UNIVERSITI PUTRA MALAYSIA

PREVALENCE OF CARPAL TUNNEL SYNDROME AND ITS ASSOCIATED RISK FACTORS AMONG COUNTER WORKERS IN TELECOMMUNICATION COMPANY

NUR SABREENA ZAKARIA

PREVALENCE OF CARPAL TUNNEL SYNDROME AMONG COUNTER WORKERS IN TELECOMMUNICATION COMPANY

BY

NUR SABREENA ZAKARIA

Thesis submitted in fulfilment of the requirement for the degree of Bachelor Science (Environmental and Occupational Health) from the Faculty of Medicine And Health Sciences, University Putra Malaysia

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ABSTRACT

PREVALENCE OF CARPAL TUNNEL SYNDROME AND ITS ASSOCIATED RISK FACTORS AMONG COUNTER WORKERS IN TELECOMMUNICATION COMPANY

NUR SABREENA ZAKARIA

Introduction: Frontline counter workers in the telecommunication company are at risk for carpal tunnel syndrome (CTS) due to range of causal factors. CTS among them could lead to physiologic disability and subtle effects on personal well-being and productivity. **Objective:** The objective of the study is to determine the prevalence and its association with risk factors of CTS among counter workers in the telecommunication company. **Method:** A cross sectional study was conducted among 100 frontline counter staffs whose working at the telecommunication company in Klang Valley area. A stratified random sampling was used to select the respondents. Respondents were interviewed by using structured questionnaire and Cornell Musculoskeletal Discomfort Questionnaire (CMDQ). The structured questionnaire is used to determine demographic data, meanwhile CMDQ is to measure the discomfort of both right and left hands. A Rapid Office Strain Assessment (ROSA) is designed instrument to quantify exposure to office work environment. ROSA is a picture based posture checklist to obtain the risk level of workstation. **Results:** By using SPSS Windows version 22, results showed that the prevalence of CTS among counter workers of the telecommunication company was 63%. Chi Square test indicated that there was no association between socio demographic factors for age, gender, BMI, and race except marital status and education level with $p>0.05$. On the right hand, nearly 53% of the respondents had discomfort on the index and middle finger ($\chi^2=8.45$, $p=0.07$), 31% on the ring finger and pinkie ($\chi^2=6.97$, $p=0.13$), 42% on the distal thumb ($\chi^2=1.93$, $p=0.75$), 38% on the hand and metacarpal area ($\chi^2=7.36$, $p=0.12$), 53% on the thumb base ($\chi^2=3.95$, $p=0.41$), and 40% reported discomfort on the heel of hand ($\chi^2=4.50$, $p=0.34$). There was no significant association between office work design and CTS. **Conclusion:** This study found that the counter workers in telecommunication company reported high case of CTS. Appropriate steps should be taken to reduce the reported symptoms as well as avoid coming case.

Key words: ***Cornell Musculoskeletal Discomfort Questionnaire (CMDQ), Rapid Office Strain Assessment (ROSA), Carpal Tunnel Syndrome (CTS), counter workers***

ABSTRAK

PREVALENS SINDROM TEROWONG KARPUS DAN PERHUBUNGAN ANTARA FAKTOR RISIKO DI KALANGAN PEKERJA KAUNTER DI SYARIKAT TELEKOMUNIKASI

NUR SABREENA ZAKARIA

Pengenalan: Pekerja kaunter dalam syarikat telekomunikasi ini mempunyai risiko untuk sindrom carpal tunnel (CTS) disebabkan pelbagai faktor sebab dan akibat. CTS boleh membawa kepada kecacatan fisiologi dan kesan pada kesejahteraan diri dan produktiviti. **Objektif:** Objektif kajian ini adalah untuk menentukan prevalens dan kaitannya dengan faktor-faktor risiko CTS di kalangan pekerja kaunter dalam syarikat telekomunikasi. **Kaedah:** Satu kajian keratin rentas telah dijalankan di kalangan 100 kakitangan kaunter barisan hadapan yang bekerja di syarikat telekomunikasi di kawasan Lembah Klang. Satu persampelan rawak berstrata telah digunakan untuk memilih responden. Responden telah ditemubual dengan menggunakan borang soal selidik berstruktur dan *Cornell Musculoskeletal Discomfort Questionnaire* (CMDQ). Soal selidik berstruktur digunakan untuk menentukan data demografi, sementara itu CMDQ adalah untuk mengukur ketidakselesaan kedua-dua tangan kanan dan kiri. *Rapid Office Strain Assessment* (ROSA) direka sebagai instrumen untuk mengukur pendedahan kepada persekitaran kerja pejabat. ROSA ialah berdasarkan postur senarai semak gambar untuk mendapatkan tahap risiko stesen kerja. **Keputusan:** Dengan menggunakan SPSS Windows versi 22, keputusan menunjukkan bahawa kelaziman CTS di kalangan pekerja kaunter syarikat telekomunikasi itu adalah 63%. Ujian *Chi Square* menunjukkan bahawa tidak ada kaitan antara faktor sosiodemografi umur, jantina, BMI, dan bangsa kecuali status perkahwinan dan tahap pendidikan dengan $p > 0.05$. Di sebelah kanan tangan, hampir 53% daripada responden mempunyai ketidakselesaan pada indeks dan pertengahan jari ($\chi^2 = 8.45$, $p = 0.07$), 31% di jari manis dan jari kelingking ($\chi^2 = 6.97$, $p = 0.13$), 42% di ibu jari distal ($\chi^2 = 1.93$, $p = 0.75$), 38% pada tangan dan kawasan *metacarpal* ($\chi^2 = 7.36$, $p = 0.12$), 53% pada asas ibu jari ($\chi^2 = 3.95$, $p = 0.41$), dan 40% melaporkan rasa tidak selesa pada tumit tangan ($\chi^2 = 4.50$, $p = 0.34$). Tidak ada hubungan yang signifikan antara reka bentuk kerja pejabat dan CTS. **Kesimpulan:** Kajian ini mendapati bahawa pekerja kaunter dalam syarikat telekomunikasi melaporkan kes CTS yang tinggi. Langkah-langkah yang sewajarnya perlu diambil untuk mengurangkan simptom yang dilaporkan serta mengelakkan kes akan datang.

Kata kunci: ***Musculoskeletal Discomfort Questionnaire (CMDQ), Rapid Office Strain Assessment (ROSA), sindrom terowong karpus, pekerja kaunter***

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURE

LIST OF ABBREVIATIONS

>	More than
<	Less than
%	Percent
±	More or less than
e.g	Example
BMI	Body Mass Index
CTD	Cumulative Trauma Disorder
CTS	Carpal Tunnel Syndrome
CMDQ	Cornell Musculoskeletal Discomfort Questionnaire
DOSH	Department of Safety and Health
MSD	Musculoskeletal Disorders
NIOSH	National Institute for Occupational Safety and Health
ROSA	Rapid Office Strain Injury
RSI	Repetitive Strain Injury
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

1.1 Background

Cumulative Trauma Disorder (CTD) has caused both personal and socio-economic impact worldwide. In various parts of the globe, CTD could also be referred to as Work Related Upper Limb Disorder, Occupational Overuse Syndrome, or Repetitive Strain Injury (Arksey, 1998). Carpal Tunnel Syndrome (CTS) is one of the common work-related upper limb musculoskeletal disorders (WRULDs). The main cause of the CTS is due to the compression of the median nerve by the carpal flexor retinaculum that forms the palmar aspects of the carpal tunnel when too much pressure is stressed out on the nerve that runs through the wrist. A painful sensation and numbness of the fingers are the results of the nerve compression (Steven *et al.* 1999).

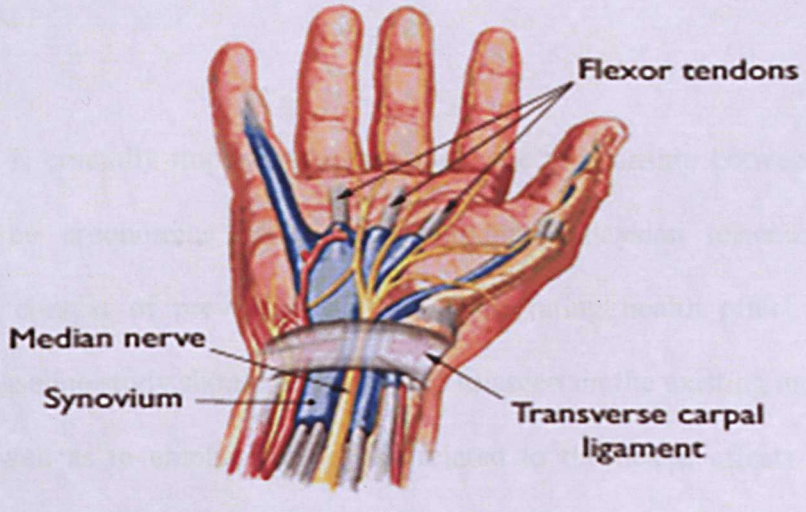

Figure 1.1: The anatomy of the median nerve. (Source: orthoinfo.aaos.org)

The symptoms of CTS usually may progress gradually over weeks and months and in some other cases, years. The symptoms that probably develop include pain in the wrist and hand, commonly both hands. Other reported symptoms are the sensations such as numbness, tingling, burning or combination on the palm side of the index, middle and ring fingers. Symptoms may occur not only when the hand is being used, but also during night rest.

The use of computers become the main highlight in many previous studies associating the relationship of different type o jobs and the risk factors influencing the occurrence of MSD (Hagbers and Wegman, 1987). While computer usage is associated with injuries to many part of our body, including the back, neck, eyes and shoulder, the scope of this study is limited to those injuries that computer users typically suffer to the wrist and hand. Tendon injuries and nerve injuries are the common computer-related injuries to the hand and wrist. The most common input devices used in modern computers are the keyboard and mouse. Computer operators are workers involved in the use of a computer for activities such as data entry. The most consistently observed risk factors are increasing hours of mouse and keyboard use and sustained awkward postures such as increasing wrist extension and keyboard elbow height.

Thus, it is crucially important to determine the relationship between computer users and the ergonomics health effect among Malaysian telecommunication workers. In context of preventing further deteriorating health effect among the subjects, a baseline study should be conducted to ascertain the existing incidence rate of CTS as well as to emphasize the risk related to the health effects in order to

formulate a suitable control measures in averting the problem. Therefore, the objective of this study was to determine the prevalence and its association with risk factors of CTS among counter workers in the telecommunication company.

1.2 Problem Statement

In Malaysia, the use of computer or visual display unit (VDU) has become the essential element in every single field of work or tasks. The usage of computers become a main focus in many previous studies associating the relationship of different jobs and the factors influencing the occurrence of MSD (Hagbers and Wegman, 1987). Telecommunication industry is growing efficiently in performance with the help of technology in term of computer. Those frontline counter workers are those working in the sector of customer service, hence requiring them to facilitate the incoming and outgoing customers and calls. In addition, most of the tasks perform by these counter workers are mainly done through the usage of computer database.

There have multiple risk factors that may contribute to CTS. However, there was limited information regarding the causes of MSD among frontline counter workers in telecommunication company. Hence, there is a need to identify the CTS risk factors and effective prevention strategies could be implemented to address the musculoskeletal problems in this study population. Therefore, this study was conducted to identify the prevalence of CTS and the associated risk factors among them.

In this era, the most common input devices used are mouse and keyboard. They are the primary input device for data entry task used by all computer operators. Carpal tunnel syndrome (CTS) is a disorder marked by weakness and pain in the hand and wrist that can be incapacitating that occurs in the nerves of the hands. Virtually, all workers who use their hands and wrists repetitively are at risk for CTS, particularly if they work in cold temperatures and have factors or medical conditions that make them susceptible. The usage of computers also became a main focus in many studies associating the relationship of different jobs and the factors influencing the occurrence of MSD (Hagbers and Wegman, 1987). Based on the occupational injuries or illnesses and fatal injuries profile, the incidence rates involving days away from work by service-type of occupation in telecommunication indicated 171 cases in 2014 (US Bureau of Labor Statistics, 2014). Meanwhile the incidence rates of MSD in the very same year was 33.8 cases in addition to the most affected part of body noted as the upper extremities with 32.0 incidence rate.

Bent-wrist typing can lead to CTS due to the compression of the median nerve at the carpal tunnel (Petterson and Patten, 1995). It has been estimated that 57% of all the costs associated with occupational upper extremity disorders were due to CTS (Feuerstein *et al.*, 1998). Major medical risk factors associated with CTS include diabetes, thyroid disease, hormone-related diseases, rheumatoid disease and obesity (Geoghegan et al., 2004). There is also evidence implicating age, gender and smoking (Boz et al., 2004).

Computer operator is a worker that uses computer for activities such as billing, scheduling, and key-in data. The highest incidence of CTS among active workers aged 25 to 45 years old with similar risk for men and women (Franklin, 1991). A 3-fold increase in the prevalence of CTS among jobs with high hand repetition compared to low hand repetition jobs (Latko *et al.*, 1999). CTS caused loss of productivity and performance because the workers who affected are forced to stop and wait until the pain is mitigated.

Thus, it is crucially important to determine the relationship between computer users and the ergonomics health effect among Malaysian telecommunication workers. In context of preventing further deteriorating health effect among the subjects, a baseline study should be conducted to ascertain the existing incidence rate of CTS as well as to emphasize the risk related to the health effects in order to formulate a suitable control measures in averting the problem. Therefore, the objective of this study was to determine the prevalence and its association with risk factors of CTS among counter workers in the telecommunication company.

Frontline counter workers are engaged with the service schemes involving almost hundred customers per day. In the job scope of customer service, the use of computer or visual display units (VDU) are required in most of the work process. The usage of these VDU can give an adverse health effect to the wrist and arms. Prolong exposure to the computer usage can lead to development of Carpal Tunnel Syndrome (CTS) and health effect such as musculoskeletal disorders in the upper limb. The requirement of VDU use may provide advantages such as efficiency and

productivity, however this poses a higher risk for workers to be affected by development or reported of carpal tunnel syndrome (CTS).

Health effect due to the usage of computer or any VDUs ought to be avoided since the main purpose of using them is to assist the workers doing their task easier and convenience for the customers. However the effect of CTS will cause the employees having high risk of non-fatal occupational injuries due to loss of hand and wrist sensation or strength. For example, slower keying data process could happen if the workers lose the sensation at fingertips or hands hence causing the pain or discomfort in which consequently can disturb the work task and this problem will probably interfere the workers' quality of life as well.

1.3 Research Justification

This study is aimed to evaluate the risk factors contributing to CTS more significantly hence early control measures can be done where appropriate. Healthy workers are the most valuable assets to the company. Widespread uses of computers and modern technology have caused a sharp increase in CTS and other repetitive strain injuries. Computer operators, assembly-line workers, and hair stylists are at risk because they repeat the same hand movements over and over again (Richard J. Bowen, 2007).

Based on the occupational injuries or illnesses and fatal injuries profile, the incidence rates involving days away from work by service-type of occupation in telecommunication indicated 171 cases in 2014 (US Bureau of Labor Statistics, 2014). Meanwhile the incidence rates of MSD in the very same year was 33.8 cases in addition to the most affected part of body noted as the upper extremities with 32.0 incidence rate.

A large 2007 study of more than 1000 patients found that the severity of CTS was mild in 42% of patients, moderate in 18%, and severe in 40%. Patients were an average of about 48 years old (Porrata H., 2007). One small 2006 study reported that nerve conduction tests on frequent computer users showed the same rate of CTS (3.5%) as in the general population. Apart from that, the incidence of carpal tunnel syndrome in the meat, poultry, and fish packing industries may be as high as 15% (Tsai CP., 2006). A 2007study of automobile assembly workers found that the estimated annual rate of CTS ranged from 1-10% (Burke J., 2007).

1.4 Conceptual Framework

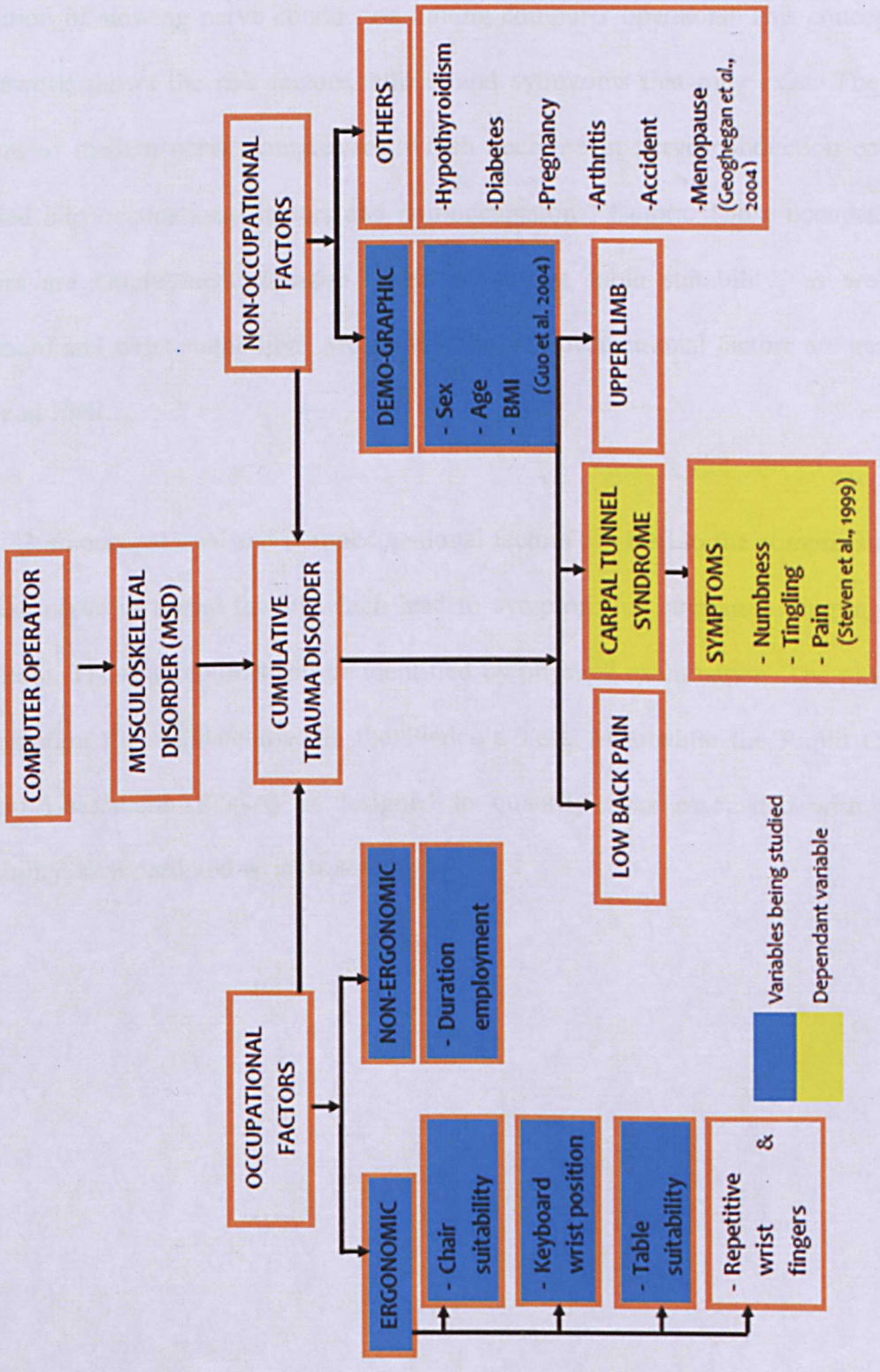

Figure 1.2: Research Conceptual Framework.

This study aimed to evaluate the effects of computer usage on CTS among computer operators in telecommunication company. It also identified the risk factors that contributed to the compression of the median nerve at the wrist which lead to a condition of slowing nerve conduction among computer operators. This conceptual framework shows the risk factors, effects and symptoms that may exist. The risk factors of median nerve compression which decrease in nerve conduction can be divided into occupational factors and non-occupational factors. Those occupational factors are employment duration, chair suitability, table suitability, as well as keyboard and wrist suitability. Meanwhile the non-occupational factors are gender, age, and BMI.

Both occupational and non-occupational factors can lead to the compression of median nerve in carpal tunnel which lead to symptoms of numbness, tingling and also pain. Those symptoms can be identified by physical examination. The physical examination that will be used is the Phalen's Test. Meanwhile the Rapid Office Strain Assessment (ROSA) is designed to quantify risks associated with chair suitability, keyboard and wrist suitability.

1.5 Objectives

1.5.1 General Objective

To determine the prevalence and its association with risk factors of carpal tunnel syndrome among frontline counter workers in a telecommunication company.

1.5.2 Specific Objectives

i. To determine the socio-demographic characteristics among the respondents.
ii. To determine the prevalence of CTS among counter workers.
iii. To determine the relationship between CTS and demographic risk factors among counter workers.
iv. To determine the association between CTS and Rapid Office Strain Assessment (ROSA) among counter workers.
v. To determine the association between CTS and hand musculoskeletal discomfort among counter workers.

1.6 Definition of Variables

1.6.1 Conceptual Definition

i. Median nerve:

A nerve that runs down the arm and forearm.

ii. Carpal Tunnel Syndrome (CTS):

Compression of median nerve which causes painful burning sensation or numbness of thumb, index fingers, middle fingers and half of ring fingers.

iii. Repetitive motion:

Doing the same thing so often without stop for long period of time.

iv. Computer operator:

A worker involved in the use of a computer for activities such as billing, scheduling and key-in data.

v. Duration of employment:

Duration of employment or number of year for each respondent for working as computer operator.

vi. Body Mass Index (BMI):

A relationship between weight and height that is associated with body fat and health risk.

1.6.2 Operational Definition

i. Median nerve:

A major nerve of the upper extremity. Bent-wrist typing can lead to CTS due to the compression of the median nerve at the carpal tunnel (Petterson and Patten, 1995).

ii. Carpal Tunnel Syndrome (CTS):

The prevalence of CTS among computer users is 0.7% to 9.2% in women and 0.4 to 2.1% in men (Andersen, 2003). The prevalence of CTS is determined by questionnaire and physical examination namely Phalen test.

iii. Repetitive motion:

A high rate repetition using hand for typing or keying in data.

iv. Computer operator:

Counter workers in the telecommunication company who use computer to process data and to do work task as customer service.

v. Duration of employment:

Data on duration of employment for each respondent are collected using questionnaire.

vi. Body Mass Index (BMI):

BMI is determined by measuring weight and height of respondents using weighing scale and body meter.

CHAPTER 2

LITERATURE REVIEW

2.1 Anatomy of Median Nerve and Carpal Tunnel

Carpal tunnel syndrome (CTS) is a prime example of a computer-related Repetitive Strain Injury. CTS occurs when median nerve which runs from the forearm into the hand, pressed, squeezed or repeatedly stressed over time. CTS is a painful and debilitating condition. CTS involves the median nerve and flexor tendon that extend from the forearm into the hand through a tunnel which made up of the wrist bones, or carpals and the transverse carpal ligament. The median, ulnar and radial nerves travel from the spinal cord to innervate the hands and are located in tunnels that may narrow for a variety of reasons (Simmons & Bosch, 2006).

Tendon injuries and nerve injuries are the common computer-related injuries to the hand and wrist. The function of nerve and tendon is to move but certain movement patterns are dangerous. Wrist is the multidimensional joint connecting the hand with the forearm. There are two movements involved at the wrist, the flexion and extension. The motion of the wrist if the palm is rotated downward is called flexion. Extension happen when the back of the hand is rotated upward and towards the elbow. Conditions in many parts of the body can cause symptoms in the hands and fingers.

The wrist contains internal openings that allow various structures such as blood vessels, nerves and tendons, to access the hand which the affects of wrist motion are important. The carpal tunnel is a passageway that forms beneath the strong, broad transverse ligament. The ligament is actually a bridge that extends across the lower palm. Then it connects the bones of the wrist which we called it carpals, and from an arch below the tunnel. The median nerve and flexor tendons are passing under that ligament bridge, through the carpal tunnel and they extend from the forearm and up into the hand.

There are some muscles in the palm and in the base of the thumb but in the forearms, where the specific muscles that move the fingers are located. Fingers movements are initiated by the muscles contraction in the forearm and the tendons. There is a wrap called synovial sheath which protects the tendon when it changes direction or move around bones. A lubricant called synovial fluid is produced by the sheath that allows the tendons to move freely (Pascarelli & Quilter, 1994). The flexor tendons rub against the sides of the tunnel when the fingers and hands are moved. This rubbing can cause irritation of the tendons and causing them to swell. They apply pressure to the median nerve when the tendons swell. Tingling, numbness and debilitating pain are the results of that movement.

2.2 Symptoms of Carpal Tunnel Syndrome

The symptoms occur because a major that is median nerve is compressed as it passes through a narrow tunnel of bone and ligament at the wrist. Numbness, tingling, "pins & needles", burning and pain in the middle and index fingers and thumb, and sometimes all five fingers are the results of nerve compression. Clinically, CTS can be confirmed by performing a nerve conduction test (Duff, 1997). Health care providers diagnose CTS based on symptoms description and the results of physical examination, laboratory test, x-rays and nerve conduction tests (Simmons & Bosch, 2006).

The source of nerve compression is the flexion and extension of the wrist because these activities impinge on the carpel tunnel. CTS typically start gradually with a vague aching in the wrist that can extend to hand and forearm. Tingling and numbness may occur in the hand and fingers especially thumb index, middle or ring fingers. Such sensations are radiated to the forearm or shoulder. This sensation occurs while doing a work such as using computer. As CTS worsens, tingling also occurs during the day and may cause pain radiating into the arms, impacting the ability to hold a cup or pen (Simmons & Bosch, 2006).

Forceful and repetitive motion can cause pain radiating or extending from the wrist up to the arm, to shoulder and down into the palm and fingers. These usually occur on the palm side of the forearm. A sense of weakness in the hand and tendency to drop object is happen when the handgrip and finger strength are decreased. A

constant loss of feeling in some fingers occurs when the condition is advanced. Patients may lose ability to feel heat and cold. Patients may feel that their hands are swollen even though there is no visible swelling. This symptom is an indicator of greater severity.

CTS can range from a minor inconvenience to a disabling condition. It depends on its cause and persistence and the individual characteristics of the patient. Many cases of CTS are mild and the symptoms are short duration. To reduce swelling, proper treatment of other medical conditions that cause CTS can often help. In severe untreated cases, the muscles at the base of the thumb may whither and loss of sensation may be permanent. CTS can become crippling which that people can no longer do their jobs or even perform simple tasks.

2.3 Prevalence and Incidence of Carpal Tunnel Syndrome

Carpal tunnel syndrome is painful condition affecting soft tissues of the hand and arm. The prevalence of work related upper extremity musculoskeletal disorders reported has increased dramatically during the past two decades. The incidence of work-related musculoskeletal disorders which include CTS in the USA has remained static since peaking in 1992. It has not steadily declined like other work-related injuries and illnesses since peaking in 1992 (Bureau of Labor Statistics, 2000). A study in 2001 reported that nerve conduction tests on frequent computer users showed same rate of CTS (3.5%) as in general population. Computer operator is among the highest workers of CTS-related events as published by the Bureau of Labor Statistics in 2002.

According to a 2005 report from the Bureau of Labor Statistics, among the major disabling diseases and illnesses, carpal tunnel syndrome was associated with the longest average time away from wok (28 days). CTS happen most common on among women between the ages thirty and sixty. CTS is major cause of missed workdays because of the pain it causes about $250 million was spent for sick days taken as a result of CTS-related problems in 1995. Heredity, tunnel size, metabolic diseases such as autoimmune disease, previous bone fracture or dislocation, hormones, obesity and occupation may contribute to CTS (Simmons & Bosch, 2006).

2.4 Carpal Tunnel Syndrome and Computer

Industrial exposure has been implicated in CTS, which computer users, production workers, nursing personnel and housewives being particularly liable to the condition (Nathan *et al.*, 2002; Yagev *et al.*, 2001). Computer operator role is to oversee the running computer systems, ensuring that the machines are running a physically secured. Mouse and keyboard are the most common input devices used in modern computer. Use of the mouse was associated with symptoms in the cross-sectional comparisons and follow up analyses (Andersen JH *et al.*, 2003).

One of the most common causes of CTS is repetitive motion. Repetitive motion is any activity that a person performs over and over again. Typing, working at a computer keyboard may involve repetitive motion. Repetitive motion forces a person to use the wrist over and over again and can lead to swelling in the carpal tunnel area, subsequent pressure on the median nerve, and thus to CTS. Awareness of CTS as a disorder associated with repeated trauma at work is now so widespread amongst workers that many have diagnosed themselves before being medically assessed, often by means of the internet (Sonja *et al.*, 2002).

Extremely repetitive movements performed over long periods, such as typing or using a computer's mouse may aggravate the tenosynovium of the flexor tendons. It puts pressure on the median nerve as the tenosynovium swells, causing discomfort and eventually damage. Because computer operators generally spent a lot of time in front of computer monitor and performing other repetitive tasks, they may be susceptible to hand and wrist problems. CTS can be prevented by posture modification or use of specific hardware (Gerr F *et al.*, 1996).

CTS is reported to occur among computer users with a prevalence of 0.7 to 9.2% in women and 0.4 to 2.1% in men (Andersen, 2003). Tingling and numbness occur was associated with mouse use. Occupations with particular risk for CTS include those involving forceful and repetitive tasks, prolonged wrist flexion and extension. Keyboards have leg that raises the back to a higher angle which causes the wrist to force into constant extension. Many keyboards' function keys and a numeric keypad have bad features or bad key layout. Jobs involving rapid repeated use of the hands or fingers, few breaks or changes of tasks, static posture, awkward positioning of forceful movements can possibly lead to CTS (Simmons & Bosch, 2006). The most common test used to confirm the diagnosis of carpal tunnel syndrome is Phalen's test. The sensitivity and specificity for Phalen's test are 68% and 73% (MacDermid *et al.*, 2004).

CHAPTER 3

METHODOLOGY

3.1 Study Design

The study design is a cross-sectional study which is used to show the prevalence of carpal tunnel syndrome among counter workers in telecommunication company.

3.2 Study Area

The study area is in Klang Valley covering a number of telecommunication centres of customer service.

3.3 Sampling

3.3.1 Study Population

The study population consists of all telecommunication company's staffs who work as frontline counter workers.

3.3.2 Study Frame

Staffs name list obtained from the administration of the company.

3.3.3 Sampling Unit

The respondents will be chosen based on inclusion criteria as below:

1. Malaysian citizen
2. Computer operator
3. Never have an experience of wrist fracture or dislocation
4. Non diabetic
5. Non rheumatoid arthritic
6. Non pregnant
7. Non menopause
8. Non hypothyroidism

3.3.4 Sample Size

Sample size is calculated by using Kirkwood Formula (1988).

$N = p (1-p) / e^2$

Which,

N = sample size

P = CTS prevalence = 18% (Shamsul et al., 2009)

e = standard error = 5%

Sample size needed is:

$N = 0.18 (1 - 0.18) / 0.05^2$

$= 59.04$

= 60 respondents

So, 20% of 60 respondents:

= 72 respondents

3.4 Instrumentation for Data Collection

3.4.1 Structured Questionnaire

The respondents in this study were given a set of questionnaire to answer. Data and information was collected through the interview of each respondent. The questionnaire comprised of three sections: section A is section A: socio-demographic information, Section B: work practices, and Section C: working background.

a) Section A

-Personal information such as age, gender, BMI, race, marital status, and educational level.

b) Section B

-Work practices pertaining the type of computer used for work, dominant hand, the typing hand, hand exercise, and the usage of smart phone/ tablet.

c) Section C

-The previous employment information such as the duration of previous employment, the involvement of computer usage during previous job, and the current part time job, if any.

3.4.2 Weighing Scale

The electronic weighing scale which was used is Tanita® Weight Digital System. The weight of every respondent was taken twice to obtain an average value. The weight is taken to obtain their body mass index (BMI) for each respondent.

3.4.3 Body Meter SECA

Body meter model Seca® 208 was used to measure the height of each respondent. The reading was taken twice to obtain an average value and the data were used to obtain their BMI. Both the weight and height data were used to calculate the BMI of the respondents shown in this formula:

$$\text{BMI} = \text{Weight (kg)} / \text{Height (m)} \times \text{Height (m)}$$

Classification	BMI (kg/m²)
Underweight	<18.50
Normal	18.50 – 24.99
Overweight	≥25.00
Obese	≥30.00

Table 3.1: BMI Categories. *(Source: Adapted from WHO 2004)*

3.4.4 Phalen's Test

The screening of CTS's diagnosis was based on Phalen's test (Phalen, 1972). Respondents were requested to set a pressure on the wrist by pushing the surface of hand's dorsal using both hands for 60 seconds. Afterward, the respondents would inform if any clinical symptoms felt such as numbness, pain or tingling on any part of the hand and wrist. These inputs were used to determine the prevalence of CTS. Phalen's test is done to test paraesthesias or numbness at the median nerve (Christensen *et al.,* 1998). The sensitivity and specificity of Phalen's test are 75% and 71% respectively (Szabo et al., 1999).

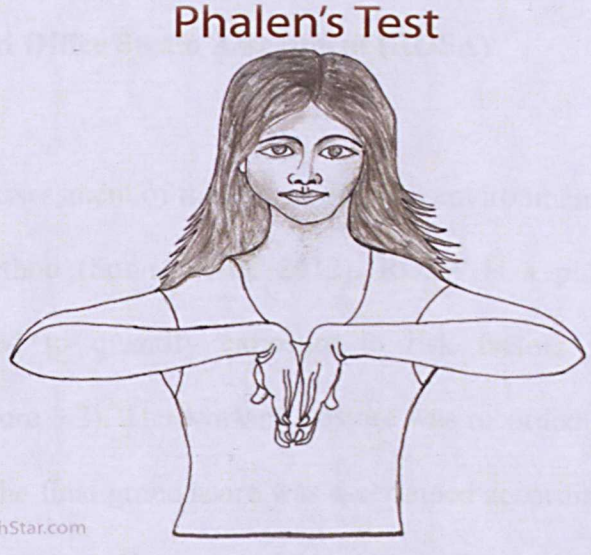

Figure 3.1: The picture-based demonstration of Phalen's test.

3.4.5 Cornell Musculoskeletal Discomfort Questionnaire (CMDQ)

In order to determine the prevalence of MSD, Cornell musculoskeletal discomfort questionnaire (Hedge, A., 1994) was used. For both right and left hand, the respondents were asked on the frequency, intensity and work disturbance of hand discomfort. There were six areas of hand involved in this questionnaire which are the index and middle finger, ring finger and pinkie, distal thumb, hand and metacarpal area, thumb base, and the heel of hand. The scores outcomes from the questionnaire were analyzed by simply counting the number of symptoms per person.

3.4.6 Rapid Office Strain Assessment (ROSA)

The assessment of the design of work environment was carried out by using ROSA method (Sonne et al. 2012). ROSA is a picture based posture checklist designed to quantify exposure to risk factors in an office work environment (Figure 3.2). The working posture was recorded using video camera for 15 minutes. The final grand score was ascertained according to the calculation of each section; chair, telephone and monitor, and keyboard and mouse. The ROSA final score was broken into two areas: further assessment not immediately required, and further assessment required as soon as possible.

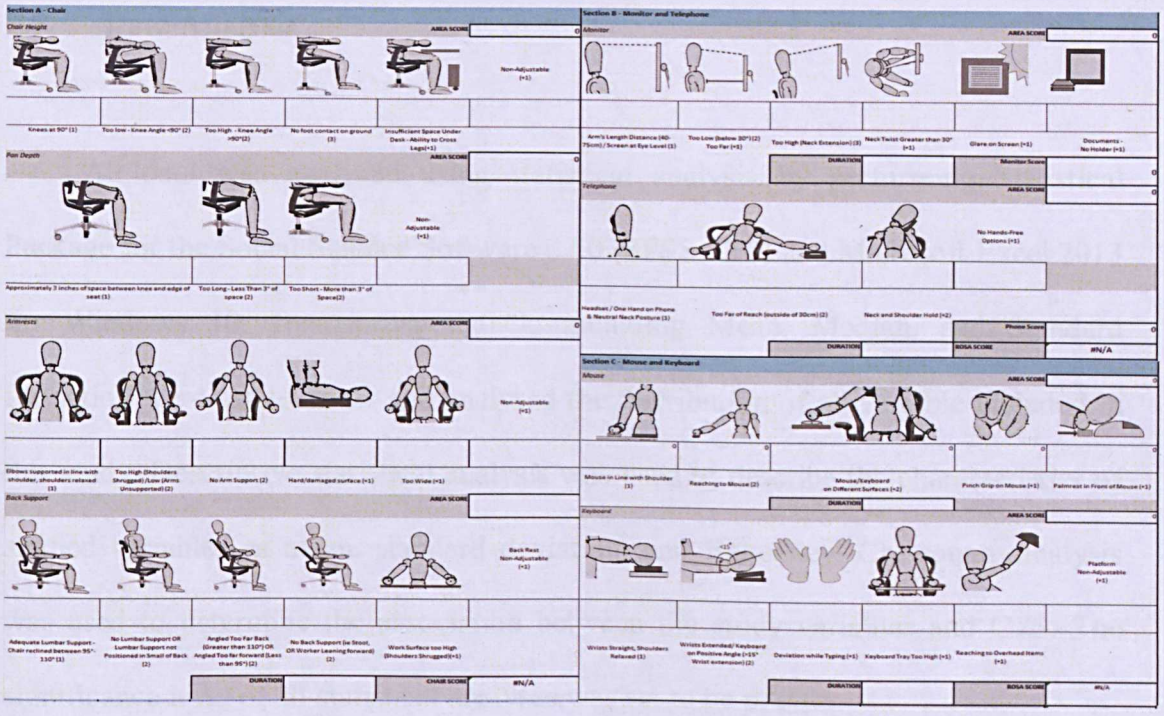

Figure 3.2: The posture checklist of ROSA assessment.

3.5 Data Analysis

All data was analysed using statistical analysis by performing Statistical Package for the Social Science Software 22.0 (SPSS 22.0) and Microsoft Excel 2013 for Windows 10. Descriptive statistic including Mean, Median, and Standard Deviation were ran to know and analysed the distribution of all variable included in this study. Descriptive statistical analysis was used to describe the characteristics of studied variables as mean, standard deviation, and frequency. Chi square analysis was used to determine the association between the study variables and CTS. The significance level of all statistical analyses was set to be $p<0.05$.

3.6 Ethical Issues

The study was carried out with approval from the Ethics Committee of University Putra Malaysia (UPM). Reference item of ethical approval was [FPSK(EXP15-OSH)U015]. The permission to conduct the research at the telecommunication company was approved by the management committee of the company. Respondents were informed about the purpose of the study. Respondents were given a subject information sheet and consent form to get their volunteered participation in this study. All information obtained was ensured to be private and confidential at all phase of the study.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Response rate

A total of 100 counter workers were selected and all of them have successfully completed the questionnaires that bring the response rate of 100%.

4.2 Socio Demographic Characteristics

There were a total of 100 respondents participated in this research. The socio-demographic characteristics of the respondents in the main questionnaire survey are tabulated in Table 4.1. Most of the respondents were in the category of more than 31 years old (50%) and the mean of age were 31.8±6.64 years old. Majority of the respondents were female (76%) and majority of them are Malay (97%) while a few of them are Indian (3%). Nearly 45% of the respondents are overweight and 22% are obese. However, there are 8% of respondents who are underweight apart from 25% who have normal BMI. A large number of respondents were married (73%) and 25% are single and the rest are divorcee (2%). On the educational level, majority of the respondents are STPM/Diploma (53%) holder, 27% respondents at SPM level and 20% are at degree level.

Table 4.1: Frequency distribution of demographic characteristics of respondents

Variables		N=100		Mean(± SD)
		Frequency	Percent(%)	
Age	< 28	36	36.0	
	28 – 31	14	14.0	31.81±6.642
	> 31	50	50.0	
BMI	Underweight	8	8.0	
	Normal	25	25.0	
	Overweight	45	45.0	
	Obese	22	22.0	
Gender	Female	76	76.0	
	Male	24	24.0	
Race	Malay	97	97.0	
	Chinese	0	0	
	India	3	3.0	
	Others	0	0	
Marital Status	Single	25	25.0	
	Married	73	73.0	
	Divorce	2	2.0	
Education Level	SRP/PMR and below	0	0	
	SPM	27	27.0	
	STPM/Diploma	53	53.0	
	Degree and above	20	20.0	
Type of computer used	Desktop	83	83.0	
	Laptop	7	7.0	
	Both	10	10.0	
Dominant hand	Right	84	84.0	
	Left	16	16.0	
Typing hand	Right	34	34.0	
	Left	4	4.0	
	Both hands	62	62.0	

4.3 Work History

Most of the respondents have been employed (69%) previously before working at the current telecommunication company; meanwhile 31% had no previous employment before working at the current company. There were 55 respondents who had previous employment involving the use of computer (55%). However, there were 45% among respondents did not have involvement of computer usage during their previous employment. About 11% of respondents have current part time job apart from working at the telecommunication company while majority (89%) of them do not have any part time job currently.

Table 4.2: Frequency distribution of work history among respondents.

Variables		N=100	
		Frequency	Percent(%)
Previous employment	Yes	69	69.0
	No	31	31.0
Previous employment involving computer use	Yes	55	55.0
	No	45	45.0
Current part time job	Yes	11	11.0
	No	89	89.0

4.4 Prevalence of carpal tunnel syndrome (CTS)

The study reveals that for the prevalence of CTS, a total of 63% of the respondents reported the symptoms as based on the result of Phalen's test. The CTS symptoms were pain and numbness on their wrist, thumb, index fingers and middle fingers. Table 4.3 showed that among the three symptoms reported on CTS, pain (41%) was the highest complaint of symptoms among the respondents, followed by numbness (35%) and tingling (26%). Detailed prevalence of CTS symptoms is shown in Table 4.3. The prevalence was slightly higher than other study because this study used questionnaire and physical examination to determine the prevalence and the respondents might had given the wrong data or information. Factor that might contribute to the high prevalence of this study was the over-estimation of the respondents pertaining the experienced symptom/s. Therefore, the accuracy of the reported data relied on the honesty and perception of respondents in answering and identifying the CTS symptoms without the diagnosis of any physician. A study done by Spielholz *et al.* (2001) founded that the subjects often are inaccurate when reporting specific workplace practices.

Study was done among 1250 government servants gave the prevalence of CTS of 18% (Ta, Na, Ba, Aa, & Ga, 2009). Another study is conducted among 9480 members of a trade union of the Danish Association of Professional Technicians showed the self-reported prevalence of 10.9% reporting tingling/numbness in the right hand at the baseline (Andersen *et al.,* 2003). The prevalence of CTS obtained from this study was relatively higher compared to other studies and it could be due to

several other factors linked to working condition among counter works such as long working hour more than 8 hours per day, relatively high working exposure with computer usage and the intermittency of shift break.

The only physical examination done in this study was the Phalen's test. The physical exam helps to confirm that symptoms are related to a nerve problem, and then localize the nerve problem to the wrist. As according to Rempel *et al.* (1999), the respondents in which had experienced numbness and tingling symptoms on their thumb, index finger and middle finger during Phalen's sign test for 60 seconds will be categorized as experienced CTS symptoms.

Table 4.3: Percentage of CTS among respondents.

Variables		Frequency (%)	
		Yes	No
Experience CTS symptoms	Numbness	35	65
	Tingling	26	74
	Pain	41	59
	Total	63	37

4.5 Association between Demographic and CTS among respondents

From the results, there were 97% of the respondents are Malay workers and only a small number of Indian respondents. Besides, most of the workers are female (76%) and the respondents are predominantly aged more than 31 years old (50%). The study showed that there was no statistical significance between CTS and socio demographic factors such as age, gender, BMI, race, type of computer used, dominant hand, typing hand, and the use of tablet or smart-phone. However, result tabulated in Table 4.4 showed that there was significant association between CTS and marital status, and educational level.

There was a significant association to the CTS symptoms in relation to the marital status in this study. A large population-based study done in central/northern Italy has illustrated that the marital status showed higher incidence peaks of in-hospital cases of CTS (Mattioli *et al.*, 2008). Results showed that the CTS symptoms were positively associated with the level of education among the respondents. Based on the result, most of the respondents have STPM/Diploma level of education.

Table 4.4: Association of demographics risk factors and CTS.

Variables		CTS symptoms (n)		□²	p-value*
		Yes	No		
Age	<28	20	16	2.334	0.311
	28 – 31	11	3		
	>31	32	18		
Gender	Female	46	30	0.831	0.362
	Male	17	7		
BMI	Underweight	6	2	1.285	0.733
	Normal	16	9		
	Overweight	26	19		
	Obese	15	7		
Race	Malay	61	36	0.018[1]	0.894
	Chinese	0	0		
	India	2	1		
Marital status	Single	11	14	5.991[1]	0.050
	Married	50	23		
	Divorced	2	0		
Education level	SPM	18	9	12.047	0.002
	STPM/Diploma	39	14		
	Degree & above	6	14		

4.6 Association between work practices and CTS among respondents.

Table 4.5 summarizes the association between CTS and the work practices factor. The association of CTS symptoms and hand exercise showed a significant p-value in this study. The respondents were being asked on whether they did the hand exercise such as light stretching on basis of before, after or during their working task. A few studies have shown a positive relationship between low CTS risk and hand exercise routine. A number of exercises have been recommended for the prevention of musculoskeletal discomfort among VDT (Visual Display Unit)/office workers (Lee et al., 1992). This study suggested a need for greater attention to the practical aspect of exercise which is readily performed at the workstation to be promoted for VDT users.

Apart from that, the type of computer used had no relationship as contributing to CTS due to the same functionality offered by either laptop or desktop computer which is likewise. In the context of dominant hand, the study revealed no association between CTS occurrence. This was contradicting with a study done by Reinstein (1981) which found that CTS occur significantly more frequently in the dominant hand of both right- and left-handed persons. The clinical implications of these findings were discussed, particularly as they are related to the role of repetitive hand activities in the etiology of CTS. This study also concluded that the increased daily activity of the dominant hand is a contributing factor in the development of CTS.

Table 4.5 also reported no association between CTS and hand typing among the respondents and this result is in agreement with the report by De Krom et al. that there was no association between CTS and typing could be demonstrated. In spite of no association between CTS and both dominant hand and typing hand, this can be explained by the physical activities or hobbies done by the respondents apart from working job. The intensive and repetitive use of hand and wrist might be due to such activities apart from the usage of computer itself. Even though the use of tablet or smartphone showed no relationship towards contributing to CTS, other study has resulted otherwise. A study conducted on the effect of CTS on smartphone users had concluded that the use of smartphones for too long can be considered to adversely affect the wrist, as well as continued use can be considered to induce muscle fatigue (S, 2012).

Table 4.5: Association of work practices factors and CTS.

Variables		CTS symptoms (n)		□²	p-value*
		Yes	No		
Type of computer used	Desktop	54	29	2.634[1]	0.268
	Laptop	5	2		
	Both	4	6		
Dominant hand	Right	53	31	0.002	0.964
	Left	10	6		
Typing hand	Right	19	15	1.246[1]	0.536
	Left	3	1		
	Both	41	21		
Hand exercise	Yes	30	25	3.748	0.053
	No	33	12		
Use of tablet/ smartphone	Yes	61	34	1.194	0.274
	No	2	3		

4.7 Association between CTS symptoms and working background.

In Table 4.6 it was revealed that those who had previous employment before working as the counter workers at this telecommunication company showed no significant association towards CTS. This might be due because of the differences between employed job fields among the respondents. On the other hand, this study also indicated a significant association between those who had previous employment involving computer use and the reporting of CTS symptoms. Although this result was contradict with another study done by Liu et al., in 2003 which found no significant correlation between CTS development and duration of employment involving the usage of computer ($r=0.220$, $p=0.146$).

The different result with respect to other report may depend on case inclusion criteria and the occupational activities of the subjects or respondents. In fact, the respondents involved in this study were ensured to be working as of computer operators and working experience must be at least of six months. In addition, these counter workers are subjected to duration of training first beforehand to ensure high efficiency in catering the customer services scheme. Table 3 also indicated that there was no association between CTS and current part time jobs. It is probable that not many of the respondents have part time jobs while being full employee at the current telecommunication company.

Table 4.6: Association of work background factors and CTS.

Variables		CTS symptoms (n)		χ^2	p-value*
		Yes	No		
Previous employment	Yes	47	22	2.499	0.114
	No	16	15		
Previous employment involving computer use	Yes	40	15	4.961	0.030
	No	23	22		
Current parttime jobs	Yes	8	3	0.502	0.479
	No	55	34		

N=100

4.8 Association between CTS symptoms and Rapid Office Strain Assessment

Based on the ROSA process, there are three distinct sections namely chair, mouse and keyboard as well as telephone and monitor sections, that need to be assessed beforehand as to obtain the final score, deemed as high risk or low risk. The ROSA final scores ranged in magnitude from 1 to 10, with each successive score representing an increase presence of risk factors. Research has shown a correlation between discomfort levels and increasing ROSA scores (Sonne, n.d.). However, in this study it was founded that there was no association between ROSA and CTS symptoms among the respondents. Therefore, the work station design of the respondents exhibited a low risk of CTS, proving that the working posture is of good state. On the other side, some finding show that ergonomic analysis of the work postures has identified that it was highly likely to generate work-related musculoskeletal disorders among dental hygienists (N & R, 2013).

Table 4.7: Association of rapid office strain assessment (ROSA) and CTS.

Variables		CTS symptoms (n)		□²	p-value*
		Yes	No		
ROSA	Low Risk	17	15	1.969	0.161
	High Risk	46	22		

4.9 Association between CTS symptoms and Hand Discomfort.

This study found that the self-reported prevalence of Musculoskeletal Discomfort (MSD) among frontline counter workers in a telecommunication company was 70.0% with 70 of 100 respondents reporting pain. There was a significant association between work disturbance on index, middle finger and heel of hand, and CTS symptoms on the right hand respectively. This might be due to the dominant hand used among the respondents which was mainly right handed. In addition, most of the typing fingers involved were the main index and middle finger, meanwhile heel of hand acted as the resting base for the hand while typing. A study done by Mircea *et al.*(2006) reported a high prevalence of discomfort/pain/ache on the right side of wrist level which was 95.5% as compared to the 86.5% of left side. Additionally, the area in the distal proximity of the wrists was the most affected site being indicated in 90% of cases for left side and 95% of cases for the right side. According to Table 3.6, Area A is the index and middle finger, Area B is the ring finger and pinkie, Area C is distal thumb, Area D is hand and metacarpal area, Area E is thumb base, and Area F is the heel of hand. The discomfort was assessed on these six areas on hands.

Table 4.8: *CTS symptoms and its association with hand discomfort.*

Variables			CTS symptoms (n)		χ^2	p-value*
			Yes	No		
Area A Right	Frequency	Never	24	23		
		1-2 times last week	22	11		
		3-4 times last week	5	2	8.452[1]	0.076
		Once every day	5	1		
		Several times per day	7	0		
	Intensity	Slightly	17	7		
		Moderately	21	7	0.481[1]	0.786
		Very uncomfortable	1	0		
	Disturbance	Not at all	7	7		
		Slightly	32	7	5.445[1]	0.020*
		Substantial	0	0		
Left	Frequency	Never	33	29		
		1-2 times last week	19	7		
		3-4 times last week	5	1	8.262[1]	0.082
		Once every day	3	0		
		Several times per day	3	0		
	Intensity	Slightly	19	5		
		Moderately	10	3	0.299[1]	0.861
		Very uncomfortable	1	0		
	Disturbance	Not at all	7	5		
		Slightly	22	3	4.567[1]	0.102
		Substantial	1	0		
Area B Right	Frequency	Never	42	27		
		1-2 times last week	9	9	6.972[1]	0.137
		3-4 times last week	6	0		

Variables			CTS Symptoms		χ^2	p-value*
			Yes	No		
	Frequency	Once every day	3	1		
		Several times per day	3	0		
	Intensity	Slightly	9	5	0.140[1]	0.709
		Moderately	12	5		
		Very uncomfortable	0	0		
	Disturbance	Not at all	4	5	3.150[1]	0.076
		Slightly	17	5		
		Substantial	0	0		
Left	Frequency	Never	41	28	3.924[1]	0.416
		1-2 times last week	14	8		
		3-4 times last week	2	1		
		Once every day	4	0		
		Several times per day	2	0		
	Intensity	Slightly	14	6	0.026[1]	0.873
		Moderately	8	3		
		Very uncomfortable	0	0		
	Disturbance	Not at all	7	3	0.007	0.935
		Slightly	15	6		
		Substantial	0	0		
Area C Right	Frequency	Never	36	22	1.932[1]	0.748
		1-2 times last week	12	10		
		3-4 times last week	6	2		
		Once every day	6	2		
		Several times per day	3	1		
	Intensity	Slightly	12	8	0.309[1]	0.857
		Moderately	13	6		
		Very uncomfortable	2	1		
	Disturbance	Not at all	7	5	4.407[1]	0.110

Variables			CTS symptoms		χ^2	p-value*
			Yes	No		
		Slightly	20	8		
		Substantial	0	2		
Left	Frequency	Never	43	26	3.983[1]	0.408
		1-2 times last week	8	8		
		3-4 times last week	5	2		
		Once every day	3	1		
		Several times per day	4	0		
	Intensity	Slightly	8	7	1.879[1]	0.391
		Moderately	11	4		
		Very uncomfortable	1	0		
	Disturbance	Not at all	4	6	4.136[1]	0.126
		Slightly	15	5		
		Substantial	1	0		
Area D Right	Frequency	Never	35	27	7.357[1]	0.118
		1-2 times last week	15	5		
		3-4 times last week	8	1		
		Once every day	3	4		
		Several times per day	2	0		
	Intensity	Slightly	15	2	4.145[1]	0.126
		Moderately	12	8		
		Very uncomfortable	1	0		
	Disturbance	Not at all	10	1	4.303[1]	0.116
		Slightly	17	7		
		Substantial	1	2		
Left	Frequency	Never	42	29	4.741[1]	0.315
		1-2 times last week	13	7		
		3-4 times last week	3	0		
		Once every day	1	1		

Variables			CTS Symptoms		χ^2	p-value*
			Yes	No		
		Several times per day	4	0		
	Intensity	Slightly	14	3	3.890[1]	0.143
		Moderately	7	4		
		Very uncomfortable	0	1		
	Disturbance	Not at all	8	1	1.773[1]	0.183
		Slightly	13	7		
		Substantial	0	0		
Area E	Frequency	Never	26	21	3.948[1]	0.413
		1-2 times last week	21	12		
		3-4 times last week	6	2		
		Once every day	9	2		
		Several times per day	1	0		
Right	Intensity	Slightly	22	10	0.450[1]	0.799
		Moderately	14	6		
		Very uncomfortable	1	0		
	Disturbance	Not at all	13	9	2.233[1]	0.327
		Slightly	22	6		
		Substantial	2	1		
	Frequency	Never	38	24	3.390[1]	0.495
		1-2 times last week	12	10		
		3-4 times last week	7	2		
		Once every day	4	1		
		Several times per day	2	0		
Left	Intensity	Slightly	14	6	0.333	0.564
		Moderately	11	7		
		Very uncomfortable	0	0		
	Disturbance	Not at all	7	6	1.252[1]	0.263
		Slightly	18	7		

Variables			CTS symptoms		χ^2	p-value*
			Yes	No		
		Substantial	0	0		
Area F	Frequency	Never	34	26	4.500[1]	0.343
		1-2 times last week	13	5		
		3-4 times last week	10	2		
		Once every day	3	3		
		Several times per day	3	1		
Right	Intensity	Slightly	14	5	2.712[1]	0.258
		Moderately	15	5		
		Very uncomfortable	0	1		
	Disturbance	Not at all	7	4	6.799[1]	0.033*
		Slightly	22	5		
		Substantial	0	2		
	Frequency	Never	35	27	4.861[1]	0.302
		1-2 times last week	16	6		
		3-4 times last week	6	1		
		Once every day	4	3		
		Several times per day	2	0		
Left	Intensity	Slightly	16	7	4.046[1]	0.132
		Moderately	12	2		
		Very uncomfortable	0	1		
	Disturbance	Not at all	10	6	5.399[1]	0.067
		Slightly	18	3		
		Substantial	0	1		

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Overall, there was a high occurrence of CTS symptoms reported in the telecommunication company. The prevalence of CTS in this study was 63%. The CTS symptoms were pain, numbness and tingling on the wrist, thumb, index fingers, and middle fingers. The most reported symptoms among the subjects were pain (41%). The findings of the study provided the evidence that marital status, educational level and hand exercise has associate on the reporting of CTS symptoms. It has been shown that these three factors can influence the respondents to develop CTS symptoms.

The other socio demography and occupational risk factors such as age, gender, BMI, race, type of computer used, dominant hand, typing hand, use of smart phone, and ROSA scores demonstrated no significant association to the reported CTS. The ROSA scores reviewed that the work station design of the telecommunication company were suitable for the frontline counter workers.

Meanwhile, the self-reported MSD revealed a high number of prevalence which was 70%, with 70 out of 100 respondents reporting pain, discomfort or ache in

the last work week. The major hand area reported on the discomfort was on the index and middle finger of right hand. In addition, the association between CTS symptoms and hand discomfort at the area of index, middle finger, and heel of hand showed a significant relationship.

5.2 Recommendation

The prevalence of CTS was high among the frontline counter workers in the telecommunication company. The problem of CTS is a major disturbance experienced by the computer users due to the long duration of usage time. The relevant authorities such as the top management and the safety and health committee members of the company should implement a healthy working environment by organizing a well-planned ergonomic intervention programs. The main purpose is to decrease the incidence rate of CTS and MSD among the telecommunication's workers.

5.2.1 Workstation Design

Work station design falls on the engineering control as of the hierarchy of control measures. Hence, engineering control is the most preferred approach to control ergonomic hazards. In this case, it involves modification and design of the workstation and work method to fit the job and the worker themselves. For example, the keyboard design should have ergonomic criteria so as to reduce the risk of CTS development.

5.2.2 Clinical Examination

Carpal tunnel syndrome (CTS) can be caught easily in its early stages, however, much of the pain and all of the disability could be avoided. Although the prevalence ascertained in this study was 63%, it can be concluded that more than half of the respondents experienced CTS, hence early prevention must be taken. An accurate medical history and the precise clinical examination will help establish the diagnosis in most cases. The more expensive electrodiagnostic test can measures nerve function. In addition, the sensory findings in CTS also may be elicited by two-point discrimination, namely vibration and monofilament testing.

5.2.3 Workload Management

In order to decrease CTS prevalence, workload management is one of the core factors. The detailed workload management plays an important role in affecting the work method, work perception, and health of employee. For example, the employer should give task to employees based on their capability and skills, not beyond or exceed it. The duration given to finish up the task should be enough and break is provided, so that the services could work more efficiently and productively. These breaks mean both momentary breaks every few minutes and longer breaks every hour or so. Break is compulsory because the over use of finger while using the computer will cause the development of CTS symptoms.

5.2.4 Health Education and Training

A detailed health education focusing solely on CTS can be one of the ways to prevent CTS case. For example, through the introduction of the right way to use the work equipments as well as the establishment of a safe and healthy working condition.

5.3 Limitation of study

There were several limitations in this study. For instance, the study focused on the frontline counter workers in the customer service scheme of telecommunication company. Therefore, the findings from this study can only be generalized to the population having the similar characteristic only as compared to the whole telecommunication industry. The reported of CTS symptoms and some other information were based on questionnaires without diagnosis of physician or medical doctor. Therefore, the accuracy of research data relied on the honesty and perception of respondents in answering the questionnaires. Data from the questionnaires could be subjected to respondent's recall bias because sometimes the respondents have the possibility to overestimate or under estimate the symptoms.

It was difficult to determine the actual posture accurately when assessing the workstation area. The workers need to do their task as usual without interruption since they work as the frontline customer service and any interruption can cause delay and need to be avoided since there is no break unless shift changes. The exposure estimated could not represent the actual exposure as cross sectional study

design only consider of the exposure during that particular time of assessment. In addition the number of respondents involved in this study was small as compared to other studies. Hence the results probably were not conclusive thoroughly to be generalized to a bigger population.

Data from the questionnaires as well as the Phalen's test conducted could be subjected to respondent's over- or under-estimation. The accuracy of the results and information relied on the perception of the respondents. For example, the findings could be less accurate and precise when using the Phalen's test as compared to the use of the gold standard method, namely the nerve conduction test. However due to the unavailability of this particular tools, only Phalen's test was the convenient option.

5.4 Recommendation for Future Research

This study determined the prevalence of CTS and MSD of hand discomfort by justifying several risk factors among the subjects of counter workers in telecommunication company. Some suggestions recommended for further study to be done by using the standard method namely nerve conduction test. The accordance findings could be more accurate and precise theoretically and technically. Further research is needed to explore additional factors that may contribute to CTS such as psychosocial factors and other occupational factors that were not being accessed in this study. It is necessary in order to identify the relationship between mutifactorial variables.

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APPENDICES

APPENDIX A:

Ethical Clearance

JKEUPM Ref No. : FPSK(EXP15-OSH)U015

a) Members of the JKEUPM who reviewed the documents:
Dr Rojanah Kahar

b) Date of approval: 10/12/2015

Endorsed at JKEUPM Meeting on **30/12/2015**, attended by:

NAME	DESIGNATION	GENDER	TICK IF PRESENT
Prof. Dato' Dr. Abdul Jalil Nordin	Nuclear Radiologist & Dean, Faculty of Medicine and Health Sciences	Male	
Prof. Dr Zamberi Sekawi	Medical Microbiologist & Deputy Dean of Research and Internationalization, Faculty of Medicine and Health Sciences	Male	√
Prof. Dato' Dr. Lye Munn Sann	Medical Statistician, Dept of Community Health, Faculty of Medicine and Health Sciences	Male	√
Prof. Dr. Tengku Aizan Abd Hamid	Gerontologist & Director, Institute of Gerontology	Female	
Prof. Dr. Lekhraj Rampal	Medical Statistician, Dept of Community Health, Faculty of Medicine and Health Sciences	Male	
Prof. Dr. Lim Thiam Aun	Anesthesiologist, Dept of Surgery, Faculty of Medicine and Health Sciences	Male	
Prof. Dr. Patimah Ismail	Professor of Biomedicine, Dept of Biomedical Sciences, Faculty of Medicine and Health Sciences	Female	√
Prof. Dr. Johnson Stanslas	Pharmacologist, Dept of Medicine, Faculty of Medicine and Health Sciences	Male	
Prof. Dr. Sherina Mohd.Sidik	Professor of Medical, Department of Psychiatry, Faculty of Medicine and Health Sciences	Female	
Prof Dr. M. Iqbal Saripan	Professor of Department of Computer and Communication Systems Engineeering	Male	
Assoc. Prof. Dr. Mansor Abu Talib	Assoc. Professor of Guidance and Counselling, Dept of Human Development and Family Studies, Faculty of Human Ecology	Male	
Assoc. Prof. Dr. Hejar Abd.Rahman	Assoc. Professor of Public Health / Head Of Unit, Department of Community Health, Faculty of Medicine and Health Sciences	Female	√
Assoc. Prof. Dr. Normala Ibrahim	Assoc. Professor of Psychiatry, Department of Psychiatry, Faculty of Medicine and Health Sciences	Female	√

Assoc Prof Dr Sharmala Paramasivam	Assoc Prof of Department English, Faculty of Modern Languages and Communication	Female	√
Assoc Prof Dr Arshad Abdul Samad	Assoc Prof of Department Language and Humanities Education, Faculty of Educational Studies	Male	
Assoc Prof Dr Muhamamd Najib Mohamad Alwi (Independent Member)	Psychiatric Consultant, Cyberjaya University College of Medical Sciences (CUCMS)	Male	√
Dr. Salmiah Md. Said	Lecturer of Epidemiology, Medical Statistics, Department of Community Health, Faculty of Medicine and Health Sciences	Female	√
Assoc. Prof. Dr. Noritah Omar (Lay Person)	Assoc. Professor of English Language, Dept of English Language, Faculty of Communication and Modern Languages	Female	
Dr. Rojanah Kahar (Lay Person)	Senior Lecturer of Dept of Human Development and Family Studies, Faculty of Human Ecology	Female	
Tan Sri Dato' Napsiah Omar (Independent Member)	Chairman, National Population and Family Development Board	Female	
En John Posko Anthony (Lay Person)	Headmaster of Sekolah Jenis Kebangsaan (Tamil) Kajang	Male	√

APPENDIX B:

FORM B1: Respondent's Information Sheet

and Consent Letter

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

BORANG B1: PENERANGAN DAN PERSETUJUAN RESPONDEN
RESPONDENT'S INFORMATION SHEET AND CONSENT

Sila baca maklumat berikut dengan teliti. Sekiranya anda mempunyai sebarang pertanyaan, sila kemukakan kepada penyelidik.
Please read the following information carefully and do not hesitate to discuss any questions you may have with the researcher.

1.TAJUK KAJIAN/*STUDY TITLE*

Prevalens sindrom terowong karpus di kalangan operator komputer di pejabat TM.
Prevalence of carpal tunnel syndrome among computer operators in TM's office.

2. PENGENALAN/*INTRODUCTION*

Kajian ini dijalankan bagi mengenalpasti peratus prevalens sindrom terowong karpus di kalangan pekerja yang menggunakan komputer di pejabat TM.
This study is conducted to identify the prevalence of carpal tunnel syndrome among the computer users in TM's office.

3. APAKAH YANG PERLU ANDA LAKUKAN?/*WHAT WILL YOU HAVE TO DO?*

Anda perlu melengkapkan borang soal selidik yang diberi oleh penyelidik di samping menjalani ujian fizikal Phalen.
You will be needed to answer the questionnaire given by the researcher and undergo a physical examination; Phalen Test.

4. SIAPA YANG TIDAK BOLEH MENYERTAI KAJIAN INI?/*WHO SHOULD NOT PARTICIPATE IN THE STUDY?*

1. Mengalami kecederaan atau pembedahan di bahagian pergelangan tangan/*Experienced of wrist fracture or dislocation.*
2. Diabetes/*Diabetic*
3. Arthritic/*Arthritic*
4. Ibu mengandung/*Pregnant*
5. Menopause/*Menopause*
6. Hypothyroidism/*Hypothyroidism*

5. APAKAH FAEDAH MENYERTAI KAJIAN INI?/*WHAT WILL BE THE BENEFITS OF THE STUDY?*

a)KEPADA ANDA SEBAGAI PESERTA?/*TO YOU AS THE SUBJECT?*

Anda dapat mengenalpasti samada mengalami sindrom terowong karpus atau tidak.
To determine the presenteeism of the carpal tunnel syndrome or not.

b) KEPADA PENYELIDIK?/*TO THE INVESTIGATOR?*

Penyelidik dapat memperolehi data bagi mengenalpasti prevalens sindrom terowong karpus dikalangan peserta kajian.
Investigator can obtain the data needed to determine the prevalence of the carpal tunnel syndrome among the subjects.

6. ADAKAH IA BERISIKO?/*WHAT ARE THE POSSIBLE RISKS?*

Tidak/*No*

7. ADAKAH MAKLUMAT DAN IDENTITI SAYA KEKAL RAHSIA?/*WILL THE INFORMATION THAT YOU PROVIDE AND YOUR IDENTITY REMAIN CONFIDENTIAL?*

Ya/*Yes*

8. SIAPA YANG SAYA PERLU HUBUNGI SEKIRANYA SAYA MEMPUNYAI SOALAN TAMBAHAN SEMASA MENGIKUTI PENYELIDIKAN INI?/*WHO SHOULD YOU CONTACT IF YOU HAVE ADDITIONAL QUESTIONS DURING THE COURSEOF THE RESEARCH?*

Penyelidik/*Investigator*: 014-5262523(Nur Sabreena Bt Zakaria)

Sila tandatangan di sini sekiranya anda telah membaca dan memahami kandungan halaman ini _____

9. PERSETUJUAN

Saya..... No Kad Pengenalan. .....
beralamat.....
.....dengan ini bersetuju untuk mengambil bahagian secara sukarela dalam penyelidikan yang tersebut di atas *(kajian klinikal/percubaan ubat-ubatan/rakaman video/kumpulan sasaran/temuduga/ soal selidik).

Saya telah diberi penjelasan secara menyeluruh mengenai penyelidikan ini dari segi metodologi, risiko dan komplikasi (seperti tertulis pada Helaian Penerangan Responden). Saya memahami bahawa saya berhak menarik diri dari penyelidikan ini pada bila-bila masa tanpa memberi sebarang alasan.Saya juga memahami bahawa sebarang maklumat yang berkaitan identiti saya akan dirahsiakan.

Saya* berminat / tidak berminat untuk mengetahui keputusan kajian yang melibatkan saya.

I setuju/tidak bersetuju untuk imei/gambar/rakaman video/ rakaman suara digunakan dalam apa jua bentuk penerbitan atau pembentangan. (sekiranya berkaitan).

*potong yang tidak berkenaan

Tandatangan .....
(*Responden*)

Tarikh :.....

Tandatangan .....
(*Saksi*)

Nama :.....

No. K/P: .....

Saya mengesahkan bahawa saya telah menerangkan kepada responden ini sifat dan tujuan penyelidikan yang tersebut di atas.

Tarikh .....

Tandatangan .....
(*Penyelidik*)

9. CONSENT

I ..... Identity Card No. .....

address.....

.....hereby voluntarily agree to take part in the research stated above *(clinical /drug trial/video recording/ focus group/interview-based/ questionnaire-based).

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

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

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

* delete where necessary

Signature .....
(Respondent)

Date :.....

Signature .....
(Witness)

Name :.....

I/C No. :.....

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

Date .....

Signature .....
(Researcher)

APPENDIX C:

Questionnaire

UNIVERSITI PUTRA MALAYSIA

BERILMU BERBAKTI

BORANG SOAL SELIDIK

TAJUK: SINDROM TEROWONG KARPUS DI KALANGAN PEKERJA KAUNTER SYARIKAT TELEKOMUNIKASI

Borang soal selidik ini bertujuan untuk mengetahui prevalens sindrom terowong karpus di kalangan pekerja kaunter TM yang menggunakan komputer dalam melakukan tugas-tugas mereka. Kerjasama anda dalam menyertai kajian ini saya dahulukan dengan ucapan terima kasih. Segala maklumat anda adalah sulit dan hanya digunakan untuk tujuan penyelidikan. Terima kasih.

BACELOR SAINS (KESIHATAN PERSEKITARAN DAN PEKERJAAN)

FAKULTI PERUBATAN DAN SAINS KESIHATAN

(A) LATAR BELAKANG DEMOGRAFI RESPONDEN

NO. SIRI ☐

Sila tandakan (/) pada mana-mana bahagian yang berkenaan.

1. Nama penuh: A1
2. Umur: A2
3. BMI: A3
4. Jantina: A4
   ☐ 1)Perempuan ☐ 2)Lelaki
5. Bangsa: A5
   ☐ 1)Melayu ☐ 2)Cina
   ☐ 3)India ☐ 4)Lain-lain
6. Status perkahwinan: A6
   ☐ 1)Bujang ☐ 2)Berkahwin ☐ 3)Bercerai
7. Taraf pendidikan: A7
   ☐ 1)SRP/PMR & ke bawah ☐ 2)SPM
   ☐ 3)STPM/Diploma ☐ 4)Ijazah & ke atas

(B) AMALAN KERJA

1. Apakah jenis komputer yang anda gunakan untuk melakukan kerja-kerja anda? B1
   ☐ 1)Komputer desktop ☐ 2)Komputer riba
   ☐ 3)Lain-lain (Nyatakan:.....)
2. Yang mana merupakan tangan dominan anda? B2
   ☐ 1)Kanan ☐ 2)Kiri
3. Jari tangan manakah yang kerap anda gunakan ketika melakukan kerja-kerja menaip? B3
   ☐ 1)Kanan ☐ 2)Kiri ☐ 3)Kedua-dua tangan
4. Adakah anda melakukan sebarang aktiviti senaman atau pergerakan tangan sebelum atau semasa anda sedang melakukan kerja-kerja melibatkan penggunaan komputer? B4
   ☐ 1)Ya ☐ 2)Tidak
5. Adakah anda menggunakan komputer/tablet/smartphone apabila berada di rumah atau di luar waktu bekerja? B5
   ☐ 1)Ya ☐ 2)Tidak
6. Jika ya, berapa lama penggunaan komputer/tablet/smartphone dalam masa sehari? B6
   _____ Jam

(C) GEJALA-GEJALA SINDROM TEROWONG KARPUS (DIISI OLEH PENYELIDIK)

1. Adakah anda mengalami rasa kebas pada jari-jari tangan atau pada pergelangan tangan anda? C1
   ☐ 1)Ya ☐ 2)Tidak

2. Adakah anda mengalami rasa kesemutan/mencucuk-cucuk pada jari-jari tangan atau pada pergelangan tangan anda? C2
   ☐ 1)Ya ☐ 2)Tidak

3. Adakah anda mengalami rasa sakit pada jari-jari tangan atau pada pergelangan tangan anda? C3
   ☐ 1)Ya ☐ 2)Tidak

4. Gejala sindrom terowong karpus: C4
   ☐ 1)Ya ☐ 2)Tidak

(D) SEJARAH PEKERJAAN

1. Adakah anda pernah bekerja di tempat lain sebelum ini? D1
   ☐ 1)Ya ☐ 2)Tidak

2. Jika ya, adakah pekerjaan tersebut melibatkan penggunaan komputer? D2
   ☐ 1)Ya ☐ 2)Tidak

3. Berapa lamakah tempoh anda bekerja dalam pekerjaan anda sebelum ini? D3
   _____ Tahun _____ Bulan

4. Adakah anda mempunyai sebarang kerja sampingan selain daripada pekerjaan anda sekarang? D4
   ☐ 1)Ya ☐ 2)Tidak

5. Apakah pekerjaan tersebut? D5
   (Sila nyatakan:.....)

APPENDIX D:

Rapid Office Strain Assessment (ROSA) Form

Assessed By _____

DEVELOPED BY MICHAEL SONNE, MHK, CK.

Section A - Chair

Chair Height

AREA SCORE

Non-Adjustable (+1)

Knees at 90° (1) | Too low - Knee Angle <90° (2) | Too High - Knee Angle >90°(2) | No foot contact on ground (3) | Insufficient Space Under Desk - Ability to Cross Legs(+1)

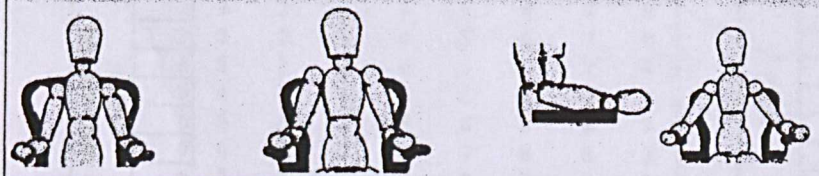
Pan Depth

AREA SCORE

Non-Adjustable (+1)

Approximately 3 inches of space between knee and edge of seat (1) | Too Long - Less Than 3" of space (2) | Too Short - More than 3" of Space(2)

Armrests



AREA SCORE

Non-Adjustable (+1)

Elbows supported in line with shoulder, shoulders relaxed (1) | Too High (Shoulders Shrugged) /Low (Arms Unsupported) (2) | Hard/damaged surface (+1) | Too Wide (+1)

Back Support

AREA SCORE

Back Rest Non-Adjustable (+1)

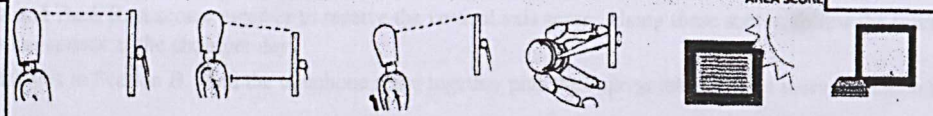
Adequate Lumbar Support - Chair reclined between 95°-110° (1) | No Lumbar Support OR Lumbar Support not Positioned in Small of Back (2) | Angled Too Far Back (Greater than 110°) OR Angled Too far forward (Less than 95°) (2) | No Back Support (ie Stool, OR Worker Leaning forward) (2) | Work Surface too High (Shoulders Shrugged)(+1)

DURATION | CHAIR SCORE

Chair	Monitor and Telephone	Mouse and Keyboard		RSA FINAL SCORE

Section B - Monitor and Telephone

Monitor



AREA SCORE

Arm's Length Distance (40-75cm) / Screen at Eye Level (1) | Too Low (below 30°) (2) Too Far (+1) | Too High (Neck Extension) (3) | Neck Twist Greater than 30° (+1) | Glare on Screen (+1) | Documents - No Holder (+1)

DURATION | Monitor Score

Telephone

AREA SCORE

No Hands-Free Options (+1)

Headset / One Hand on Phone & Neutral Neck Posture (1) | Too Far of Reach (outside of 30cm) (2) | Neck and Shoulder Hold (+2)

DURATION | Phone Score | ROSA SCORE

Section C - Mouse and Keyboard

Mouse

AREA SCORE

Mouse in Line with Shoulder (1) | Reaching to Mouse (2) | Mouse/Keyboard on Different Surfaces (+2) | Pinch Grip on Mouse (+1) | Palmrest in Front of Mouse (+1)

DURATION | MOUSE SCORE

Keyboard

AREA SCORE

Platform Non-Adjustable (+1)

Wrists Straight, Shoulders Relaxed (1) | Wrists Extended/ Keyboard on Positive Angle (>15° Wrist extension) (2) | Deviation while Typing (+1) | Keyboard Too High - Shoulders Shrugged (+1) | Reaching to Overhead Items (+1)

DURATION | KEYBOARD SCORE | ROSA SCORE

DURATION INSTRUCTIONS

If less than 30 minutes continuously, or less than 1 hour per day, mark as -1.
If between 30 minutes and 1 hour continuously, or between 1 and 4 hours per day, mark as 0.
If greater than 1 hour continuously, or more than 4 hours per day, mark as +1.

Peripherals and Monitor Score

RAPID OFFICE STRAIN ASSESSMENT

EMPLOYEE NAME: _____
DATE: _____
ASSESSED BY: _____

ROSA SCORING INSTRUCTIONS

1. Add Seat Pan and Seat Depth scores together to receive Section A vertical Axis Score. Add Arm Rest and Back Rest scores together to receive the vertical axis score. Using these scores, follow the scoring chart to receive the Chair Score. Add the appropriate duration score based on the amount of time the worker spends in the chair per day.
2. Add the score for the Monitor with the appropriate duration score to receive the value for the horizontal axis in Section B. Add the telephone score together plus the appropriate duration score to receive the vertical axis for Section B. Using these scores, follow the scoring chart to receive the Section B score.
3. Add the score for the keyboard to the appropriate duration score to receive the value for the horizontal axis in Section C. Add the score of the mouse to the appropriate duration score to receive the vertical axis for Section C. Using these scores, follow the scoring chart to receive the Section C score.
4. Use the score from step 2 to receive the score for the vertical axis in the peripheral and monitor section. Use the score from step 3 to receive the score for the horizontal axis in the peripheral and monitor section.
5. Use the score from Step 1 (Section A) to receive the value for the vertical axis in the grand score chart. Use the score from step 4 to receive the score for the horizontal axis in the grand score chart. Using these two scores, find the coresponding Grand ROSA score.

SECTION A SCORE

seat pan height /depth \ Arm Rest and Back Support	2	3	4	5	6	7	8	9
2	2	2	3	4	5	6	7	8
3	2	2	3	4	5	6	7	8
4	3	3	3	4	5	6	7	8
5	4	4	4	4	5	6	7	8
6	5	5	5	5	6	7	8	9
7	6	6	6	7	7	8	8	9
8	7	7	7	8	8	9	9	9

SECTION B SCORE

Phone \ Monitor	0	1	2	3	4	5	6	7
0	1	1	1	2	3	4	5	6
1	1	1	2	2	3	4	5	6
2	1	2	2	3	3	4	6	7
3	2	2	3	3	4	5	6	8
4	3	3	4	4	5	6	7	8
5	4	4	5	5	6	7	8	9
6	5	5	6	7	8	8	9	9

SECTION C SCORE

Mouse \ Keyboard	0	1	2	3	4	5	6	7
0	1	1	1	2	3	4	5	6
1	1	1	2	3	4	5	6	7
2	1	2	2	3	4	5	6	7
3	2	3	3	3	5	6	7	8
4	3	4	4	5	5	6	7	8
5	4	5	5	6	6	7	8	9
6	5	6	6	7	7	8	8	9
7	6	7	7	8	8	9	9	9

MONITOR AND PERIPHERALS SCORE

Monitor and Telephone \ Mouse and Keyboard	1	2	3	4	5	6	7	8	9
1	1	2	3	4	5	6	7	8	9
2	2	2	3	4	5	6	7	8	9
3	3	3	3	4	5	6	7	8	9
4	4	4	4	4	5	6	7	8	9
5	5	5	5	5	5	6	7	8	9
6	6	6	6	6	6	6	7	8	9
7	7	7	7	7	7	7	7	8	9
8	8	8	8	8	8	8	8	8	9
9	9	9	9	9	9	9	9	9	9

Peripherals and Monitor

Chair \ Peripherals and Monitor	1	2	3	4	5	6	7	8	9	10
1	1	2	3	4	5	6	7	8	9	10
2	2	2	3	4	5	6	7	8	9	10
3	3	3	3	4	5	6	7	8	9	10
4	4	4	4	4	5	6	7	8	9	10
5	5	5	5	5	5	6	7	8	9	10
6	6	6	6	6	6	6	7	8	9	10
7	7	7	7	7	7	7	7	8	9	10
8	8	8	8	8	8	8	8	8	9	10
9	9	9	9	9	9	9	9	9	9	10
10	10	10	10	10	10	10	10	10	10	10

ROSA FINAL SCORE

Username _____ Group _____

Date _____

Assessed By _____

THE RAPID OFFICE STRAIN ASSESSMENT
DEVELOPED BY MICHAEL SONNE, MHK, CK.

Section A - Chair

Chair Height — AREA SCORE: 0

Non-Adjustable (+1)

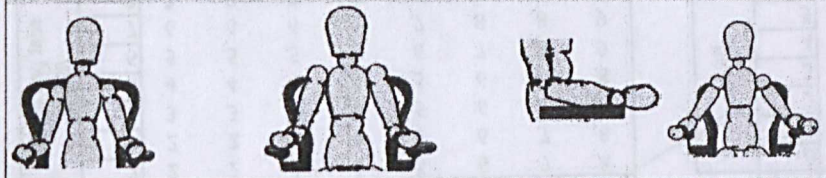
Knees at 90° (1) | Too low - Knee Angle <90° (2) | Too High - Knee Angle >90°(2) | No foot contact on ground (3) | Insufficient Space Under Desk - Ability to Cross Legs(+1)

Pan Depth — AREA SCORE:

Non-Adjustable (+1)

Approximately 3 inches of space between knee and edge of seat (1) | Too Long - Less Than 3" of space (2) | Too Short - More than 3" of Space(2)

Armrests — AREA SCORE:



Non-Adjustable (+1)

Elbows supported in line with shoulder, shoulders relaxed (1) | Too High (Shoulders Shrugged) /Low (Arms Unsupported) (2) | Hard/damaged surface (+1) | Too Wide (+1)

Back Support — AREA SCORE:

Back Rest Non-Adjustable (+1)

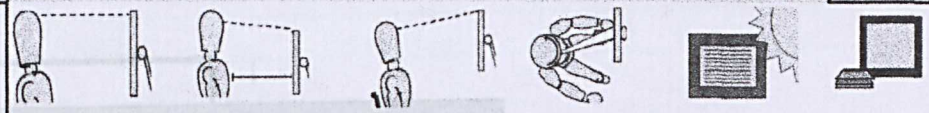
Adequate Lumbar Support - Chair reclined between 95°-110° (1) | No Lumbar Support OR Lumbar Support not Positioned in Small of Back (2) | Angled Too Far Back (Greater than 110°) OR Angled Too far forward (Less than 95°) (2) | No Back Support (ie Stool, OR Worker Leaning forward) (2) | Work Surface too High (Shoulders Shrugged)(+1)

DURATION: _____ CHAIR SCORE: _____

Chair	Monitor and Telephone	Mouse and Keyboard		ROSA FINAL SCORE

Section B - Monitor and Telephone

Monitor — AREA SCORE:



Arm's Length Distance (40-75cm) / Screen at Eye Level (1) | Too Low (below 30°) (2) Too Far (+1) | Too High (Neck Extension) (3) | Neck Twist Greater than 30° (+1) | Glare on Screen (+1) | Documents - No Holder (+1)

DURATION: _____ Monitor Score: _____

Telephone — AREA SCORE:

No Hands-Free Options (+1)

Headset / One Hand on Phone & Neutral Neck Posture (1) | Too Far of Reach (outside of 30cm) (2) | Neck and Shoulder Hold (+2)

Phone Score: _____

DURATION: _____ ROSA SCORE: _____

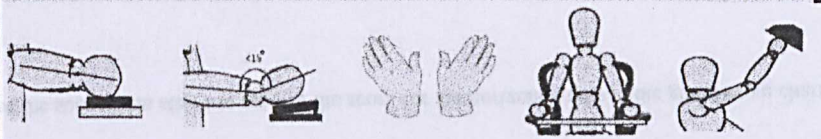
Section C - Mouse and Keyboard

Mouse — AREA SCORE:

Mouse in Line with Shoulder (1) | Reaching to Mouse (2) | Mouse/Keyboard on Different Surfaces (+2) | Pinch Grip on Mouse (+1) | Palmrest in Front of Mouse (+1)

DURATION: _____ MOUSE SCORE: _____

Keyboard — AREA SCORE:



Platform Non-Adjustable (+1)

Wrists Straight, Shoulders Relaxed (1) | Wrists Extended/ Keyboard on Positive Angle (>15° Wrist extension) (2) | Deviation while Typing (+1) | Keyboard Too High - Shoulders Shrugged (+1) | Reaching to Overhead Items (+1)

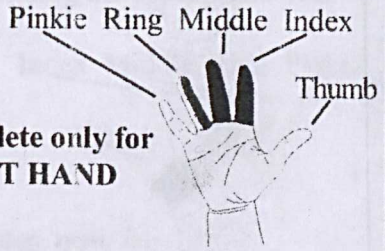
DURATION: _____ KEYBOARD SCORE: _____ ROSA SCORE: _____

DURATION INSTRUCTIONS	Peripherals and Monitor Score
If less than 30 minutes continuously, or less than 1 hour per day, mark as -1. If between 30 minutes and 1 hour continuously, or between 1 and 4 hours per day, mark as 0. If greater than 1 hour continuously, or more than 4 hours per day, mark as +1.	

APPENDIX E:

Cornell Musculoskeletal Discomfort Questionnaire

The shaded areas in the diagrams below show the position of the body parts referred to in the questionnaire. Please answer by marking the appropriate box.



Complete only for RIGHT HAND

	During the last work week how often did you experience ache, pain, discomfort in:	If you experienced ache, pain, discomfort, how uncomfortable was this?	If you experienced ache, pain, discomfort, did this interfere with your ability to work?
Area A (Shaded area)	☐ Never ☐ 1-2 times last week ☐ 3-4 times last week ☐ Once every day ☐ Several times every day	☐ Slightly uncomfortable ☐ Moderately uncomfortable ☐ Very uncomfortable	☐ Not at all ☐ Slightly interfered ☐ Substantially interfered
Area B (Shaded area)	☐ Never ☐ 1-2 times last week ☐ 3-4 times last week ☐ Once every day ☐ Several times every day	☐ Slightly uncomfortable ☐ Moderately uncomfortable ☐ Very uncomfortable	☐ Not at all ☐ Slightly interfered ☐ Substantially interfered
Area C (Shaded area)	☐ Never ☐ 1-2 times last week ☐ 3-4 times last week ☐ Once every day ☐ Several times every day	☐ Slightly uncomfortable ☐ Moderately uncomfortable ☐ Very uncomfortable	☐ Not at all ☐ Slightly interfered ☐ Substantially interfered
Area D (Shaded area)	☐ Never ☐ 1-2 times last week ☐ 3-4 times last week ☐ Once every day ☐ Several times every day	☐ Slightly uncomfortable ☐ Moderately uncomfortable ☐ Very uncomfortable	☐ Not at all ☐ Slightly interfered ☐ Substantially interfered
Area E (Shaded area)	☐ Never ☐ 1-2 times last week ☐ 3-4 times last week ☐ Once every day ☐ Several times every day	☐ Slightly uncomfortable ☐ Moderately uncomfortable ☐ Very uncomfortable	☐ Not at all ☐ Slightly interfered ☐ Substantially interfered
Area F (Shaded area)	☐ Never ☐ 1-2 times last week ☐ 3-4 times last week ☐ Once every day ☐ Several times every day	☐ Slightly uncomfortable ☐ Moderately uncomfortable ☐ Very uncomfortable	☐ Not at all ☐ Slightly interfered ☐ Substantially interfered

The shaded areas in the diagrams below show the position of the body parts referred to in the questionnaire. Please answer by marking the appropriate box.

Complete only for LEFT HAND

	During the last work week how often did you experience ache, pain, discomfort in:	If you experienced ache, pain, discomfort, how uncomfortable was this?	If you experienced ache, pain, discomfort, did this interfere with your ability to work?
Area A (Shaded area)	☐ Never ☐ 1-2 times last week ☐ 3-4 times last week ☐ Once every day ☐ Several times every day	☐ Slightly uncomfortable ☐ Moderately uncomfortable ☐ Very uncomfortable	☐ Not at all ☐ Slightly interfered ☐ Substantially interfered
Area B (Shaded area)	☐ Never ☐ 1-2 times last week ☐ 3-4 times last week ☐ Once every day ☐ Several times every day	☐ Slightly uncomfortable ☐ Moderately uncomfortable ☐ Very uncomfortable	☐ Not at all ☐ Slightly interfered ☐ Substantially interfered
Area C (Shaded area)	☐ Never ☐ 1-2 times last week ☐ 3-4 times last week ☐ Once every day ☐ Several times every day	☐ Slightly uncomfortable ☐ Moderately uncomfortable ☐ Very uncomfortable	☐ Not at all ☐ Slightly interfered ☐ Substantially interfered
Area D (Shaded area)	☐ Never ☐ 1-2 times last week ☐ 3-4 times last week ☐ Once every day ☐ Several times every day	☐ Slightly uncomfortable ☐ Moderately uncomfortable ☐ Very uncomfortable	☐ Not at all ☐ Slightly interfered ☐ Substantially interfered
Area E (Shaded area)	☐ Never ☐ 1-2 times last week ☐ 3-4 times last week ☐ Once every day ☐ Several times every day	☐ Slightly uncomfortable ☐ Moderately uncomfortable ☐ Very uncomfortable	☐ Not at all ☐ Slightly interfered ☐ Substantially interfered
Area F (Shaded area)	☐ Never ☐ 1-2 times last week ☐ 3-4 times last week ☐ Once every day ☐ Several times every day	☐ Slightly uncomfortable ☐ Moderately uncomfortable ☐ Very uncomfortable	☐ Not at all ☐ Slightly interfered ☐ Substantially interfered

The shaded areas in the diagrams below show the position of the body parts referred to in the questionnaire. Please answer by marking the appropriate box.

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	During the last work week how often did you experience ache, pain, discomfort in:	If you experienced ache, pain, discomfort, how uncomfortable was this?	If you experienced ache, pain, discomfort, did this interfere with your ability to work?
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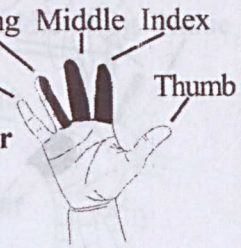
Area B (Shaded area)	☐ Never ☐ 1-2 times last week ☐ 3-4 times last week ☐ Once every day ☐ Several times every day	☐ Slightly uncomfortable ☐ Moderately uncomfortable ☐ Very uncomfortable	☐ Not at all ☐ Slightly interfered ☐ Substantially interfered
Area C (Shaded area)	☐ Never ☐ 1-2 times last week ☐ 3-4 times last week ☐ Once every day ☐ Several times every day	☐ Slightly uncomfortable ☐ Moderately uncomfortable ☐ Very uncomfortable	☐ Not at all ☐ Slightly interfered ☐ Substantially interfered
Area D (Shaded area)	☐ Never ☐ 1-2 times last week ☐ 3-4 times last week ☐ Once every day ☐ Several times every day	☐ Slightly uncomfortable ☐ Moderately uncomfortable ☐ Very uncomfortable	☐ Not at all ☐ Slightly interfered ☐ Substantially interfered
Area E (Shaded area)	☐ Never ☐ 1-2 times last week ☐ 3-4 times last week ☐ Once every day ☐ Several times every day	☐ Slightly uncomfortable ☐ Moderately uncomfortable ☐ Very uncomfortable	☐ Not at all ☐ Slightly interfered ☐ Substantially interfered
Area F (Shaded area)	☐ Never ☐ 1-2 times last week ☐ 3-4 times last week ☐ Once every day ☐ Several times every day	☐ Slightly uncomfortable ☐ Moderately uncomfortable ☐ Very uncomfortable	☐ Not at all ☐ Slightly interfered ☐ Substantially interfered

The shaded areas in the diagrams below show the position of the body parts referred to in the questionnaire. Please answer by marking the appropriate box.



Complete only for RIGHT HAND

	During the last work week how often did you experience ache, pain, discomfort in:	If you experienced ache, pain, discomfort, how uncomfortable was this?	If you experienced ache, pain, discomfort, did this interfere with your ability to work?
Area A (Shaded area)	☐ Never ☐ 1-2 times last week ☐ 3-4 times last week ☐ Once every day ☐ Several times every day	☐ Slightly uncomfortable ☐ Moderately uncomfortable ☐ Very uncomfortable	☐ Not at all ☐ Slightly interfered ☐ Substantially interfered
Area B (Shaded area)	☐ Never ☐ 1-2 times last week ☐ 3-4 times last week ☐ Once every day ☐ Several times every day	☐ Slightly uncomfortable ☐ Moderately uncomfortable ☐ Very uncomfortable	☐ Not at all ☐ Slightly interfered ☐ Substantially interfered
Area C (Shaded area)	☐ Never ☐ 1-2 times last week ☐ 3-4 times last week ☐ Once every day ☐ Several times every day	☐ Slightly uncomfortable ☐ Moderately uncomfortable ☐ Very uncomfortable	☐ Not at all ☐ Slightly interfered ☐ Substantially interfered
Area D (Shaded area)	☐ Never ☐ 1-2 times last week ☐ 3-4 times last week ☐ Once every day ☐ Several times every day	☐ Slightly uncomfortable ☐ Moderately uncomfortable ☐ Very uncomfortable	☐ Not at all ☐ Slightly interfered ☐ Substantially interfered
Area E (Shaded area)	☐ Never ☐ 1-2 times last week ☐ 3-4 times last week ☐ Once every day ☐ Several times every day	☐ Slightly uncomfortable ☐ Moderately uncomfortable ☐ Very uncomfortable	☐ Not at all ☐ Slightly interfered ☐ Substantially interfered
Area F (Shaded area)	☐ Never ☐ 1-2 times last week ☐ 3-4 times last week ☐ Once every day ☐ Several times every day	☐ Slightly uncomfortable ☐ Moderately uncomfortable ☐ Very uncomfortable	☐ Not at all ☐ Slightly interfered ☐ Substantially interfered