2^{nd} follow-up (20th Weeks)	.451	.000	-3.356	-1.556	.451
	3^{rd} follow-up (24th Weeks)	.487	.000	-3.604	-1.660	.487
	4^{th} follow-up (26th Weeks)	.493	.678	-.779	1.190	.493
1^{st} follow-up	Baseline	.586	.000	14.359	16.700	.586
	Exit model (12th Weeks)	.352	.000	1.445	2.849	.352
	2^{nd} follow-up (20th Weeks)	.263	.245	-.835	.217	.263
	3^{rd} follow-up (24th Weeks)	.300	.111	-1.085	.114	.300
	4^{th} follow-up (26th Weeks)	.319	.000	1.716	2.989	.319
2^{nd}follow-up	Baseline	15.838*	.685	<.001	14.471	17.205
	Exit model (12th Weeks)	2.456*	.451	<.001	1.556	3.356
	1^{st} follow-up(16th Weeks)	.309	.263	.245	-.217	.835
	3^{rd} follow-up (24th Weeks)	-.176	.213	.410	-.601	.248
	4^{th} follow-up (26th Weeks)	2.662*	.309	<.001	2.046	3.278
3^{rd} follow-up	Baseline	16.015*	.729	<.001	14.559	17.470
	Exit model (12th Weeks)	2.632*	.487	<.001	1.660	3.604
	1^{st} follow-up(16th Weeks)	.485	.300	.111	-.114	1.085
	2^{nd} follow-up (20th Weeks)	.176	.213	.410	-.248	.601
	4^{th} follow-up (26th Weeks)	2.838*	.268	<.001	2.303	3.373
4^{th} follow-up	Baseline	13.176*	.715	<.001	11.750	14.603
	Exit model (12th Weeks)	-.206	.493	.678	-1.190	.779
	1^{st} follow-up(16th Weeks)	-2.353*	.319	<.001	-2.989	-1.716
	2^{nd} follow-up (20th Weeks)	-2.662*	.309	<.001	-3.278	-2.046
	3^{rd} follow-up (24th Weeks)	-2.838*	.268	<.001	-3.373	-2.303

Based on estimated marginal means, the mean * difference is significant at p-value < 0.05.

a. Adjustment for multiple comparisons: Bonferroni.

CHAPTER V
CONCLUSION AND DISCUSSIONS

This chapter displayed a findings and discussion which into five components; discussions, conclusion, limitation, generalizability, and recommendation for further research. This study evaluated the effectiveness of the Multidimensional Ergonomic Intervention (MEI) model on reducing musculoskeletal discomfort, improving physical performance and increasing awareness of safe work practices among street sweepers in Chiang Rai province as follows;

5.1 Discussion

In this study investigated the effectiveness of the Multidimensional Ergonomic Intervention (MEI) model. All outcome variables were reducing musculoskeletal discomfort, improving physical performance and increasing awareness of safe work practices among street sweepers. There are discussed as follows;

5.1.1 Effectiveness of MEI model on reducing musculoskeletal discomfort

1. Prevalence rate of musculoskeletal discomfort

The result indicated that the MEI model on decreasing the prevalence rate of musculoskeletal discomfort. It reported that decreased the prevalence rate of musculoskeletal discomfort after implementation of the model by musculoskeletal discomfort assessment. Although Stambuli (2012) pointed out that musculoskeletal discomfort were affected to more risk factors. The musculoskeletal pain was significantly associated with age but was not significant with alcohol consumption and smoking (Ueno, Hisanaga, Jonai, Shibata, & Kamijima, 1999). According to Ghasemkhani et al., MSDs in worker were not associated with age and BMI (Ghasemkhani et al., 2008). The finding indicated significantly association between musculoskeletal discomfort and number of years of occupation (Chaiklieng, Juntratep, Suggaravetsiri, & Puntumetakul, 2012). Moreover, Theerawanichtrakul and Sithisarankul (2014) found that it was positively associated between MSD and walking distance, length and weight of broom, and weight of broom and dustpan. However, the personal factor should be advised to health behavior change. Yet it was related the attitude and belief since there was accepted to take action. Orem et al (2003) pointed out that a person was allowed to seek alternative treatment and self-care for management their health. The results were reported that 83% of people had lumbar pain used the self- care recovery treatment and 20% used muscle relaxants (Andersson, Ejlertsson, Leden, & Scherstén, 1999). Topical medications were useful for relieving acute and chronic musculoskeletal discomfort; it was reported that 50% of patients reduction in musculoskeletal discomfort (Mason, Moore, Derry, Edwards, & McQuay, 2004). Massaging was recommended the most effective to relieve the musculoskeletal discomfort and improve range of motion among worker (Sisko, Videmsek, & Karpljuk, 2011). Moreover, the evidence was indicated that significantly effective of massage to decreases back pain, safe treatment alternative and that cheap cost of care (Cherkin, Sherman, Deyo, & Shekelle, 2003). Interestingly, the massage was appeared that effective to improve musculoskeletal pain among patients on chronic musculoskeletal pain (Plews-Ogan, Owens, Goodman, Wolfe, & Schorling, 2005). Despite, there were a variety of treatments for musculoskeletal discomfort, there might have been selected the treatment to suitable of own self.

Moreover, majority of prevalence of musculoskeletal discomfort was ranked wrists/hands, shoulders and neck. According to Tsuritani et al. (2002) found that majority of prevalence of MSD was ranked lower back, shoulders, legs, neck, and upper back among middle-aged women in Japan. The research study was investigated the prevalence and related factors of musculoskeletal discomfort among road sweepers in Bangkok showed that the most of them body region was shoulders and knees (Theerawanichtrakul & Sithisarankul, 2014). Moreover, musculoskeletal disorders were often involved wrist, elbow, shoulder and back in occurring to expose over time such as repetitive movement, awkward postures and forceful exertions (Chaffin et al., 2006). The risk factors of musculoskeletal discomfort includes awkward postures, repetitive motion, static postures, and forceful exertions (NIOSH, 2007). The occupation related musculoskeletal discomfort among street sweepers were repetitive movement from using broom sweeping, bending back for removing garbage, and walking area.

The MEI model consists of 4 components including cognitive behavior; education training; stretching exercise; and adding foam sleeve handle grip. The study indicated the effectiveness on reducing prevalence rate of musculoskeletal discomfort. Cognitive behavior could be used strategies and skills to apply for many challenges in life such as management chronic pain, mental and behavioral disorders, control drinking, and maintain exercise. Moreover, cognitive behavioral therapy involved emotion and actions of situation responses which- leads to adaptation of life events (Prendes & & Resko, 2012). Hence, cognitive behavior therapy focuses on the interaction between thinking, feeling and behavior that usually linked with current problems and limited period of time (Freeman et al., 2007). According to Amick III et al (2003), the ergonomics intervention reduced musculoskeletal symptoms among office workers, it had reduced the average pain levels in both groups over the workday. In addition, Mahmud, Kenny, Zein, & Hassan (2011) indicated that prevalence rate of MSD was relatively high and corrective exercise program was effective to decrease it. Grip Work (2011) recommended that the smooth foam tubes were appropriate and simple to use as it felt comfortable while relieving pressure on the hand. Therefore, the MEI model resulted the change in prevalence rate of musculoskeletal discomfort.

2. Musculoskeletal discomfort score

Musculoskeletal discomfort score indicated that significantly different effect of MEI model on changes in mean MSD score between intervention and control group at baseline, exit model, 1st, 2nd, 3rd and 4th follow-up. Musculoskeletal discomfort score showed high risk level musculoskeletal discomfort. Demure et al. (2000) indicated that an ergonomic intervention was associated reduction with discomfort score. Moreover, the evaluation of the effect of an office ergonomic workplace and training intervention to reduce MSD was significant decreased overall MSD among training ergonomic practice group (M. M. Robertson & O'Neill, 2003). Stretching exercises were effective to reduce musculoskeletal discomfort and pain related to static posture and repetitive movement (da Costa & Vieira, 2008). Musculoskeletal discomfort were often involved wrist, elbow, shoulder, and back in occurring to expose over time such as repetitive movement, awkward postures and forceful exertions (Chaffin et al., 2006). The musculoskeletal disorder was regarded as multifactorial causation including physical or mechanical factors, psychosocial factors or organizational, and individual or personal factors (EUOSHA, 2008). Moreover, awkward and static postures, repetitive handling, repetitive or monotonous work, demanding, straining work, lack of recreation times, high time pressure, frequently of overtime hours, and reduced physical capacity were all the risk factors which led to musculoskeletal disorders (Korhan, 2012).

5.1.2 Effectiveness of MEI model on improving physical performance

1. Muscle strength

The result showed significantly difference in muscle strength score at the exit model, 1st, 2nd, 3rd and 4th follow-up. In this study, the performance was depended on 4 integrated components of the MEI model. The exercise interventions program indicated the improvement of physical performance (strength, endurance, flexibility and balance) within the first 3 months (King et al., 2002). The exercise intervention was useful to people who had the musculoskeletal problem related working tasks (Leah, 2011). In general, stretching effects could increase of muscular performance (Dintiman, 1964). In contrast, stretching exercise was recommended to decrease muscle strength, following by long-term stretching, all of which were conducted in two sessions daily as 45 second per sessions in 7 days per week and the end of 8 weeks (Kubo, Kanehisa, & Fukunaga, 2002). According to Miszko et al. (2003), it was found that there were significantly muscle strength and changes in physical function after intervention for 16 weeks. This study reported that significantly muscle strength after the MEI model 12^{th} weeks.

2. Upper body strength

The finding reported significant difference in mean of upper body strength score from exit model, 1^{st}, 2^{nd}, 3^{rd} and 4^{th} follow-up. Street sweeping workers commonly use manual effort by using broom to push and shove garbage. Broom is used outdoor to clean surfaces by sweeping all kinds of debris. Long handled brooms does not bending position which reduces fatigue and increase productivity levels (Ministry of Urban Development Government of India, 2000). According to California Department of Industrial Relations (2005), workers who sweep may involve awkward postures of wrists and prolonged contact pressure on hands. Moreover, the back and neck are often in an awkward forward bent postures. Musculoskeletal discomforts caused primarily by working condition (repetitive movement, force and awkward postures) and by individual behavior (self-practice safety practice) (European Agency for Safety and Health at Work, 2007). Repetitive movement condition uses upper limb frequently such as scapula, shoulders, hands and wrists, which leads to musculoskeletal discomfort among street sweepers. The MEI model, the stretching exercise involved guide for improving muscle strength. Moreover, cognitive behavior; education training; and adding foam sleeve handle grip were effective indirectly help increasing upper body strength score. According to Jones and Rikli, the Arm curl test was significant to assess upper body strength and needed for performing household and other activities involving lifting and carrying things such as groceries, suitcases and grandchildren (Jones & Rikli, 2002).

3. Lower body strength

The result showed significantly different in lower body strength score at exit model, 1st, 2nd, 3rd and 4th follow-up. 30- second chair stand due to assessment muscular strength and endurance on lower body strength (Panti, 2007), it conducted after the end of model and follow-up. Moreover, there was significantly increase on the sit and reach measured mean score after stretching exercise, which indicated the improvement of the physical performance within 12-week (Kokkonen, Nelson, & Cornwell, 1998). The MEI model, the effectiveness of stretching exercise could increase power activities and strengthen muscle to prevent muscle injury and soreness (Lavender et al., 2007; Rubini et al., 2007). According to Valachi and Valachi (2003), stretching the muscles helped remaining strong and healthy. Stretching exercise was the action to perform a particular exercise for improving flexibility and joint range of motion; it was traditionally considered the joint range of motion that could be measured (Magnusson & Renström, 2006).

Therefore, from MEI model, the most improved physical performance among street sweepers on musculoskeletal discomfort was stretching exercise. Another core component helped supporting awareness when practicing the activities regularly in this program.

5.1.3 Effectiveness of MEI model on increasing awareness of safe work

1. Rapid entire body assessment (REBA)

The result showed high risk level in both groups among street sweepers at the baseline. Participants were 10.41 of mean REBA score at baseline, 5.38 of mean REBA score at exit model and 6.79 of REBA score at 1^{st} follow-up**.** According to Meksaw et al (2012) found that 11 of mean REBA score and 4 of mean REBA score after used intervention program to reduce the problem in massaging rubber sheet machine (Meksawi, Tangtrakulwanich, & Chongsuvivatwong, 2012). Analysis of REBA scores, it was generated to indicate the risk level and urgency with which should be taken (Hignett & McAtamney, 2000). This study was conducted on the MEI model to reduce musculoskeletal discomfort among street sweepers. The result showed medium risk level after implementing the MEI model in intervention group. The REBA score was indicated the over high risk stage among street cleaners of municipalities in Seoul and GyeongGi Province, Korea (Lee et al., 2007). Ergonomics problems were used with REBA techniques to assess the unpredictable whole body postures of working and to use for data collecting of the body posture for movement, action, coupling, and repetition. According to the massaging rubber sheet machine, it showed the reduce of the problem in 11 of mean REBA score and 4 of mean REBA score after using this intervention program (Meksawi et al., 2012). Thus, REBA tool was measured useful for rapid assessment of musculoskeletal loads and observe the tasks on various action on risk levels to conduct the resolve risk of ergonomic problem. In contrast, it could not identify different types on severity of various risk factors for the control in the tasks (Moussavi-Najarkola & Mirzaei, 2012).

The MEI model involved change in REBA scores; two components were cognitive behavior therapy and ergonomic education training. Cognitive therapy was one technique of therapy that focused on the relationships and connections between our thoughts, feelings and actions. Recognizing that each circumstance was affected by the environment in which live and environment involves both our current situations such as family, friends, job, culture, various stressor and supports, etc., as well as our past family history, past relationships, previous successes and failures, etc. Within our environment, there are four elements that interact with each other which will be presented as below; (Greig et al., 2007)

2. Awareness safe work practice

Awareness scores, it was significantly different in mean awareness score from exit model, 1st, 2nd, 3rd and 4th follow-up. Similarly, both groups showed significant different effect of MEI model on changes in mean awareness score at baseline, exit model, 1st, 2nd, 3rd and 4th follow-up. According to Das et al., the effectiveness of occupational health awareness intervention among female sweepers working under the Midnapore municipality of west Bengal, India, it showed the considerable increase in the awareness levels and preventive approaches of diseases among the women sweepers (Das et al., 2013). Moreover, the result showed significant increased awareness of the effects of an office ergonomics intervention training program on musculoskeletal pain and discomfort (M. M. Robertson & O'Neill, 2003). According to Clark (2004), work practice helps to prevent ergonomic risk factors on workers and illness. Providing participatory ergonomics program for safety and health on workers by training course and education ergonomic risk factors work practices, techniques of safety on work, and personal protective equipment (Occupational Safety and Health Administration (OSHA), 2008). Cognitive behavior could be used strategies and skills to apply for many challenges in life such as management chronic pain, mental and behavioral disorders, control drinking and maintain exercise. Moreover, cognitive behavioral therapy involved with emotion and actions of situation responses which-led to adaptation of life events (Prendes & & Resko, 2012)

5.2 Conclusion

The multidimensional ergonomic intervention (MEI) model benefit among street sweepers by reducing musculoskeletal discomfort, improving physical performance and increasing awareness of safe work practices among street sweepers. The MEI model was integrated 4 elements including cognitive behavior; education tanning; stretching exercise; and adding foam sleeve handle grip. Cognitive behavior therapy, was related to self-practice MSD, concept of thinking, self-esteem and coping skill related MSD and Effectiveness to changes you though related ergonomic safety practice MSD that training by psychiatric nurse. Musculoskeletal discomfort was related to health risk among street sweepers, hazardous street sweeping affects the musculoskeletal discomfort, consequences of musculoskeletal discomfort, musculoskeletal discomfort can be prevented and ergonomic safety practice such as safety working practice, posture that training by physiotherapist. Stretching exercise, was related to benefits of stretching exercise, safety consideration of stretching exercise, step of stretching exercise include wrist and hand, shoulder and arm, back pain, leg and feet. Adding foam sleeve handle grip, it was used approximately 45 centimeters length of smooth foam tube was provided. The researcher supported foam sleeve broom handle grip for conducting the experiment in this study. The study was delivered via booklet: Safety on work among street sweepers that involved an ergonomic safety practice such as measurement tool for working condition, safety working practice, posture of work, and stretching exercise to reduce musculoskeletal discomfort in workplace and provide easy language that all workers can understand. Moreover, the booklet was used pictures to provide the activities due to limit education on street sweepers in Chiang Rai municipality.

Eligible target populations were selected to participate in the total of 75 street sweepers in Chiang Rai province and they are voluntary participants in the study. There were 68 street sweepers who met screening criteria on musculoskeletal discomfort of having level score ≥ 4 by physiotherapist (intervention group =34; control group = 34). Street sweepers from intervention group were conducted to MEI model in 12 weeks. The participants in control group where the multidimensional ergonomic intervention (MEI) model was not implemented. Assessment was conducted at baseline, exit model (12^{th} weeks), 16^{th} weeks, 20^{th} weeks, 24^{th} weeks and 28^{th} weeks. The participants in this study were not dropped-out and lost to follow – up on the model. The study was started on September until December, 2014 and follow-up in January, February, March and April 2015. Findings of this study as follows;

5.2.1 Demographic characteristic and working factors

Findings founded that most of variable among street sweepers were comparable between intervention and control group. Both groups had higher numbers of female than male and most of them were primary school. Majority of both participants were together with parent; intervention group was 91.18% and control group was 97.06%. There were more number of their street sweepers no smoking and never drinking. Street sweepers, most of them were not taking a break during their sweeping on field. Both groups were never exercise. Most of participants were reduced musculoskeletal discomfort from Let recover by themselves, massage and topical treatment respectively.

Working factors, it was statistically associated between intervention group and control groups included age, working years, Body mass index, walking distance, using broom per month, length and weight of broom, total weight broom and dustpan, proportion between height of the chin among street sweepers with height of the boom and proportion between height of street sweepers and height of the boom.

Comparing demographic characteristics and working factors between intervention and control groups were shown no statistically associated most of characteristics, except to reduce musculoskeletal discomfort statistical association. In summary, there were no difference characteristics among street sweepers and no impact of imbalance baseline characteristics into both group; intervention and control group.

5.2.2 Effectiveness of MEI model on reducing MSD

1. Musculoskeletal discomfort assessment

The prevalence of musculoskeletal discomfort in past 1 month; Intervention group, it was decreased at exit model, 1^{st}, 2^{nd} and 3^{rd} follow-up and control group, it was slightly increased at exit model and 3^{rd} follow-up except 1^{st}, 2^{nd} and 4^{th} follow-up were decreased to the prevalence of musculoskeletal discomfort. The prevalence of musculoskeletal discomfort in past 7 days; Intervention group, it was decreased at exit model, 1^{st}, 2^{nd} and 3^{rd} follow-up but it was increased at 4^{th} follow-up and control group, it was slightly increased at exit model and 3^{rd} follow-up except 1^{st}, 2^{nd} and 4^{th} follow-up were decreased to the prevalence of musculoskeletal discomfort.

2. Musculoskeletal discomfort score by physiotherapist

Musculoskeletal discomfort score by physiotherapist, it shows similarly between intervention and control group at the baseline point and it indicated that high risk level musculoskeletal discomfort. Intervention, there were decreased mean musculoskeletal discomfort score from exit model, 1st, 2^{nd}, 3^{rd} follow-up except from 4^{th} follow-up was slightly increased. Control group, it was slightly increased at exit model and 3rd follow-up except 1^{st}, 2^{nd} and 4^{th} follow-up were decreased to mean musculoskeletal discomfort score. Significantly different effect of MEI model on changes in mean musculoskeletal discomfort score between intervention and control group at baseline, exit model, 1^{st}, 2^{nd}, 3^{rd} and 4^{th} follow-up. Similarly, the within subjects testing showed significantly different effect of MEI model on changes in mean musculoskeletal discomfort score over 6 time points.

In summary, the MEI model to decrease the prevalence of MSD in street sweepers. Significantly different the effect of MEI model on changes in mean MSD score between intervention and control group at exit model, 1^{st}, 2^{nd}, 3^{rd} and 4^{th} follow-up. The finding showed high severity MSD levels at baseline, moderate severity MSD levels at exit model and 1^{st} follow-up, and slight severity MSD levels at 2^{nd}, 3^{rd} and 4^{th} follow-up. So, the MEI model can to reduce of MSD among street sweepers.

5.2.3. Effectiveness of MEI model on improving physical performance.

1. Musculoskeletal strength

Musculoskeletal strength score by physiotherapist, it showed no difference in mean musculoskeletal strength score at baseline point between intervention and control group. However, there were significantly different in mean musculoskeletal strength score from exit model, 1st, 2nd, 3rd and 4th follow-up. Similarly between intervention and control group at the baseline point and significantly different effect of MEI model on changes in mean musculoskeletal strength score over 6 time points.

2. Upper body strength

Upper body strength score by physiotherapist, it shows similarly between intervention and control group at the baseline point and it indicated that less than 11 score in the both group (intervention =9.65, control= 9.62). Criterion performance scores of arm curl test less than 11 in the both male and female that mean risk of upper body strength (Jones & Rikli, 2002). Comparing upper body strength score by sport scientist between intervention and control group was reported that significantly different effect of MEI model on changes in mean upper body strength score at baseline, exit model, 1st, 2nd, 3rd and 4th follow-up. Similarly, the within subjects testing showed significantly different effect of MEI model on changes in mean upper body strength score over 6 time points.

3. Lower body strength

Lower body strength score by physiotherapist, it shows similarly between intervention and control group at the baseline point and it indicated that more than 8 score in the both group (intervention =10.24, control= 10.21). Criterion performance scores of with sit and stand on the chair less than 8 in the both male and female that mean risk of upper body strength. Lower body strength score, it was reported that no difference of lower body strength score but it was significantly different in mean lower body strength score from exit model, 1st, 2nd, 3rd and 4th follow-up between intervention and control group. Similarly, intervention and control group were decreased mean lower body strength score from exit model, 1^{st}, 2^{nd}, 3^{rd} follow-up except from 4^{th} follow-up was slightly increased. Control group, it was slightly increased at exit model and 3^{rd} follow-up except 1^{st}, 2^{nd} and 4^{th} follow-up were decreased to mean lower body strength score.

In summary, Significantly different in mean muscle strength score , upper body strength score and lower body strength score at exit model, 1st , 2nd , 3rd and 4th follow-up. So, the MEI model to improve physical performance in street sweeper.

5.2.4. Effectiveness of MEI model on increasing awareness of safe work practices.

1. Rapid entire body assessment (REBA)

REBA score, it was high level into intervention and control group at baseline. The result was indicated no difference of REBA score between intervention and control group in baseline but it was significantly different in mean REBA score from exit model, 1^{st} follow-up. For the model testing, it was shown significantly different effect of MEI model on changes in mean REBA score between both groups at baseline, exit model and 1^{st} follow-up. Similarly, the within subjects testing showed significantly different effect of MEI model on changes in mean REBA score over 3 time points.

2. Awareness safe work practice

Awareness score, it was shows no difference of awareness score between intervention and control group. However, there were significantly different in mean awareness score from exit model, 1st, 2nd, 3rd and 4th follow-up. Similarly, both groups were shows significantly different effect of MEI model on changes in mean awareness score at baseline, exit model, 1st, 2nd, 3rd and 4th follow-up. The within subjects testing showed significantly different effect of MEI model on changes in mean experience discomfort score over 6 time points.

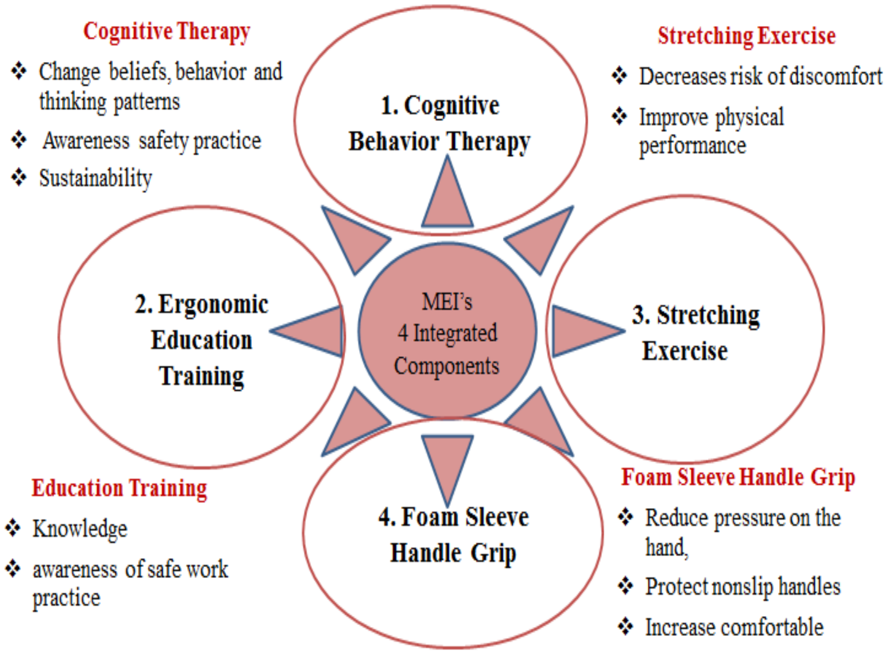
In summary, both groups indicated that significantly different in mean awareness score from exit model, 1st, 2^{nd}, 3^{rd} and 4^{th} follow-up. The data indicated that moderate awareness score at baseline and very high awareness at exit model, 1^{st}, 2^{nd}, 3^{rd} and 4^{th} follow-up. It was high level into intervention and control group at baseline. The finding showed that significantly different effect of MEI model on changes in mean REBA score between both groups at exit model and 1st follow-up. The result showed good posture involves the MEI model in among street sweepers. So, the MEI model to increase awareness of safe work practices in street sweeper.

Conclusion overall the MEI model

This study conducted MEI model which consisted of 4 integrated components; 1) cognitive behavior therapy 2) ergonomic education training 3) stretching exercise, and 4) innovation foam sleeve handle grip. Cognitive behavior by psychiatric nurse, it was one type of concept on thoughts which plays an importance on role of behavior change, beliefs change, thinking patterns and awareness of safety work practice. Moreover, it can help a model sustainability (Torres et al., 2007). Ergonomic education training by Occupational nurse, the training or education model can help a long way to increase safety awareness on worker to perform on their jobs and can protect or improve risk factors of MSD (Dudley & Delong, 2001). Stretching exercise by sports scientist, it is one type to reduce muscle discomfort and to prevent muscles injury/illness and improve performance (Magnusson & Renström, 2006). A fundamental of stretching exercises affects the mechanical properties of the musculoskeletal discomfort. Innovation foam sleeve handle grip, a foam sleeve was a device which was created for applications which require extra hand grip and need to prolong handle tool such as safety bars, fitness equipment and long broom handle (GripWorks, 2011). All outcomes reported that the effectiveness of the multidimensional ergonomic intervention (MEI) model were reducing musculoskeletal discomfort, improving physical performance, and increasing awareness of safe work practices.

The MEI model will be developed to ease and combine the booklet for implementation in real situation; it will provide other municipalities to use them. The model will train staff of another municipality by staff from research study. Generally, the municipality staff can conduct the ergonomic education training and stretching exercise. Innovation foam sleeve handle broom can be managed from municipality except cognitive behavior therapy can provide from hospital nurse.

Figure 34 The MEI model



5.3 Study Limitations

1. Gender imbalance, there were 59 female samples, with only 9 male as the condition of the work were mainly sweeping and collecting waste into bins, these activities required female labor force. While collecting municipal solid waste were located in the local disposal site and dump site which required male labor force.

2. Possibility of contamination might be occurred. In this study was conducted in the Chiang Rai's Muang District area that may have an interaction between intervention and control groups during activities. However, the street sweepers were normally worked in their separate-assigned zone, and hardly communicated and/or met each other's

3. Participants were asked about level or experience of the MSD – one month after the intervention. This may be difficult for them to recall accurate memory of discomfort level.

4. Outside information on "Health service", social/cultural interactions and communication technology may be influenced and interfered the results.

5.4 Generalizability

1. The MEI model can be generalized to street sweepers in another municipality due to the context of street sweepers were similarly such as approximately 1-3 kilometer for response street sweeping distance in daily work, and same posture in activities including street sweeping distance and bending back.

2. The MEI model can be applied to other occupation which used repetitive movement and award posture such as house sweeping, janitor.

5.5 Recommendation for further research

1. The promoting the implementation of MEI model to others municipality to get more consolidated evidence.

2. The MEI model consisted of 1) cognitive behavior ergonomic therapy, 2) education training, 3) stretching exercise, and 4) adding foam sleeve handle grip. The innovation of broom handle grip could be applied/added to any street sweepers for daily used. It is easy to use, comfortable and durable.

3. This study integrated 4 components including cognitive behavior therapy, ergonomic education training, stretching exercise, and adding foam sleeve broom handle grip to reduce MSD. all of which can be boost in decreasing mean MSD score after 24th weeks) of MEI model implementation. The model after 3 months (24th weeks) that decreased in mean MSD score.

4. The health facility should be supported by municipality, the policy set up to maintain or protect the musculoskeletal discomfort that helps to success on musculoskeletal discomfort.

5. Testing the cost-effectiveness of the MEI model to reduce musculoskeletal discomfort.

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APPENDIX

Appendix A – Interview forms

Questionnaire: Effectiveness of multidimensional ergonomic intervention (MEI) model to reduce occupational related musculoskeletal discomfort among street sweepers

Dear Participants

The researcher will be conducted this survey together with Chiangrai municipality to provide a program to reduce work-related musculoskeletal discomfort among street sweepers in Chiangrai municipality, Chiang Rai province, Thailand. The Chiangrai municipality providers know about this survey and support it. However, your participation in this study are voluntary and the information you give us will be confidential, which means your name will not be mentioned anywhere and information provided by you will be presented only in a summarized form.

Please select carefully the answer for each question and the possible responses. Choose and mark (√) the response option that best represents you opinion and knowledge, attitude, and practice. Please notify the interviewer if you any concern about of the questions or other problem.

Introduction of the questionnaire

The questionnaire is divided into 3 parts present as follows;

Part I Socio-demographic characteristic and work factors

Part II Musculoskeletal Discomfort Assessment (MSDA)

Part III Awareness Safe Work Practice of Musculoskeletal Discomfort

Thank you for information

Part I: Socio-demographic characteristic and work factors

Guidance: Please select carefully the answer for each question and choose the answer by marking (√) the response option that best represents.

1.1 Socio-demographic characteristic

1. Gender ( ) 1. Male ( ) 2. Female

2. Age .... Years

3. Education ( ) 1. No education ( ) 2. Primary school
( ) 3. Junior High School ( ) 4. Senior High School
( ) 5. Vocational Certificate ( ) 6. High Vocational Certificate
( ) 7. Bachelor degree

4. Marital Status ( ) 1.Single ( ) 2.Married
( ) 3.Widowed/ Divorced/Separated

5. How tall are you?................................. Centimeter

6. How weight are you?................................Kilogram

7. History of illness ( ) 1. No ( ) 2. Yes (specify).............................

8. Do you take any medicine regularly?
( ) 1. No ( ) 2.Yes (specify).............................

9. Do you take annual medical checkup?
( ) 1. No ( ) 2.Yes (Abnormal symptoms)................

10. How often do you exercise?
( ) 1. Never ( ) 2. Work out at 1-2 times/week
( ) 3. Work out at 3-4 times/week ( ) 4. Work out at ≥ 5 times/week

11. Do you smoking? ( ) 1. No ( ) 2. Yes (specify).................. cigarettes a day

12. Do you drink alcohol? ( ) 1. No ( ) 2. Yes (specify).................... glasses a day

13. How often do you energy drinking?

( ) 1. Never ( ) 2. Drinking 1-2 times/week

( ) 3. Drinking 3-4 times/week ( ) 4. Drinking ≥ 5 times/week

14. How do you reduce musculoskeletal discomfort? (Answer more than one item)

( ) 1.Let recover by themselves ( ) 2. Bought drug release muscle on themselves

( ) 3. Use a topical treatment

( ) 4. Massage ( ) 5. Hot packs and clod packs

( ) 6. Stop working ( ) 7. See the doctor in clinic

( ) 8. See the doctor in hospital has the right to treatment

( ) 9.Others

1.2 work factors

15. How long have you worked here? .... years

16. How many hours a day do you work? ....hours/day

17. Period of time for working 1. In the morning................. 2. In the afternoon.............

18. How many minutes for sweeping as a continuous movement before take a break?
....minutes/times

19. Average walking distance ....Kilometers/ day

20. Do you change the broom?

( ) 1. No ( ) 2. Yes (specify)..............................(month or years)

21. Do you have equipment without boom and dust pan to use working on field?

( ) 1. No ( ) 2. Yes (specify)...

Use measurement tool

22 Length of broom.. Centimeter

23. Proportion of height between broom and street sweepers .... Centimeter

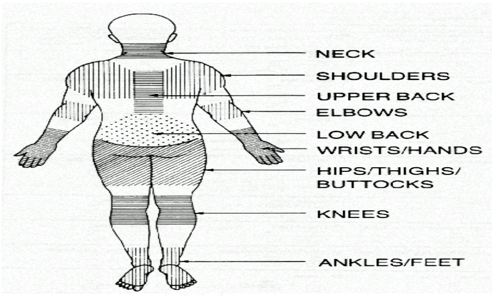
24. Weight of broom.. Kilograms

25. Weight of broom and dustpan .... Kilograms

Part II: Musculoskeletal Discomfort Assessment (MSDA)

Guidance: The following questions ask how you feel about your body discomfort.

1. Please select carefully the answer for each question and choose the answer by marking (√) the response option that best represents.



Body Region	Have you had trouble at any time during the last months		Have you had trouble at any time during the last 7 days	
Neck	☐ No	☐ Yes	☐ No	☐ Yes
Shoulders				
Right	☐ No	☐ Yes	☐ No	☐ Yes
Left	☐ No	☐ Yes	☐ No	☐ Yes
Upper Back	☐ No	☐ Yes	☐ No	☐ Yes
Elbows				
Right	☐ No	☐ Yes	☐ No	☐ Yes
Left	☐ No	☐ Yes	☐ No	☐ Yes
Wrists/Hands				
Right	☐ No	☐ Yes	☐ No	☐ Yes
Left	☐ No	☐ Yes	☐ No	☐ Yes
Lower back	☐ No	☐ Yes	☐ No	☐ Yes
Hip/Thight				
Right	☐ No	☐ Yes	☐ No	☐ Yes
Left	☐ No	☐ Yes	☐ No	☐ Yes
Knees				
Right	☐ No	☐ Yes	☐ No	☐ Yes
Left	☐ No	☐ Yes	☐ No	☐ Yes
Ankles/Feet				
Right	☐ No	☐ Yes	☐ No	☐ Yes
Left	☐ No	☐ Yes	☐ No	☐ Yes

Part III: Awareness safe work practice of musculoskeletal discomfort (ASWP-MSD)

Guidance: Please answer by marking (√) the response option that best represents your opinion as follows;

No	Statement	disagree 1	slightly agree 2	agree 3	strongly agree 4
1	The broom handle should be between your chin and eye level				
2	The appropriate the weights of the bamboo handle approximately 900 gm-1 kg				
3	The broom handle should be no wider than chin				
4	The broom handle should be have a diameter that allows for a comfortable grip or 3-4 cm diameter				
5	Add a foam sleeve over the broom handle for a better and more comfortable grip, it is can to improve musculoskeletal discomfort				
6	Dustpan should be durable and lightweight				
7	The cause of musculoskeletal discomfort are repetitive movement by sweeping ,bending for removing garbage and walking area to be responsible				
8	Sweeping may involve awkward positions of wrists, and prolonged contact pressure on hands.				
9	The back and neck discomfort are often in an awkward forward bent posture				
10	Safe work practice to reduce musculoskeletal discomfort				
11	Maintain a neutral spine, body and shoulder position during working				
12	Do not the hands movement more than shoulders and keep your between shoulders for sweeping				
13	Keep elbows and arms close to body stabilize the shoulder can to minimize musculoskeletal discomfort				

No	Statement	disagree 1	slightly agree 2	agree 3	strongly agree 4
14	Alternate right and left hands at the top of the broom handle can to reduce musculoskeletal discomfort				
15	Do not bend your back, If needed, bend your knees and kneel down to get closer to the work				
16	Stretching exercises to reduce musculoskeletal discomfort				
17	Do not stretching exercise if you muscle pain or swelling				
18	Stretching exercises do not stretch to the point of pain				
19	Do stretching exercises about 20 minute and at least 2-3 times a week				
20	Stretching exercises before working can to prevent musculoskeletal discomfort				

<u>Note</u>

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Appendix B – Rapid Entire Body Assessment (REBA)

Task	Analyst

Group A		
Posture/Range	**Score**	**Total**
Trunk		
Upright	1	If back is twisted or tilted to side: +1
Flexion: 0-20° Extension: 0-20°	2	
Flexion: 20-60° Extension: >20°	3	
Flexion: >60°	4	
Neck		
Flexion: 0-20°	1	If neck is twisted or tilted to side: +1
Flexion: >20° Extension: >20°	2	
Legs		
Bilateral Wt Bearing; Walk; Sit	1	Knee(s) Flexion 30-60°: +1
Unilateral Wt Bearing; Unstable	2	Knee(s) Flexion >60°: +2
Score from Table A		
Load / Force		
< 5 kg < 11 lb	0	Shock or Rapid Buildup: +1
5 - 10 kg 11 - 22 lb	1	
> 10 kg > 22 lb	2	
Score A **[Table A + Load/Force Score]**		
Activity		
One or more body parts are static for longer than 1 minute		+1
Repeat small range motions, more than 4 per minute		+1
Rapid large changes in posture or unstable base		+1

Group B			
Posture/Range	**Score**	**Total: Left and Right**	
Upper Arms (Shoulders)		L	R
Flexion: 0-20° Extension: 0-20°	1	Arm Abducted / Rotated: +1 Shoulder Raised: +1 Arm Supported: -1	
Flexion: 20-45° Extension: >20°	2		
Flexion: 45-90°	3		
Flexion: >90°	4		
Lower Arms (Elbows)		L	R
Flexion: 60-100°	1	No Adjustments	
Flexion: <60° Flexion: >100°	2		
Wrists		L	R
Flexion: 0-15° Extension: 0-15°	1	Wrist Deviated / Twisted: +1	
Flexion: >15° Extension: >15°	2		
Score from Table B		L	R
Coupling		L	R
Good	0	No Adjustments	
Fair	1		
Poor	2		
Unacceptable	3	Left	Right
Score B **[Table B + Coupling Score]**		L	R
Score C (from Table C)		L	R
Activity Score		L	R
REBA Score **[Score C + Activity Score]**		L	R

REBA

Table A

		Trunk				
		1	2	3	4	5
Neck = 1	Legs					
	1	1	2	2	3	4
	2	2	3	4	5	6
	3	3	4	5	6	7
	4	4	5	6	7	8
Neck = 2	Legs					
	1	1	3	4	5	6
	2	2	4	5	6	7
	3	3	5	6	7	8
	4	4	6	7	8	9
Neck = 3	Legs					
	1	3	4	5	6	7
	2	3	5	6	7	8
	3	5	6	7	8	9
	4	6	7	8	9	9

Table B

		Upper Arm					
		1	2	3	4	5	6
Lower Arm = 1	Wrist						
	1	1	1	3	4	6	7
	2	2	2	4	5	7	8
	3	2	3	5	5	8	8
Lower Arm = 2	Wrist						
	1	1	2	4	5	7	8
	2	2	3	5	6	8	9
	3	3	4	5	7	8	9

Table C

		Score A											
		1	2	3	4	5	6	7	8	9	10	11	12
Score B	1	1	1	2	3	4	6	7	8	9	10	11	12
	2	1	2	3	4	4	6	7	8	9	10	11	12
	3	1	2	3	4	4	6	7	8	9	10	11	12
	4	2	3	3	4	5	7	8	9	10	11	11	12
	5	3	4	4	5	6	8	9	10	10	11	12	12
	6	3	4	5	6	7	8	9	10	10	11	12	12
	7	4	5	6	7	8	9	9	10	11	11	12	12
	8	5	6	7	8	8	9	10	10	11	12	12	12
	9	6	6	7	8	9	10	10	10	11	12	12	12
	10	7	7	8	9	9	10	11	11	12	12	12	12
	11	7	7	8	9	9	10	11	11	12	12	12	12
	12	7	8	8	9	9	10	11	11	12	12	12	12

REBA Decision

REBA Score	Risk Level
1	Negligible
2 - 3	Low
4 - 7	Medium
8 - 10	High
11 - 15	Very High

Appendix C – Physical Exam Forms

Range of motion: To test a discomfort on movement

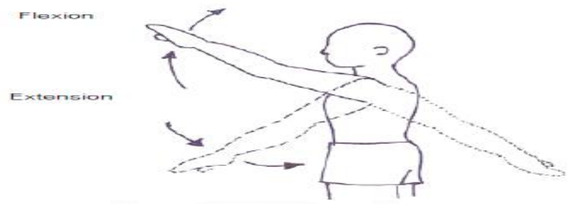
Guidance: The physical exam will be assessed muscles discomfort on movement by nurses present step by step as follows:

1. Neck

Flexion Extension Hyperextension Lateral flexion

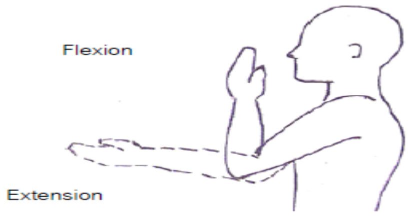
Scale	Flexion	Extension	Hyperextension	Lateral flexion
Discomfort				
No discomfort				

2. Hands, Shoulders and Scapulars

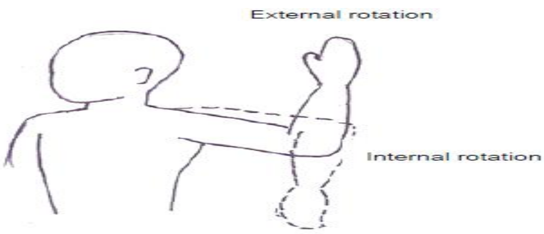


Scale	Flexion		Extension		Hyperextension	
	Right	Left	Right	Left	Right	Left
Discomfort						
No discomfort						

Scale	Abduction		Adduction	
	Right	Left	Right	Left
Discomfort				
No discomfort				



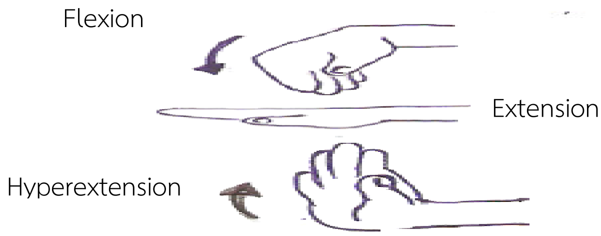
Scale	Flexion		Extension	
	Right	Left	Right	Left
Discomfort				
No discomfort				



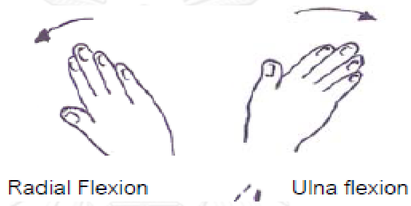
Scale	Internal Rotation		External Rotation	
	Right	Left	Right	Left
Discomfort				
No discomfort				

Scale	Circumduction	
	Right	Left
Discomfort		
No discomfort		

3. Wrists

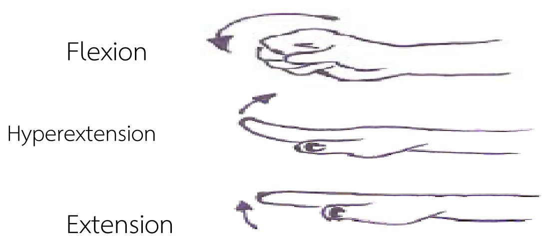


Scale	Flexion		Extension		Hyperextension	
	Right	Left	Right	Left	Right	Left
Discomfort						
No discomfort						

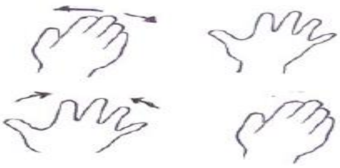


Scale	Radial Flexion		Ulnar Flexion	
	Right	Left	Right	Left
Discomfort				
No discomfort				

4. Fingers



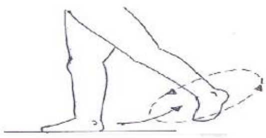
Scale	Flexion		Extension		Hyperextension	
	Right	Left	Right	Left	Right	Left
Discomfort						
No discomfort						



Scale	Abduction	
	Right	Left
Discomfort		
No discomfort		

5. Hips

Scale	Flexion		Extension	
	Right	Left	Right	Left
Discomfort				
No discomfort				



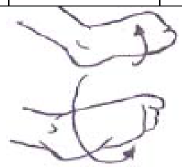
Scale	Circumduction	
	Right	Left
Discomfort		
No discomfort		

6. Knees

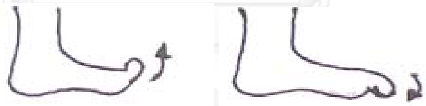
Scale	Flexion		Extension	
	Right	Left	Right	Left
Discomfort				
No discomfort				

7. Feet

Scale	Dorsal Flexion		Plantar Flexion	
	Right	Left	Right	Left
Discomfort				
No discomfort				



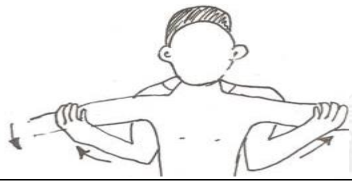
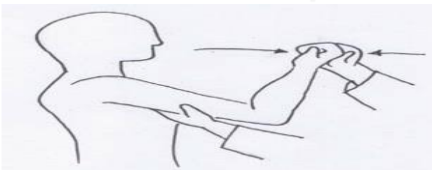
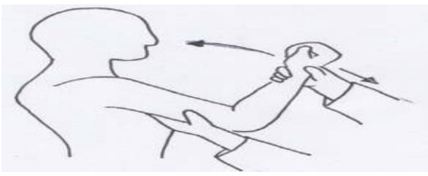
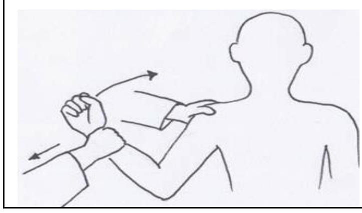
Scale	Inversion		Eversion	
	Right	Left	Right	Left
Discomfort				
No discomfort				

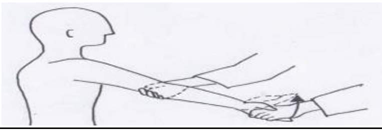
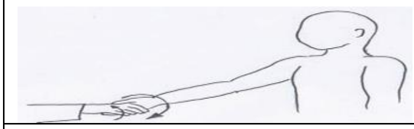
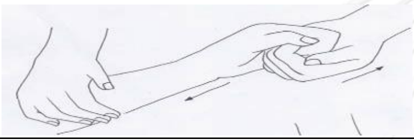
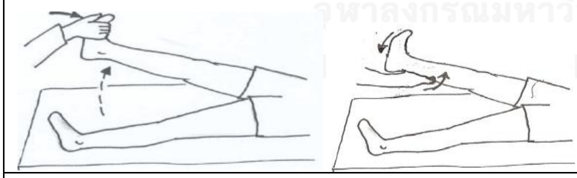
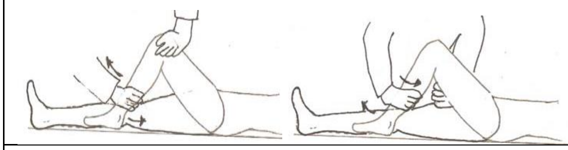
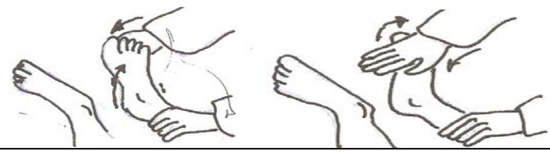


Scale	Flexion		Extension	
	Right	Left	Right	Left
Discomfort				
No discomfort				

Test of muscle strength

Guidance: The physical exam will be assessed muscles strength by nurses present step by step as follows:

Activity	Resistance	No Resistance
1. Test trapezium muscle 		
2. Test shoulders muscle(Abduction) 		
3.Test shoulders muscle(Adduction) 		
4. Test triceps muscle 		
5.Testbiceps muscle 		
6. Test brachioradialis muscle 		

Activity	Resistance	No Resistance
7. Test supinationmuscle 		
8. Test pronation muscle 		
9. Test wrist muscle 		
10. Test fingers muscle 		
11.Test hand grip of fingers 		
12. Test hips muscle 		
13. Test knees muscle 		
14. Test feet muscle 		

Appendix D – Physical Performance form

Arm curl test (dumbbell): Upper body strength

Name	Gender	Age	Baseline	After intervention	Follow up 1st	Follow up 2nd	Follow up 3th	Follow up 4th

<u>Note</u>

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Appendix D

Physical Performance form

30-Second chair stand: Lower body Strength

Name	Gender	Age	Baseline	After intervention	Follow up 1st	Follow up 2nd	Follow up 3th	Follow up 4th

<u>Note</u>

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Appendix E – Validity and Reliability

สรุปผลกาคตตรวจสอบความเที่ยงตรง)Validityของผู้ทรงคุณวุฒิ (

รายนามกรรมการผู้เชี่ขยวชาญใตการตรวจสอบความเที่ยวตรงของเครื่องมือในการศึกษาวิจัย

.1ดร พิมาน ธีระรัตนสุนทร.

อาจารย์ประจำหลักสูตรอาชีวอนามัยและความปลอดภัย สำนักวิชาสหเวชศาสตร์และสาธารณสุขศาสตร์

มหาวิทยาลัยวลัยลักษณ์

.2รศ ดีรพัฒน์ บุญจนาวิโรจน์ .ดร .

อาจารย์ประจำภาควิชาพลศึกษา คณะครุศาสตร์ มหาวิทยาลัยราชภัฏเชียงราย

.3ดร วิศรุต บุตรากาศ .

หัวหน้าสาขาวิชากายภาพบำบัด สำนักวิชาวิทยาศาสตร์สุขภาพ มหาวิทยาลัยแม่ฟ้าหลวง

ผลการตรวจสอบความเที่ยงตรง)Validityของแบบสอบถาม (ดังนี้

.1แบบประเมินอาการไม่สุขสบายของกล้ามเนื้อและกระดูก

.2แบบประเมินความตระหนักในการป้องกันอาการไม่สุขสบายของกล้ามเนื้อและกระดูกจากการทำงาน

แบบสอบถาม	ค่า IOC
ตำแหน่งที่มีอาการไม่สุขสบายของกล้ามเนื้อและกระดูก	1.00
ความตระหนักในการป้องกันอาการไม่สุขสบายของกล้ามเนื้อและกระดูกจากการทำงาน	0.81

สรุปผลการแสดงความคิดเห็นของกรรมการผู้เชี่ยวชาญ

.1สอบถามถึงตำแหน่งที่มีอาการไม่สุขสบายของกล้ามเนื้อและกระดูก

ข้อที่	ผู้เชี่ยวชาญคนที่ 1			ผู้เชี่ยวชาญคนที่ 2			ผู้เชี่ยวชาญคนที่ 3			รวม คะแนน	ค่า IOC	แปล ผล
	1-	0	+1	1-	0	+1	1-	0	+1			
1			✓			✓			✓	3	1.00	ใช้ได้
2			✓			✓			✓	3	1.00	ใช้ได้
3			✓			✓			✓	3	1.00	ใช้ได้
4			✓			✓			✓	3	1.00	ใช้ได้
5			✓			✓			✓	3	1.00	ใช้ได้
6			✓			✓			✓	3	1.00	ใช้ได้
7			✓			✓			✓	3	1.00	ใช้ได้
8			✓			✓			✓	3	1.00	ใช้ได้
9			✓			✓			✓	3	1.00	ใช้ได้

IOC $= \frac{1.00+1.00+1.00+1.00+1.00+1.00+1.00+1.00+1.00}{9}$

$= \frac{9}{9} = 1.00$ <u>แปลผล</u> ใช้ได้

.2แบบประเมินความตระหนักในการป้องกันอาการไม่สุขสบายของกล้ามเนื้อและกระดูกจากการทำงาน

1.1อุปกรณ์ที่เหมาะสมในการทำงาน

1.2ท่าทางที่เหมาะสมและปลอดภัยในการทำงาน

การยืดเหยียดกล้ามเนื้อเพื่อลดอาการไม่สุขสบายของกล้ามเนื้อและกระดูก 1.3

ข้อที่	ผู้เชี่ยวชาญคนที่ 1			ผู้เชี่ยวชาญคนที่ 2			ผู้เชี่ยวชาญคนที่ 3			รวม	ค่า IOC	แปลผล
	1-	0	+1	1-	0	+1	1-	0	+1	คะแนน		
1			✓			✓			✓	3	1.00	ใช้ได้
2			✓			✓			✓	3	1.00	ใช้ได้
3			✓			✓			✓	3	1.00	ใช้ได้
4		✓			✓				✓	1	0.33	ปรับปรุง
5			✓			✓			✓	3	1.00	ใช้ได้
6			✓			✓			✓	3	1.00	ใช้ได้
7		✓				✓		✓		1	0.33	ปรับปรุง
8		✓			✓				✓	1	0.33	ปรับปรุง
9			✓			✓			✓	3	1.00	ใช้ได้
10		✓				✓			✓	2	0.66	ใช้ได้
11			✓			✓			✓	3	1.00	ใช้ได้
12			✓			✓			✓	3	1.00	ใช้ได้
13			✓			✓		✓		2	0.66	ใช้ได้
14			✓			✓			✓	3	1.00	ใช้ได้
15			✓		✓				✓	2	0.66	ใช้ได้
16			✓			✓			✓	3	1.00	ใช้ได้
17			✓			✓		✓		2	0.66	ใช้ได้
18			✓			✓			✓	3	1.00	ใช้ได้
19			✓			✓			✓	3	1.00	ใช้ได้
20			✓		✓				✓	2	0.66	ใช้ได้

$$IOC = \frac{1.00+1.00+1.00+0.33+1.00+1.00+0.33+0.33+1.00+0.66+1.00+1.00+0.66+1.00+0.66+1.00+0.66+1.00+1.00+0.66}{20}$$

$$= \frac{16.29}{20} = 0.81$$ <u>แปลผล</u> ใช้ได้

Appendix F Booklet for participants

คู่มือ

ความปลอดภัยในการทำงานสำหรับพนักงานกวาดถนน

ผู้แต่ง

1. นางสาวกาญจนา ปินตาคำ
   วิทยาลัยวิทยาศาสตร์สาธารณสุข จุฬาลงกรณ์มหาวิทยาลัย
2. ผศ.ดร. วัฒน์สิทธิ์ ศิริวงศ์
   วิทยาลัยวิทยาศาสตร์สาธารณสุข จุฬาลงกรณ์มหาวิทยาลัย
3. นายบุญ ลีบะพรม
   เจ้าพนักงานสาธารณสุขชุมชน กองสาธารณสุขและสิ่งแวดล้อม
   เทศบาลนครเชียงราย

ที่ปรึกษา

1. ศ.นพ. สุรศักดิ์ ฐานีพานิชสกุล
   คณบดีวิทยาลัยวิทยาศาสตร์สาธารณสุข จุฬาลงกรณ์มหาวิทยาลัย
2. ผศ.ดร. เนาวรัตน์ ลาภะรัก
   วิทยาลัยวิทยาศาสตร์สาธารณสุข จุฬาลงกรณ์มหาวิทยาลัย
3. นายวันชัย จงสุขอานันท์
   นายกเทศมนตรีนครเชียงราย
4. นางสาวอรวิฏา เมืองมาเล
   ผู้อำนวยการกองสาธารณสุขและสิ่งแวดล้อม เทศบาลนครเชียงราย

คำนำ

โดยทั่วไป พนักงานกวาดถนนส่วนใหญ่มักพบปัญหาความไม่สบายของกล้ามเนื้อและกระดูก เนื่องมาจากการขาดการรับรู้ความเสี่ยงและความตระหนักต่อความปลอดภัยในการทำงาน รวมถึงการทำงานด้วยท่าทางที่ไม่เหมาะสม จนทำให้เกิดความไม่สบายของกล้ามเนื้อและกระดูก แล้วนำไปสู่ผลกระทบระยะยาวต่อสุขภาพของตนเอง

ดังนั้นจึงจำเป็นอย่างยิ่ง ที่พนักงานกวาดถนนจะต้องมีความรู้ ความเข้าใจในสาเหตุและการที่ทำให้เกิดปัญหา สามารถป้องกันและฟื้นฟูความไม่สบายของกล้ามเนื้อและกระดูกได้อย่างเหมาะสมและปลอดภัย

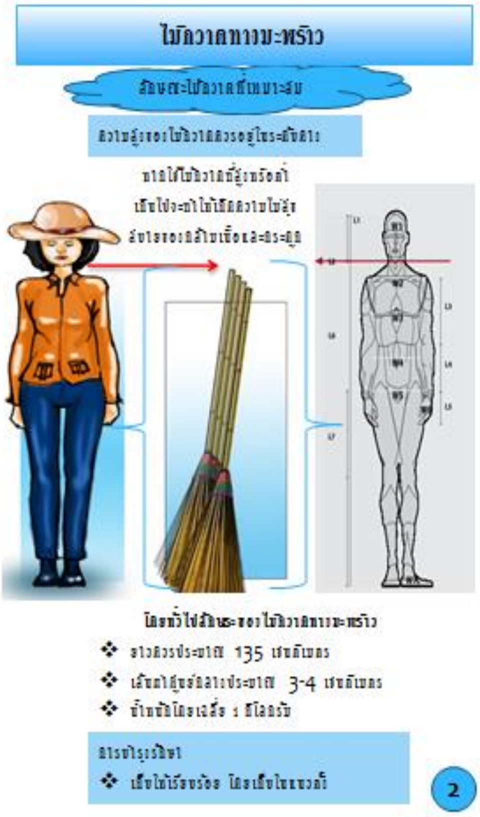
ผู้จัดทำ หวังเป็นอย่างยิ่งว่าคู่มือเล่มนี้ จะเป็นประโยชน์ในการทำงานของพนักงานกวาดถนน ที่จะทำให้เกิดความตระหนักถึงความปลอดภัยในการทำงานและความไม่สบายของกล้ามเนื้อและกระดูก เนื่องจากจะส่งผลต่อการมีสุขภาพที่ดีและเกิดประสิทธิภาพในการทำงานต่อไป

กาญจนา ปินตาคำ
วัฒน์สิทธิ์ ศิริวงศ์
บุญ ลีบะพรม

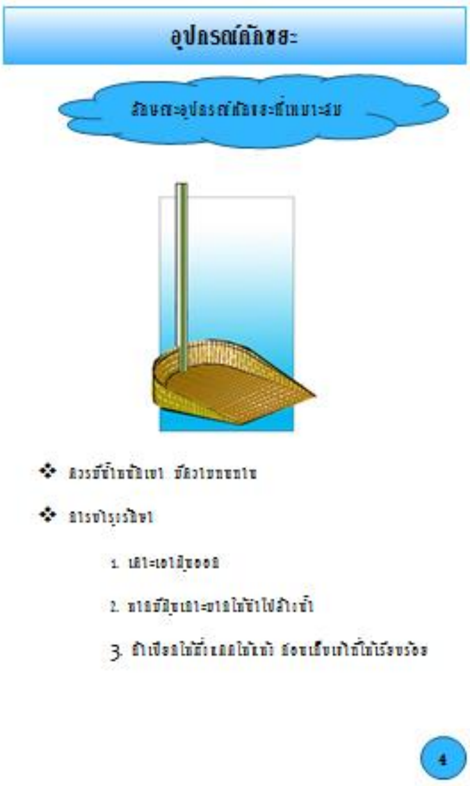
สารบัญ

อุปกรณ์ในการทำงาน

- ไม้กวาดทางมะพร้าว
- อุปกรณ์ตักขยะ


ไม้กวาดทางมะพร้าว
ลักษณะไม้กวาดที่เหมาะสม
ความสูงของไม้กวาดควรอยู่ในระดับคาง
หากใช้ไม้กวาดที่สูงหรือต่ำ
เกินไปจะทำให้เกิดความไม่สุข
สบายของกล้ามเนื้อและกระดูก
โดยทั่วไปลักษณะของไม้กวาดทางมะพร้าว
ยาวควรประมาณ 135 เซนติเมตร
เส้นผ่าศูนย์กลางประมาณ 3-4 เซนติเมตร
น้ำหนักโดยเฉลี่ย 1 กิโลกรัม
การบำรุงรักษา
เก็บให้เรียบร้อย โดยเก็บในแนวตั้ง
2


ไม้กวาดทางมะพร้าว
ประโยชน์ของการสวมปลอกด้ามไม้กวาด
ช่วยให้จับถนัดมือไม่ลื่นหลุด
ลดแรงเสียดทานของมือขณะกวาดถนน
ทำให้รู้สึกสบายมือ ลดอาการไม่สุขสบายขณะกวาด
3


อุปกรณ์ตักขยะ
ลักษณะอุปกรณ์ตักขยะที่เหมาะสม
ควรมีน้ำหนักเบา มีความทนทาน
การบำรุงรักษา
1. เคาะเอาฝุ่นออก
2. หากมีฝุ่นเกาะมากให้นำไปล้างน้ำ
3. ถ้าเปียกให้ตากแดดให้แห้ง ก่อนเก็บเข้าที่ให้เรียบร้อย
4


ท่าทางที่เหมาะสมและปลอดภัยในการทำงาน
ท่าทางการกวาดขยะ
ท่าทางการก้มตัวหยิบขยะ
ท่าทางการเดิน
ท่าทางการยืน
5

ท่าทางการกวาดที่ถูกต้องเหมาะสม

6

ท่าทางการก้มตัวที่ถูกต้องเหมาะสม

7

ท่าทางการเดินที่ถูกต้องเหมาะสม

8

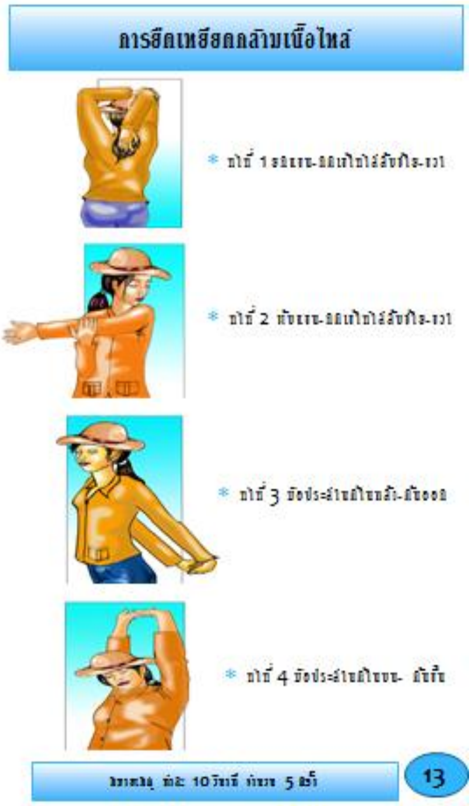
ท่าทางการยืนที่ถูกต้องเหมาะสม

9


การยืดเหยียดกล้ามเนื้อเพื่อลดความไม่สุขสบาย
กล้ามเนื้อไหล่ : จากการกวาด
มือและข้อมือ : จากการกวาด
กล้ามเนื้อขา น่องและเท้า : จากการเดินและยืน
10


ประโยชน์ของการยืดเหยียดกล้ามเนื้อ
11


หลักการยืดเหยียดกล้ามเนื้อ
ข้อควร
ระวั
12


การยืดเหยียดกล้ามเนื้อไหล่
13

การยืดเหยียดกล้ามเนื้อหลัง

* ท่าที่ 1 ก้มแตะพื้น- เกร็งค้าง

* ท่าที่ 2 มือจับหลังแอ่นหลัง-เกร็งค้าง

* ท่าที่ 3 มือประสานเหนือศีรษะแล้วเอียงตัวไปทางด้านซ้ายและขวา-เกร็งค้างสลับกัน

ใช้เวลาถือ ท่าละ 10 วินาที จำนวน 5 ครั้ง

14

การยืดเหยียดกล้ามเนื้อข้อมือและมือ

* ท่าที่ 1 กระดกข้อมือ-ออกแรง ทำสลับซ้าย-ขวา

* ท่าที่ 2 คว่ำมือ-ออกแรง ทำสลับซ้าย-ขวา

* ท่าที่ 3 มือประนมมือ- ดันเข้า

ใช้เวลาถือ ท่าละ 10 วินาที จำนวน 5 ครั้ง

15

การยืดเหยียดกล้ามเนื้อขา น่อง และเท้า

* ท่าที่ 1 เหยียดขาไปด้านหลัง – เกร็งขาหลังค้างไว้ ทำสลับซ้าย-ขวา

* ท่าที่ 2 งอขาพับไปด้านหลังแล้วจับปลายเท้าเข้าหาลำตัว-เกร็งค้าง ทำสลับซ้าย-ขวา

* ท่าที่ 3 ยืนด้วยปลายเท้า ยกส้นเท้าทั้งสองข้างขึ้น-เกร็งค้าง

ใช้เวลาถือ ท่าละ 10 วินาที จำนวน 5 ครั้ง

16

การยืดเหยียดกล้ามเนื้อที่ขา น่อง และเท้า

* ท่าที่ 5 งุ้มเท้าลง- เกร็งค้าง

* ท่าที่ 6 กระดกเท้าขึ้น-เกร็งค้าง

* ท่าที่ 7 กางนิ้วเท้าออก-เกร็งค้าง

ใช้เวลาถือ ท่าละ 10 วินาที จำนวน 5 ครั้ง

17

เอกสารอ้างอิง

[illegible]

[illegible] 2548. [illegible]

[illegible] 2551. [illegible]

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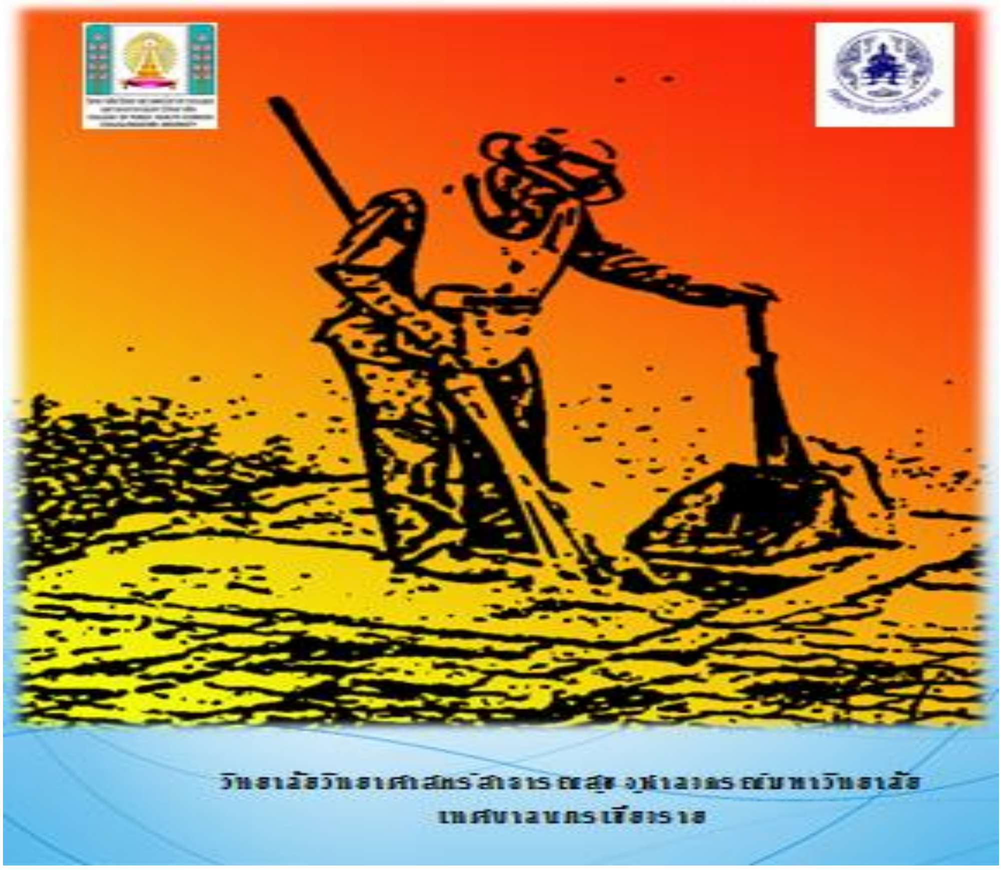

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