EFFECTS OF ERGONOMICS PRACTICES ON HOME WORKSTATION TOWARDS EMPLOYEE'S PHYSICAL HEALTH CONDITIONS

KRYSTLE JAMEELA BINTI MATHEW SAN

FACULTY OF ENGINEERING
UNIVERSITY OF MALAYA
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2021

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KRYSTLE JAMEELA BINTI MATHEW SAN

DISSERTATION SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SAFETY, HEALTH AND ENVIRONMENT ENGINEERING

FACULTY OF ENGINEERING
UNIVERSITY OF MALAYA
KUALA LUMPUR

2021

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Matric No: 17202633/1

Name of Degree: Master of Safety, Health and Environment Engineering

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[EFFECTS OF ERGONOMICS PRACTICES ON HOME WORKSTATION TOWARDS EMPLOYEE'S PHYSICAL HEALTH CONDITIONS]

ABSTRACT

This study was conducted to observe the ergonomics practice on home workstation of employees who are working from home. A survey on ergonomics practices on home computer workstation was sent to the respondents through social media platform and email. The respondents involved white-collar professional employees in Malaysia, aged from 20 and above, who transitioned from office to home due to the COVID-19 pandemic. The survey includes questions relating to demographic profile of the respondents, computer workstation ergonomics self-assessment checklist, and standardized questionnaires for analysis of the musculoskeletal symptoms on the wellbeing resulting from the workstation conditions. It was found that the homeworking employees experienced many physical discomforts in body regions specifically in the neck (n=147, 69.7%), shoulder (n=148, 70.1%), upper back (n=139, 65.9%) and lower back (n=135,64%). Pearson correlation analyses were performed to examine the relationship between primary outcomes of musculoskeletal discomforts due to workstation conditions and the sitting postures which resulting in negative correlations. It was found that majority of the homeworking employees suffered poor body postures due to poor workstation and work practice at home.

Keywords: Office ergonomics, telework, physical health, musculoskeletal disorder, human-computer interface.

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[KESAN PENGAMALAN ERGONOMIK STESEN KERJA TERHADAP KESIHATAN FIZIKAL PEKERJA YANG BEKERJA DARI RUMAH]

ABSTRAK

Kajian ini dijalankan untuk mengkaji pengamalan ergonomik ke atas meja kerja pekerja yang bekerja dari rumah. Tinjauan telah diedarkan melalui media sosial dan e-mel. Responden yang terlibat terdiri daripada pekerja pejabat yang berumur dua puluh tahun dan ke-atas, yang telah beralih tempat kerja dari pejabat ke tempat kediaman kerana norma baharu akibat wabak COVID-19. Kajian ini merangkumi soalan yang berkaitan dengan profil demografik responden, senarai semak penilaian kendiri meja komputer di rumah berasaskan ergonomik dan soal selidik gejala muskuloskeletal yang terhasil oleh keadaan stesen kerja di rumah. Didapati pekerja-pekerja ini mengalami simptom ketidakselesaan fizikal pada anggota badan khususnya di bahagian leher ((n=147, 69.7%), bahu (n=148, 70.1%), tulang belakang (n=139, 65.9%) dan atas punggung (n=135,64%) yang disebabkan oleh kondisi meja kerja di rumah. Analisis korelasi Pearson menunjukkan korelasi negatif setelah pemeriksaan dilakukan ke atas dua pemboleh-ubah iaitu kesan ketidakselesaan muskuloskeletal disebabkan oleh stesen kerja dengan jenis postur badan ketika duduk di meja kerja. Sebilangan besar daripada pekerja ini mengalami postur badan yang buruk kerana pemilihan jenis meja kerja dan amalan kerja yang salah.

Kata kunci: Ergonomik, telekomunikasi, kesihatan fizikal, gangguan muskuloskeletal.

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ACKNOWLEDGEMENTS

I would like to express my deep and sincere gratitude to my research supervisor, Prof. Madya Dr. Wan Norliza binti Wan Mahadi, for giving me the opportunity to conduct this research and providing invaluable guidance from time to time. It was a great privilege and honor to work with her. Thank you.

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MSDs	:	Musculoskeletal disorders
WFH	:	Work from home
SOCSO	:	Social Security Organization

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CHAPTER 1: INTRODUCTION

1.1 Background of Study

The fight against the highly infectious disease, COVID-19, started in early 2020 before the outbreak spread worldwide. As the number of covid cases increased, health officials announced that social distancing would help to combat the spread of COVID-19. Thus, the Prime Minister of Malaysia implemented the Movement Control Order (MCO) to impose self-isolation where Malaysian citizens are urged to stay at home to limit face-to-face interactions with others. As a result, many offices are closed, and companies have provided their employees with laptops to work from home. The working arrangement of millions of employees have shifted to a virtual mode which led to more screen time. The portability of laptops and the development of new technologies have also revolutionized working patterns and enable employees to work remotely.

This new normal has switched business casual attire to home office. Employees are required to recreate their working space overnight without adequate knowledge on the requirements to create a comfortable workstation. Consequently, these resulted in a workspace setting that is not ideal for one’s posture. For instance, employees have resorted to utilizing their existing furniture to set up their workspace such as dining tables, dining chair, couches, coffee table and other alternative furnishings that are not meant for prolonged usage (Pottorff, T. 2021, March). Furthermore, some employees are also facing challenges due to their limited budget to set up a good workstation with the appropriate equipment. When the pandemic started, people were not too concern about the effects that the new working arrangement would have towards their physical body as it was assumed to be a temporary situation. However, the continuous extension of the lockdown has caused the employees to suffer bad posture and fatigue due to unsuitable workstation.

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Consequently, musculoskeletal disorders begin to develop as well as the onset of mental disorders such as stress, depression, and anxiety. The impact of poor workstation has proven to result in negative effects as one's body is forced to adapt and function outside of their ergonomically designed professional workplaces. It also had affected businesses by increasing employees' compensation claims and absenteeism, reducing productivity and quality of work, and lastly, high staff turnover and low morale. As the pandemic escalates further, many companies are looking at prolonged period of mandating work from home for the foreseeable future. Hence, having a comfortable workstation is essential to ensure one's well-being.

1.2 Significance of the Research

This study intends to study the effects of having a proper computer workstation at home towards their physical conditions. Past studies have shown that there is a correlation between poor office ergonomics practices and the risk of experiencing musculoskeletal disorder injuries at the office or workplace. Furthermore, Social Security Organization (SOCSO) has reported that work-related musculoskeletal injury is the most common occupational disease.

As transition to telework has become a "new normal" occurrence where many employees have shifted to work in a home office unexpectedly, this may ultimately result in emerging ergonomics issues. Therefore, this research intends to further expand the findings of office ergonomics at home by observing the implementation of ergonomics practices on home computer workstation among homeworking employees through the distribution of survey. Based on the survey results, issues, and limitations prior to the implementation of ergonomics practices on home computer workstation can be identified to assist the organization and the employee in reducing musculoskeletal disorders in the future.

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1.3 Problem Statement

The vitality of ergonomics is not a matter of concern as this scientific principle is one among the many sciences that originates from the very start of civilization. Based on the research conducted by Gerding, T., Syck, M., Daniel, D., Naylor, J., Kotowski, S. E., Gillespie, G. L., Freeman, A. M., Huston, T. R., & Davis, K. G. (2021), it was learned that despite being a practice that is positively published, there were many evidence that shows the relationship between poor office ergonomics and a intensified risk of musculoskeletal injuries at the workplace. On the contrary, there is not much affirmation that exists which relates poor workstation with the adoption of new ways of working where home becomes the workplace. Current home office arrangements may range from a computer positioned on a dining table, a laptop placed on the lap, or work being completed while sitting on a couch or on the bed. None of these workstations are equipped for prolonged computer use, especially from an ergonomic perspective.

1.4 Research Objectives

The objectives of this research are as follows:

i. To observe the implementation of ergonomics practices on home computer workstation among working from home employees in Malaysia.

ii. To emphasize on the impact of implementing ergonomics on computer workstation at home towards reducing physical health issues.

Through this study, we would have the benefit to set up workstation in an ergonomically way that is right for one's body posture and to reduce musculoskeletal disorders as the future of work has been altered indefinitely.

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1.5 Research Questions

1. Is the proper ergonomics practice being implemented on the workstation by the employees who are working from home?
2. What are the effects of the implementation of ergonomics practice on their workstations towards the employee's physical health?

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CHAPTER 2: LITERATURE REVIEW

2.1 Work from Home, Telecommuting or Telework

Due to a significant increase in COVID-19 confirmed cases, Malaysia had to undergo Movement Control Order, which involved the closure of all government and private sectors except for essential services. As a result, many people are required to work from home. As mentioned by Mumin, N. (2020), the term “working from home” can also be referred as telecommuting or teleworking. It is widely implemented as an alternative working arrangement in most developed countries because of its advancement of information communication and computer-based technology. The vast availability of technology has enabled remarkable flexibility and offering benefits to both employers and employees.

The approach of teleworking has lived since 1970s, but in a more finite scope. The International Labour Organization defines teleworking as the use of information and communications technologies (ICTs) including smartphones, tablets, laptops or desktop computers for work that is performed outside the employer’s premises (Belzunegui-Eraso, A., & Erro-Garcés, A. 2020). The benefits related with teleworking include enhanced family-work integration, minimization in fatigue and boost productivity. However, the lack of physical and organizational barrier between work and home can adversely impact an individual’s mental and physical health. For instance, it may be due to extended hours, uncertain delineation between work and home, and deficient support from organization. Hence, a systematic examination is necessary to determine the impact of organizational, physical, environmental and psychosocial factors on individuals’ mental and physical health.

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2.2 Ergonomics History, Milestones and Definition

According to the study Zunjic, A. (2017), ergonomics is one of the scientific discoveries that originated from the beginning of civilization. During the Paleolithic Era, the first axe was made by a primitive man by altering its shape to the human hand anatomy. The invention was a result of an unintentional application of ergonomics foundation. In that era, the application or ergonomics' principles and laws are on an instinctual basis. Overtime, ergonomics gradually became a scientific discipline in which different parts of the world would have their respective ergonomics considerations and scientific research. The correlation between "labor" and "health" was first acknowledged in the time of Ancient Egypt, Greek and Roman where there were reports of health problems that are caused by work. As stated in the classic book titled "De morbis artificum diatriba" by an Italian physician named Ramazzini, B. (2001), the interconnection between working conditions and pathology was first organized from an occupational health perspective. The impact of awkward working postures on bodies of metal mining workers was mentioned in the book and those impacts were considered as diseases. It can be said that "Industrial Revolution" started in the 18th century requested explanation of the relationship between labor and health. Thereafter, important changes began in the beginning of the twentieth century which accelerates the formal constitution of ergonomics as a science. The evolution of preventive measures based on ergonomics' perspective, techniques, and approaches such as the occupational fatigue and the founding of principles in scientific management of labor also started about that time.

The events that occurred during the World War I and World War II contributed to the evolution of ergonomics, especially in the study of human errors. Back in those days, many accidents involved airplanes. One example of the accidents was the pilot had misinterpreted the altimeter due to its poor interface design. Following that issue, human cognitive features were taken into deliberation, the aircraft's altimeter was changed to a

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more easy-to-read and single pointer design. It is necessary to design a tool, equipment or machinery in a way that increases the efficiency of its use by reducing the number of errors. Ergonomics experts were also appointed to solve various issues by applying not only ergonomics solutions, but also the science of human factors in product, consumer equipment, medicine, welfare, aeronautic, traffic systems and public facilities.

The publication of scientific literature and the establishment of institutions that deals with science is important for the growth of any scientific field. In 1857, a Polish scientist named Wojciech Jastrzebowski created the word "ergonomics" in his book called "An outline of Ergonomics, or the Science of Work" which was originally written in Polish. The term ergonomics was extracted from the Greek word, "ergon" and "nomos", means redress of laws into work. In 1949, when the K. F. Hugh Murrell assembled a working group of people who dealt with issues related to the scope of ergonomics in the British Admiralty, that was when the word ergonomics became popular again. Since then, the word ergonomics has been frequently used around the world. Ergonomics books started to publish since last century. The printing of the scientific journal "Ergonomics" began in 1957 and universities started organizing programs pertaining to this field. As mentioned in the study by Zunjic, A. (2017), Kan-ichi Tanaka introduced human engineering to Japan in 1921 by establishing the Kurashiki Institute of Science of Labor in Japan and published the book called "Research of Efficiency: Ergonomics". Several ergonomically renowned textbooks written by scientists such as Woodson, McCormick and Sanders also were published in the United States since the 1950s. In addition, the first edition of a masterpiece by Grandjean "Fitting the Task to the Man" was published in 1963.

International Ergonomics Association or also known as IEA was established in 1959. The association organizes ergonomics-related alliance formed in different countries

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or other parts around the world up till today. The mission of the IEA is to elaborate and advance ergonomics science and practice, and to improve the quality of life by expanding its scope of application and contribution to society (Jayaratne, K. 2012). Hereby, with the establishment of IEA, this indicated that ergonomics was acknowledged worldwide and classified as a scientific discipline. In Britain, the Ergonomic Society was established in 1952 and it consisted of people from psychology, biology, physiology, and design meanwhile in the United States, the Human Factors Society was established in 1957.

Ergonomics can be defined in various ways but each of it constitutes only one trait of ergonomics. As cited in the article by Wikimedia Foundation (2021, May 26), the International Ergonomics Association defined ergonomics or human factors as the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design to optimize human well-being and overall system performance. In the study by Shoubi, M. V., Barough, A. S., & Rasoulijavaheri, A. (2013), it stated that conforming to OSHA, ergonomics is described as "designing the job to fit the workers, instead of forcing the worker to fit the job". It implies that to consider the factor of the design, prettiness, propensity, financial aspects, human anatomy and physiology prior to improve the level of work. Also, to not expect or force labor to work efficiently in an uncomfortable work situation. However, the most suitable definition of ergonomics is contained in its name "the laws of work". Ergonomics is a comprehensive and human-systems perspective for work systems design by considering cognitive, organizational, physical, environmental, and etc. (Kibria, M. G., & Rafiquzzaman, M. 2019). The main concerns of the ergonomics are productivity, performance advancement, elimination of injuries, and fatigue reduction. These objectives can be accomplished by substituting the worker's job interface such as work process, work environment, work management and tools. For example, it is important to construct an ergonomically adjustable desk or

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computer workstation to avoid repetitive body movements, awkward postures, and static forces in both sitting and viewing position. By applying ergonomics principles to the workstation, it improves human-computer relationship, and enhances user's comfort, health and safety. Table 2.1 demonstrates definition and scope of ergonomics and the crucial factors which should be considered in each scope.

Table 2.1: Definition and scope of ergonomics.

<table>
<tr><th colspan="4">Ergonomics</th></tr>
<tr><td rowspan="5">Definition</td><td colspan="3">Investigating the relations among individuals and systems</td></tr>
<tr><td colspan="3">Principles of optimizing of human and overall system efficiency</td></tr>
<tr><td colspan="3">Redesigning and modifying the job toward more pleasant work environment</td></tr>
<tr><td colspan="3">Making tasks execution easier and comfortable</td></tr>
<tr><td>Examples</td><td colspan="2">• Using appropriate posture for sitting
• Using appropriate posture for lifting
• Establishing equipment in more standard</td></tr>
<tr><td rowspan="8">Scope</td><td colspan="2" rowspan="4">Physical:
Human anatomy, physiological and biomechanical</td><td>Working posture</td></tr>
<tr><td>Repetitive movement</td></tr>
<tr><td>Material handling</td></tr>
<tr><td>Safety & health</td></tr>
<tr><td rowspan="4">Cognitive:
Mental</td><td colspan="2">Mental workload</td></tr>
<tr><td colspan="2">Decision making</td></tr>
<tr><td colspan="2">Skilled performance</td></tr>
<tr><td colspan="2">Work stress</td></tr>
</table>

2.3 Human Factor

The aspect of "human factor" is often utilized synonymously with "ergonomics". Human factor and ergonomics are known as the application of psychological and physiological principles to the engineering and design of the product, processes, and systems. The term human factor is more accustomed in United States, whereas the term ergonomics has its origin in Europe. The aim of human factor specifically focuses on the interaction of human and "thing" such as safe furniture, and easy to use interfaces to machines, equipment, or tools. Besides that, it minimizes human error, and boost productivity, safety, health and comfort. Repetitive strain injuries and musculoskeletal

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disorders can develop over time and can lead to permanent disability. Therefore, it is important to practice good ergonomics design. Human factor and ergonomics are engaged with "fit" between the user, equipment, and environment, and "fitting a job to a person". To assess the fit between a person and technology, human factor specialists consider the job that is being carried out, the demands on the user (such as the equipment used in terms of its size, shape, and how appropriate it is for the task), and the information used.

2.4 Anthropometry and Its Principles

Anthropometry is the scientific analysis of various body regions of the human. The use of anthropometry is important to design and modify a product and service. Anthropometry is also different among nations, ethnicities, and regions. This means that constitution of a product for a particular nation may not be the same with other nations. It is not realistic to construct a work system or equipment that is suitable for everyone or "one size fits all". Therefore, to board 90% of the targeted population, it is essential to consider the anthropometry data of 5^{th} percentile of female and 95% percentile of male (Kibria, M. G., & Rafiquzzaman, M. 2019). The three basic ergonomics design principles are design for extreme individual (5^{th} percentile of female for minimum population and 95^{th} percentile of male for maximum population), design for average and lastly, design for adjustability. Most researchers use design for adjustability principle for furniture design. The chosen anthropometric data are based on the 5^{th} percentile of the female and 95^{th} percentile of male which cover 90% of the population.

Computer workstation or workstation furniture is an important element that needs to be designed ergonomically, as it is adjusted as per user's intension, comfort and to maintain natural posture. Anthropometric measurements are collected to design the most suitable computer workstation to reduce the perceived musculoskeletal discomfort. User's anthropometric measurement or data should be clearly rooted in the design of the

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ergonomically furniture such as backrest, armrest, seat height, seat depth, seat width, and desk height (Lale, K., & Korhan, O. 2012). Design for adjustability principle also plays an important role in designing ergonomic adjustable furniture because it ensures that user is able to work within natural posture, working elements are within reach, working at suitable height, reducing pressure points, provide clearance and allow user to work comfortably. Research by Hoque, A. S. M., Parvez, M. S., Halder, P. K., & Szecsi, T. (2014) examined eleven anthropometric measurements to design ergonomics workstation furniture. The mentioned measurements are sitting height, sitting shoulder height, popliteal height, hip breadth, sitting elbow height, buttock-popliteal length, buttock-knee depth, thigh clearance, sitting eye height, shoulder breadth and sitting knee height (Table 2.2). The anthropometric data which is important to design a workstation includes seat parameters from a workstation as shown in Figure 2.1 as well as the seated body dimensions as shown Figure 2.2.

Table 2.2: Anthropometric dimensions and its definition.

No.	Anthropometric dimensions	Definition
1	Sitting height	The vertical distance measured from vertex to the sitting surface.
2	Sitting shoulder height	The distance measured vertically distance from the sitting surface to top of the shoulder.
3	Popliteal height	Distance measured vertically with 90º knee flexion from footrest to popliteal surface of the knee.
4	Hip breadth	The maximum horizontal distance across the hips when subjects in sitting position.
5	Sitting elbow height	The vertical distance from the sitting surface to bottom of the elbow.
6	Buttock-popliteal length	Distance measured horizontally with 90º knee flexion from posterior surface to buttock.
7	Buttock-knee depth	Distance measured horizontally with 90º knee flexion from kneecap to uncompressed buttock
8	Thigh clearance	Distance measured vertically from highest point on the top of the right thigh to sitting surface.
9	Sitting eye height	Distance measured vertically from the sitting surface to the inner canthus (corner) of the eye.
10	Shoulder (bideltoid) breadth	The maximum distance between two deltoid muscles.

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11	Sitting knee height	Distance measured vertically with 90º knee flexion from knee quadriceps muscles to footrest.

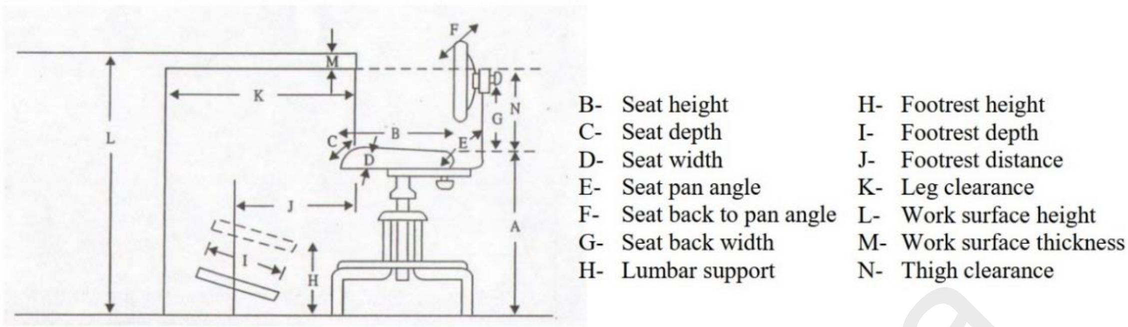

Figure 2.1: Seat parameters for workstation.

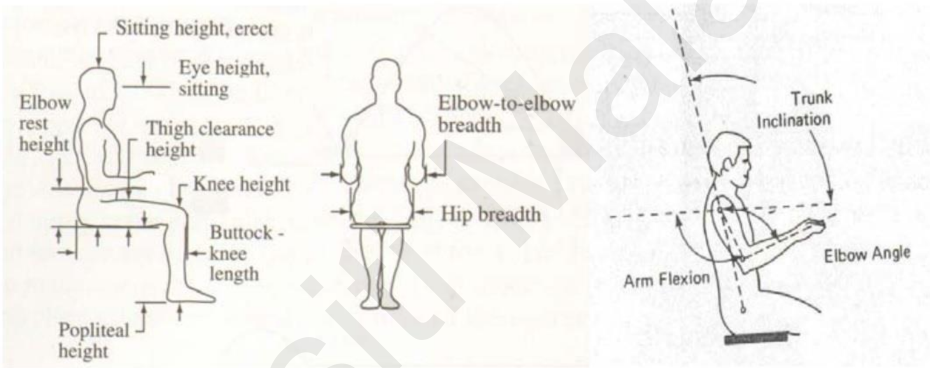

Figure 2.2: Seated body dimensions.

2.5 Musculoskeletal Disorders

There are several names for Musculoskeletal Disorders such as Repetitive Strain Injuries, Repetitive Motion Injuries, Cumulative Trauma Disorders, Occupational Overuse Syndrome, Soft Tissue Disorders, Sprains or Strains, and Musculoskeletal Injuries. Besides affecting the muscles, nerves, tendons, ligaments, joints, or spinal discs of one's body, musculoskeletal disorders also involve pinched nerve, herniated disc, meniscus tear, sprains, strains, tears, hernia (traumatic and non-traumatic), pain, swelling, numbness, carpal or tarsal tunnel syndrome, and Raynaud's syndrome. The regions that are susceptible to developing musculoskeletal pains are the lower back, upper back, neck, and upper extremities (Mani, K. 2018). Carpal Tunnel Syndrome, Tendonitis, Muscle or

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Tendon Strain, Ligament Sprain, Tension Neck Syndrome, Thoracic Outlet Compression, Rotator Cuff Tendonitis, Epicondylitis, Radial Tunnel Syndrome, Digital Neuritis, Trigger Finger or Thumb, DeQuervain's Syndrome, Mechanical Back Syndrome, Degenerative Disc Disease, Ruptured or Herniated Disc are the examples of common musculoskeletal disorders (Figure 2.3).

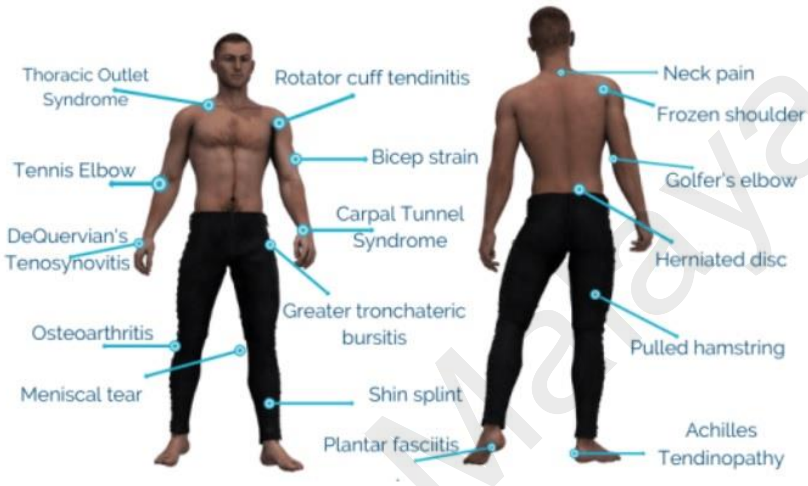

Figure 2.3: Types of musculoskeletal injuries.

Risk factor is the element which causes an individual to be in risk of developing musculoskeletal disorders. Among the factors that are attributed to musculoskeletal disorder are awkward posture, prolonged static postures, bending, twisting, repetitive movement, excessive workload, force, glare, job strain, lifting, and vibration. These following risks can be categorized into postural risk factors, environmental risk factors, individual risk factors, psychosocial risk factors, and risk factors associated with duration and excessive office work. According to Middlesworth, M. (2019, May 10), when an individual is exposed to musculoskeletal disorder risk factors, they will experience fatigue. Once fatigue outruns one's recovery system, musculoskeletal imbalance will occur. As fatigue escalates and the musculoskeletal imbalance persists, musculoskeletal disorder will start to develop.

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An ergonomic hazard causes discomfort or strain to the user. Objects, environments, and systems are the three primary types of ergonomics hazards that result in poor or unnatural body posture, uncomfortable or awkward movements. To determine the ergonomic hazards in the workplace, it is important to consider the furniture, workstation, desk, chair, tools, or equipment for users to carry out their jobs as well as the physical processes they are performing. Ergonomics practice in the workplace aims to design and arrange space, objects and systems so that the user will experience the safest, most natural, and most efficient movement and body position as much as possible.

2.6 Statistics of Work Disorders in Malaysia

An individual may experience musculoskeletal pain which affects the muscles, tendons, ligaments or bones. The pain may be felt in one area or spread across different parts of the body. This is due to prolonged symptoms of pain, body ache and fatigue. It was discovered that musculoskeletal upper extremity symptoms and complaints of the arm, neck and shoulder are common especially among office employees in developing countries.

In Malaysia, musculoskeletal disorder is one of the most common occupational diseases as compared to other diseases such as accident at workplace or respiratory diseases. According to the statistics reported by Social Security Organization or also known as SOCSO, work-related musculoskeletal pain is seen to be on the rise as it has reported an exponentially increasing trend with a total number of 1151 cases in 2018, compared to 10 cases in 2005 (Figure 2.4).

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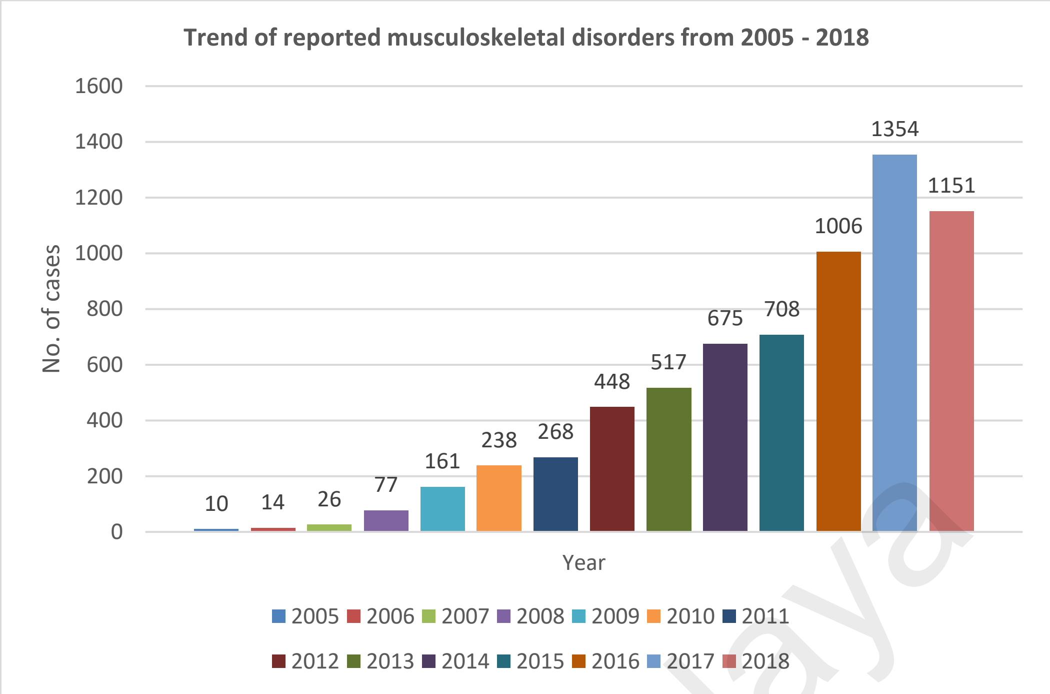

Figure 2.4: Trend of reported musculoskeletal disorders from 2005 to 2018, *Laporan Tahunan*. PERKESO. (2019).

2.7 Musculoskeletal Disorders (MSDs) Among Computer Users

Currently, computer is an indispensable tool in the official set up of all the workplaces due to advance technology and software. The number of people suffering from musculoskeletal disorders have also increased concurrently with computer usage. Musculoskeletal disorders are common occupational health issues linked to poorly designed computer workstation. Factors such as prolonged, repetitive, and awkward movements increase the risk for the computer users to develop musculoskeletal disorders. Therefore, it is essential to have awareness and knowledge regarding the relationship between computer usage and musculoskeletal disorders to prevent one's health from becoming more severe. A study by Kibria, M. G., & Rafiquzzaman, M. (2019) was conducted to evaluate the risks associated with musculoskeletal discomforts among a total of 265 lecturers in Bangladesh where an increased usage of computer was observed. Participants' anthropometric measurements and dimensions of the existing furniture were compared, measured, and evaluated prior to come out with a suitable design of an

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ergonomic computer workstation that would reduce health-related problems. The outcome of the study showed that there were enormous percentage of inconsistency between users' anthropometry and furniture dimensions. The results obtained showed that musculoskeletal symptoms were noticed among different body regions associated with the participants. From this study, it was concluded that the inflated frequency of musculoskeletal disorders was caused by prolonged sitting work, incorrect postures and improper workstation setup.

One of the findings by Park, M.-Y., Kim, J.-Y., & Shin, J.-H. (2000) stated that researchers had compared discomfort level between an adjustable demo chair and conventional chair, and it was concluded that the adjustable Video Display Terminal workstation reduced discomfort among the users. In addition, researchers also concluded that the eye, head, shoulders and back discomforts were associated with improper setting of monitors and keyboards.

Another research was conducted by Lale, K., & Korhan, O. (2012) to investigate the relationship between computer workstations, musculoskeletal discomforts, and office employees. The research aimed to propose an ergonomic computer workstation by using user's anthropometric measurements to resolve the fancy health related problems and lost productivity due to recognized musculoskeletal discomfort. It was concluded that the sitting position which involves the mismatched of the body dimensions and furniture dimensions would resort in user's discomfort. This mismatch phenomenon was also studied by Rosyidi, C. N., Susmartini, S., Purwaningrum, L., & Muraki, S. (2016). The study aimed to determine the mismatch between the existing desks and chairs in elementary schools, and the anthropometric measurements of students in several regions of Central, Java, Indonesia. Similar to the study of Lale, K., & Korhan, O. (2012), from

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the analysis, it was found that seat height, seat depth and desk height of the existing desk and chair resulted in a high mismatched with the students' anthropometric measurements.

Body posture and musculoskeletal problems have a significant relationship with each other. Posture is the position of the body in which they are arranged for sitting, standing, lying, etc. An individual can experience awkward posture due to several reasons such as joint impairments, muscle pain and soft tissue injuries. In the study conducted by Hussain, H. M., Khwaja, A., Ali, S. Z., Feroz, J., Memon, A. U. R., Khan, K., & Khanzada, S. R. (2015), it mentioned that many of the medical students of Isra University, Hyderabad, encountered with various types of musculoskeletal problems due to poor posture which they adopted during their course of study. For example, during lectures, working on computer, lab activities and to complete assignments using laptops. Other reasons also include prolonged seating, lacked awareness on ergonomics workstation, and poor facility provided by the institute. In the research conducted by Hussain, H. M., Khwaja, A., Ali, S. Z., Feroz, J., Memon, A. U. R., Khan, K., & Khanzada, S. R. (2015), it is agreed that knowledge regarding change of posture and increase movements while using computer is important for students in order for them to reduce the risk of injury.

Musculoskeletal disorders are common among office employees around the world. These disorders can have harmful effects on employees' health and productivity. Mahmud, N., Kenny, D. T., Zein, R. M., & Hassan, S. N. (2011) conducted research on musculoskeletal disorders among office employees, and the factors contributed to the risk of developing musculoskeletal disorders were divided into individual, ergonomics and psychosocial factors. In this study, it was concluded that the risk of developing musculoskeletal disorders were higher among workers who had a high work strain, longer use of mouse and keyboard, high muscle tension and previous musculoskeletal disorders in the neck and shoulder.

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Another study by Khan, S. H., Mohan, T. R. C., Al Abed, A. A. A., B, S. K., & Bhumik, A. (2020) stated that the normal sitting lumbar angle must be more than ninety degrees. Anything that refrain from ninety degrees' lumbar angle to less or more can contribute to cause low back pain due to compression, impingement, or irritation of the lumbar nerve root. Another cause of low back pain is forward neck flexion for a prolonged period so that the chin moves towards the chest. Head position is considerably important factor to contribute to pain. Forward head position with neck flexion displaces it from neutral position, hence, exerting much load on the spine.

2.8 Impact of Poor Workstation on Mental Well-being

A majority of people around the world are still unaware of the importance of applying ergonomics into their daily life. Deficiency in implementing ergonomics principles at the workplace can contribute to emotional depression, physical exhaustive, productivity and product quality. Work stress is a major issue in the occupational safety and health aspects as well as for organizational well-being. An individual's body posture could lead to work stress. The body posture may lead to problems in the areas of neck, shoulder, arm, thigh, and knee. An awkward and prolonged static posture could reduce blood flow towards the tendon which causes fatigue and strain. In addition, stress could also be experienced by a person who is excessive working or repetitively making the same movement due to body fatigue and strain. All these musculoskeletal problems could cause strains and eventually, affect one's health. For example, office workers normally use computers on an average of six to twelve hours daily and a long working hour with insufficient rest could result in chronic fatigue. This fatigue that is being ignored or dragged for quite some time, in turn can leads to stress.

An effective ergonomics application at the workplace can give positive impact on occupational safety and health. For example, an ergonomically designed workstation is

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one of the strategies to reduce work stress, give comfort to user, increase user's productivity, and also aid in faster work completion. In the journal by Makhbul, Z. M., & Hasun, F. M. (2019), other mentioned common cause of stress in the workplace associated with a poor ergonomic workstation and environment are as follows:

i. No support in terms of preparing ergonomic facilities such as furniture or workstation for employees to carry out their work duty at home.
ii. Lack of skills: Employees are being asked to carry out a job for which they do not have experience or training such as ergonomics awareness and training.
iii. Poor physical working environment: Excessive heat, cold or noise, poor lighting, uncomfortable seating, faulty equipment, etc.

2.9 Legal and Standard Requirement

In Malaysia, Department of Occupational Safety and Health or also known as DOSH has introduced the Guidelines on Ergonomics Risk Assessment at Workplace 2017 to provide a structured plan and an objective emphasizes in identifying, assessing, and controlling risk factors associate with the work tasks and activities in the workplace. The purpose of this guideline is to assist employers, employees and safety and health practitioners in reducing ergonomics-related injuries and musculoskeletal disorders. As a result, the best ergonomics practices can be implemented into the designs to support workplace operation and requirements. Other standard guidelines mentioned in the "Guidelines for Manual Handling at Workplace 2018" are as follows:

i. Section 15, OSHA 1994
ii. Section 12, FMA 1967

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2.10 Office ergonomics

Computer technology is changing the nature of the workplace. The increasingly sedentary work style may result in a variety of adverse health effects. Office ergonomics covers all the factors that impact on the health, wellbeing and productivity of people who work in an office environment, from chairs, desks and computers to shift patterns, work practices and stress management. Perhaps the most familiar aspect of office ergonomics relates to the physical environment, especially office chairs. To be ergonomic, a chair should be adjusted in seat height, backrest height and angle and armrest height (Table 2.5). Anthropometrics is used by ergonomics designers to assist in deciding the specifications for a chair, designers use a branch of ergonomics called anthropometrics. This covers body measurements, ranges of joint movement, reach distances and clearance dimensions. All of these are crucial to have any chance of creating products and spaces that fit a person properly and comfortably. Work equipment can have a considerable impact on user comfort, health, wellbeing, and performance. Poorly designed office equipment can influence headaches, job-related stress and musculoskeletal problems primarily affecting the lower back, neck, shoulders, and upper limbs. The use of office equipment that possesses good ergonomics is likely to reduce the risk of musculoskeletal problems. It also demonstrates an employer's commitment to its employees' health and wellbeing. In the study by Robertson, M. M., & O'Neill, M. J. (2003), trainees described that the office ergonomics training was beneficial, and they could apply it to their environment. In addition, it spotted increase in office ergonomics knowledge and skills of the participants from pre to post knowledge test especially in the categories of body postures, ergonomic design features, and corporate resources. Through training, the knowledge gained in terms of understanding proper use of their work environment to achieve a neutral posture and enhance working posture.

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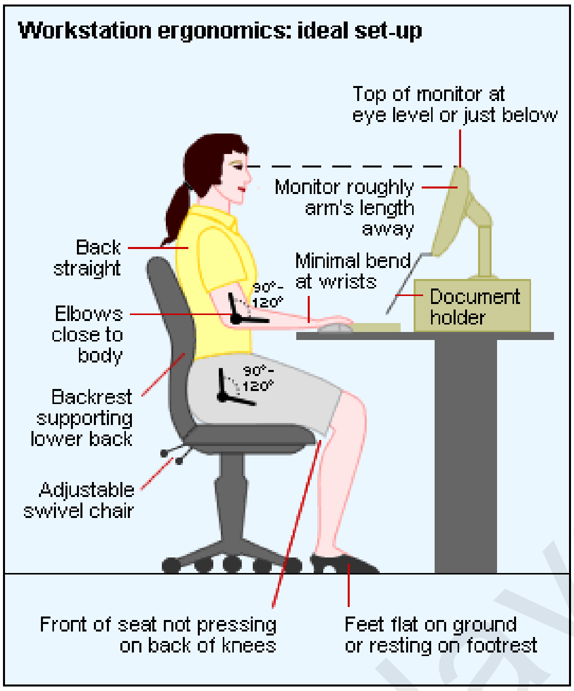

Figure 2.5: Workstation ergonomics: The ideal setup.

2.11 Ergonomics Awareness Training and Education

Ergonomics risk factors includes contact stress, awkward posture (where pose of the body that deviate significantly from the neutral position while performing work activities), and repetitive movement are proven to be the main cause to other ergonomics associated musculoskeletal disorders. In the study by Shariat, A., Cleland, J. A., Danaee, M., Kargarfard, M., Sangelaji, B., & Tamrin, S. B. (2018), it stated that many studies demonstrated musculoskeletal disorders were the key to absenteeism and disability as well as contributed to medical leave due to physical injuries or pain. This negative impact strongly influences the efficiency of the employee in terms of individual's productivity and quality of life as well as impacting the employer's organization.

It is important to educate computer users about office ergonomics through trainings. The purpose of the training is to educate workers and staffs from different managerial levels in the organization about office safety. The effectiveness of office ergonomics training reported improvements in knowledge and workstation habits and a reduction in musculoskeletal disorders. Various educational interventions include the use of posters, emails, pictures of body stretching and stress relief activities, and informational booklets can be used to increase workers' knowledge to prevent body injuries when using computer.

As mentioned in the study of Mahmud, N., Kenny, D. T., Zein, R. M., & Hassan, S. N. (2011), workers in a petrochemical research and development facility who underwent education programs such as participatory training (an active learning session with discussions and problem-solving exercises) and traditional trainings (lectures and handouts) reported improvements in workstation posture and symptom severity as compared to those who did not receive any training. It was also reported that those who attended training suffered lesser pain or discomfort, and a positive perception of psychosocial work stress. It is suggested that knowledge derived from training would not be effective unless workers are provided with the suitable equipment to implement it.

A cross-sectional survey that assessed the awareness of office ergonomics and the prevalence of musculoskeletal disorders had been previously conducted among the target group of Universiti Teknologi Malaysia (UTM) office workers. The findings reported a low level of office ergonomics awareness and high 12-months prevalence rates of musculoskeletal disorders in the shoulder with 51.6%, neck with 48.2%, and back with 42.2%. Results from the study suggested that UTM staffs needed office ergonomics training because they have not previously attended any formal training. According to Makhbul, Z. M., & Hasun, F. M. (2019), training plays an important role in minimizing stress outcomes due to unergonomic workstation physical environment. Through training, companies are able to educate their staff to alter their workstations to fulfill individual's needs and comfort. Musculoskeletal and fatigue problems also could be reduced if trainings are administered.

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CHAPTER 3: METHODOLOGY

3.1 Participants and Procedure

This study was conducted between mid of April to end of August 2021. Data were collected through via social media platforms and emails from 31st July 2021 to 1st August 2021. Eligible participants were identified by an initial screening question (inclusion criterion) that asked if the participant is an adult white collar or professional employees in Malaysia, aged from 20 and above, who worked at an office desk and had transitioned to work from home due to the COVID-19 pandemic. The survey was a cross-sectional evaluation of the ergonomics practices on home workstation of work from home employees in Malaysia. It investigated the ergonomics stressors and discomforts due to workstation conditions. 211 professional employees returned surveys about their home computer workstation conditions.

3.2 Survey

The survey of this research included questions relating to demographic profile of the respondents, computer workstation ergonomics self-assessment checklist, and standardized questionnaires for analysis of the musculoskeletal symptoms on the wellbeing resulting from the workstation conditions. The questions on Musculoskeletal symptoms were adapted from Nordic questionnaire meanwhile the self-assessment questionnaire was adapted from the study of Khan, M. A., Asif, M., Chughtai, M. R. B., Rajput, H. I., & Khalfe, S. A. H. (2017). Full attachment of this questionnaire is provided in Appendix A. The first part of questionnaire contained three questions concerned participants' demographic details such as respondents' gender, age group, and total hours spent in front of computer per day. The second part of the questionnaire consisted of six questions regarding the respondents' acknowledgement about office ergonomics, the

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provision of office ergonomics training whether the respondents received or not prior to work from home, the respondent's types of tables and chairs used for home workstation, the respondents' views whether they were satisfied with their workstation setup or not, and reasons to dissatisfactory working conditions when working at home. The third part of questionnaire contained questions pertaining to workstation assessment such as the respondent's sitting postures when working, physical pain or discomforts in certain body regions experienced by the respondents due to workstation conditions, and a section for open comment was provided for respondents to express additional concerns. For this part of the survey, the pain or discomfort in body regions such as the neck, shoulder, upper back, elbow, lower arm, wrist, hand, lower back, thigh, knee, calf, ankle and feet were investigated. This observation checklist was used to evaluate the posture of each respondent while they were working at their own computer workstation.

3.3 Data Analysis

All the data was analyzed using computer software "Statistical Package for Social Science" (SPSS). Descriptive statistics were determined for each variable, including frequency and percentage of samples responded are applied to summarize the data. Each question is coded according to the number of options and a unique code is used for each option of the closed questions. Pearson correlation analyses were performed to examine individual associations between musculoskeletal discomforts due to workstation conditions and the observed sitting postures of the respondents. Meaningful correlations were identified as very weak (0.00 to 0.19), weak (0.20 to 0.39), moderate (0.40 to 0.59), strong (0.60 to 0.79) and strong (0.80 to 1.0).

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CHAPTER 4: RESULTS AND DISCUSSIONS

4.1 Survey Results

More than half of the survey respondents who transitioned to home office work environment due to the pandemic outbreak reported that they experienced body discomforts. Many of the home computer workstations and working practices result in poor body postures. Poor body postures which lead to physical health issues is very prevalent among homeworking employees. Therefore, work from home employees raise concern for impacts on their long-term health. For this research, 211 surveys were completed, and all respondents are computer users. 104 (49.3%) respondents were female, and 107 (50.7%) respondents were male (Table 4.1). The number of male and female respondents in this study were almost proportioned. Figure 4.1 shows majority of the respondents were in the age group of 30 to 39 years (64%, n=135).

Table 4.1: Demographic details of respondents.

Age group	Female	Male	Total respondents
20 - 29 years	29	25	54
30 - 39 years	62	73	135
40 - 49 years	11	7	18
50 - 59 years	2	2	4
Total	104 (49.3%)	107 (50.7%)	211 (100%)

4.1.1 Musculoskeletal Discomforts Suffered by Respondents

Table 4.2 shows that respondents involved in this study experienced body discomforts perceived due to workstation conditions specifically in the shoulder (70.1%, n=148), neck (69.7%, n=147), upper back (65.9%, n=139), and lower back (64%, n=135). About more than half of the homeworking employees reported having neck, shoulder, and back pain. This was consistent with main location of musculoskeletal symptoms among computer users. The significant findings in this study were that the most common

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sites of pain like neck, shoulder and back pain were almost similar in the study conducted by Borhany, T., Shahid, E., Siddique, W. A., & Ali, H. (2018). Furthermore, previous studies on musculoskeletal symptoms among workers involved in computer work showed both neck and shoulder were common body parts affected (Eltayeb, S. M., Staal, J. B., Hassan, A. A., Awad, S. S., & de Bie, R. A., 2008). Another body site that frequently affected was the back which consisted of upper back and lower back as observed in the study of Moom, R. K., Singb, L. P., & Moom, N. (2015).

Table 4.2: Body parts with symptoms.

		I have pain/discomfort in the following body parts	I don't have pain/discomfort in the following body parts	Total respondents
1	Neck	147 (69.7%)	64 (30.3%)	211 (100%)
2	Shoulder	148 (70.1%)	63 (29.9%)	211 (100%)
3	Upper back	139 (65.9%)	72 (34.1%)	211 (100%)
4	Elbow	99 (46.9%)	112 (53.1%)	211 (100%)
5	Lower arm	85 (40.3%)	126 (59.7%)	211 (100%)
6	Wrist	85 (40.3%)	126 (59.7%)	211 (100%)
7	Hand	54 (25.6%)	157 (74.4%)	211 (100%)
8	Lower back	135 (64%)	76 (36%)	211 (100%)
9	Thigh	91 (43.1%)	120 (56.9)	211 (100%)
10	Knee	58 (27.5%)	153 (72.5%)	211 (100%)
11	Calf	30 (14.2%)	181 (85.8%)	211 (100%)
12	Ankle	31 (14.7%)	180 (85.3%)	211 (100%)
13	Feet	56 (26.5%)	155 (73.5%)	211 (100%)

4.1.2 Musculoskeletal Discomforts in Different Age Groups

Based on the findings of this study, it was found that the numbers of pains or musculoskeletal discomforts suffered by the respondents were equal across all age groups (Table 4.3). It does not conform to the common perception that attributes physical problems increased with age. Although, age is one of the factors that influences the physical health of a person because it is known that physical health typically declines with age. However, exposure to risk factors such as continuous working without breaks,

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poorly designed of home workstation and wrong sitting postures can act as risk factors for these musculoskeletal symptoms.

Table 4.3: Shoulder, neck, upper back, and lower back discomforts across different age groups.

	Age group (year)	I have pain/discomfort in the following body part. (n)	I don't have pain/discomfort in the following body part. (n)	Total (n)
Shoulder	20 – 29	38	16	54
	30 - 39	93	42	135
	40 - 49	14	4	18
	50 - 59	3	1	4
Neck	20 - 29	38	16	54
	30 - 39	91	44	135
	40 - 49	14	4	18
	50 - 59	4	-	4
Upper back	20 – 29	36	18	54
	30 - 39	87	48	135
	40 - 49	12	6	18
	50 - 59	4	-	4
Lower back	20 – 29	34	20	54
	30 - 39	85	50	135
	40 - 49	12	6	18
	50 - 59	4	-	4

4.1.3 Frequency of Computer Use

75 respondents spent 7 to 8 hours on computers per day (35.5%) meanwhile 59 respondents spent 9 hours or more on computers per day (Figure 4.1).

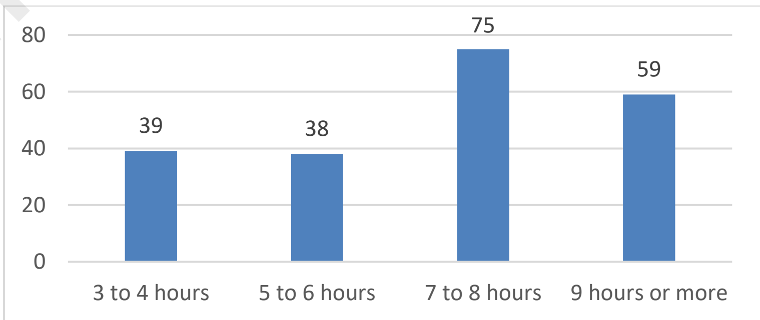

Figure 4.1: Duration of computer use among respondents.

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Out of 39 respondents who spent 3 to 4 hours on computer, 29 persons experienced neck pain, 29 persons experienced shoulder pain, 27 persons experienced upper back pain and 28 persons experienced lower back pain. Out of 38 respondents who spent 5 to 6 hours on computer, 24 persons experienced neck pain, 23 persons experienced shoulder pain, 21 persons experienced upper back pain and 20 persons experienced lower back pain. Out of 75 respondents who spent 7 to 8 hours on computer, 50 persons experienced neck pain, 53 persons experienced shoulder pain, 50 persons experienced upper back pain and 49 persons experienced lower back pain. Out of 59 respondents who spent 9 hours or more on computer, 44 persons experienced neck pain, 43 persons experienced shoulder pain, 41 persons experienced upper back pain and 38 persons experienced lower back pain (Table 4.4).

Musculoskeletal disorders develop over the course of time as the result of exposure to risk factors, leading to chronic soft tissue, muscle or tendon fatigue outpacing our body's ability to recover and repair. A person who spends prolonged hours working on computer normally would experience more risks to body discomforts compared to a person who spends shorter duration working on computer. In this study, it was observed that the factor of total time spent on computer may not be very significant as compared to a study that was carried out by Borhany, T., Shahid, E., Siddique, W. A., & Ali, H. (2018) who evaluated that those who had the symptoms of musculoskeletal problems in different anatomical sites like neck, shoulder, wrist and headache were the ones who used computers for more than 6 hours. Table 4.4 showed that even respondents of this study who worked only 3 to 4 hours daily on computer workstation suffered from musculoskeletal discomforts. Another contributing factors could be working in a static posture for prolonged hours, and continuous use of computer without frequent breaks or moves may also affect work.

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Table 4.4: The effects of total hours spent on computer towards shoulder, neck, upper back, and lower back discomforts.

	Total hours spent on computer	I have pain/discomfort in the following body part. n (%)	I don't have pain/discomfort in the following body part. n (%)	Total n (%)
Shoulder	3 – 4	29 (74.5%)	10 (25.6%)	39 (100%)
	5 – 6	23 (60.5%)	15 (39.5%)	38 (100%)
	7 – 8	53 (70.7%)	22 (29.3%)	75 (100%)
	9 & more	43 (72.9%)	16 (27.1%)	59 (100%)
Neck	3 – 4	29 (74.5%)	10 (25.6%)	39 (100%)
	5 – 6	24 (63.2%)	14 (36.8%)	38 (100%)
	7 – 8	50 (66.7%)	25 (33.3%)	75 (100%)
	9 & more	44 (74.6%)	15 (25.4%)	59 (100%)
Upper back	3 – 4	27 (69.2%)	12 (30.8%)	39 (100%)
	5 – 6	21 (55.3%)	17 (44.7%)	38 (100%)
	7 – 8	50 (66.7%)	25 (33.3%)	75 (100%)
	9 & more	41 (69.5%)	18 (30.5%)	59 (100%)
Lower back	3 – 4	28 (71.8%)	11 (28.2%)	39 (100%)
	5 – 6	20 (52.6%)	18 (47.4%)	38 (100%)
	7 – 8	49 (65.3%)	26 (34.7%)	75 (100%)
	9 & more	38 (64.4%)	21 (35.6%)	59 (100%)

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4.1.4 Types of Tables and Chairs Used for Home Workstation

Figure 4.2 reveals 116 respondents had chosen computer table with fixed height for their home workstations, followed by 42 respondents chose dining table, 17 respondents chose computer table with adjustable height, 13 respondents chose living room coffee table, 12 respondents chose portable table with fixed height, 10 respondents chose lap desk and 1 respondent with other type of desk.

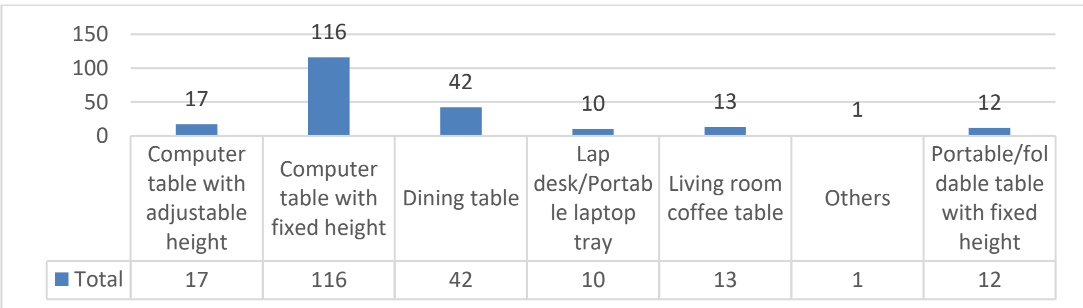

Figure 4.2: Types of tables chosen by respondents for their home workstations.

Figure 4.3 shows that 54 of the respondents reported using standard office chair with adjustable height for their home computer workstation, followed by 53 of the respondents were using ergonomic office chair, 37 of the respondents were using dining chair, 22 of the respondents were using stool, 19 of the respondents were using couch and standard office chair with fixed height respectively, 2 of the respondents were using gaming chair and 5 respondents with other types of chairs.

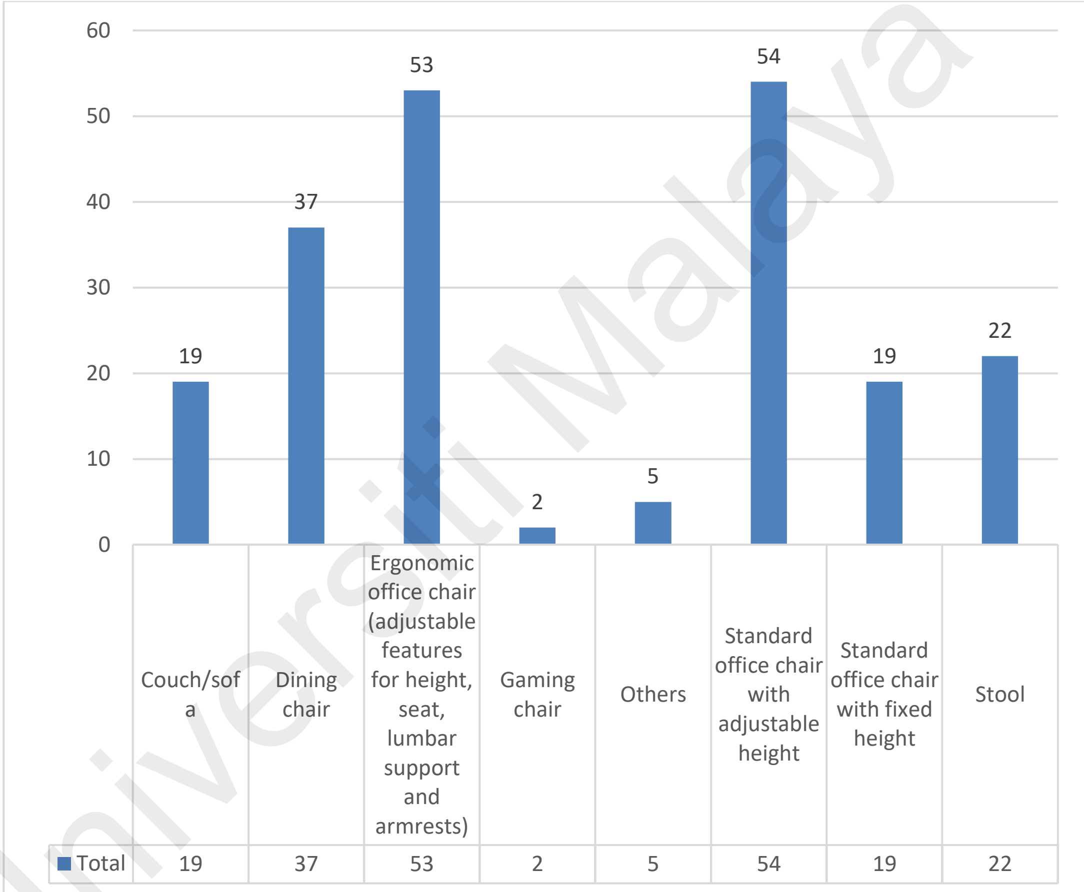

Figure 4.3: Types of chairs chosen by respondents for their home workstations.

Ergonomic office chair has a wide range of comfort-maximizing adjustable features. It was observed from the survey result of this study that even though ergonomic office chair was widely chosen among respondents, yet the findings showed that many of them still experienced musculoskeletal discomforts. Other contributing factors to musculoskeletal discomforts in respondents could be the disproportion between users'

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anthropometric dimensions and available furniture. In the study of Ansari, S., Nikpay, A., & Varmazyar, S. (2018), an ergonomic chair with adjustable parts was designed to reduce musculoskeletal disorders. Some ergonomic characteristics of this chair include adjustability of footrest, backrest, armrests and height of desk which can be used by many people with different body sizes to achieve a well-match between anthropometric characteristics of students and the used furniture. Besides reducing musculoskeletal disorders, using appropriate designed furniture may reduce fatigue and discomforts in sitting posture, allows students to sit comfortably for longer periods of time consequently and improves their performances.

There is other responsible factor to why certain respondents had chosen non-ergonomic table or chair, and this was subjected to the affordability of the user. Even though ergonomics furniture costs more than any ordinary furniture but it caters to the comfort of the user for prolonged usage. Ergonomics is a well worth investment. It reduces cost such as reduction in musculoskeletal disorders, in accidence rate, in lost workdays, in worker's compensation costs, in cost per claim and labor costs. Also, it improves employee engagement such as reduction in employee turnover and absenteeism.

4.1.5 Provision of Office Ergonomics Training

From the survey results, 168 of the participants acknowledged that they knew or heard of office ergonomics, followed by 43 of the participants responded that they did not know about office ergonomics (Figure 4.4).

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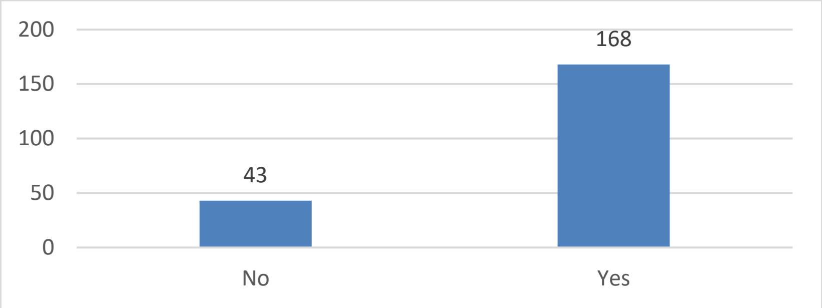

Figure 4.4: Respondents' acknowledgement of office ergonomics.

Although a huge number of respondents claimed that they acknowledged what office ergonomics is, but through observation on respondents' work practices, poor work postures were still common among work from home employees. From Table 4.5, observations of the work practice revealed that most common poor posture of the respondents was caused by the lower back not supported by a backrest when sitting (156). This followed by work surface not adjusted at elbow height (129), wrists were not in straight positions when typing (129), elbow not close to body when operating the mouse (128), and head not in an upright position as topline of the monitor was not adjusted at a level slightly below eye (121). Question 10 and 11 of Table 4.5 also shows that majority of the respondents did not own document holder when working on computers at home.

Table 4.5: Work postures among work from home employees observed.

		Yes	No	Total
1	Do you have sufficient leg room at your desk?	171	40	211
2	Is the desk space adequate for the work?	173	38	211
3	Is your work surface adjusted at your elbow height?	82	129	211
4	Is your chair adjusted at appropriate height with your feet flat on the floor or fully supported by footrest, so your thighs are horizontal with a 90-to-110-degree angle at the hip?	159	52	211
5	Is you lower back supported by a backrest so that it promotes the natural curve of the lower back?	55	156	211
6	Does your chair have armrests so your upper arms and shoulders should be relaxed?	119	92	211
7	Does the placement of your computer monitor is directly in front of you with an arm length between the monitor and you?	162	49	211

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8	Is the top line of the computer monitor adjusted at or slightly below eye level for a comfortable head and neck upright posture?	90	121	211
9	Is your computer screen free from noticeable glare that might cause you to bend your head or body to read screen?	105	106	211
10	Do you use a document holder when you work from other documents?	60	151	211
11	Do you position the document holder close to the monitor or laptop screen?	47	164	211
12	Does the placement of your keyboard is directly in front of you and flat on the work surface with your wrists fairly straight when typing?	82	129	211
13	Is your mouse located as close as possible to the keyboard with your elbow close to the body and your wrists are fairly straight on the work surface when operating it?	83	128	211
14	Are frequently used items positioned within easy reach of your normal working position?	173	38	211
15	Do you take short breaks from your workstation to stretch and move about?	167	44	211

Figure 4.5 shows that 146 of the overall respondents revealed that their companies or employers did not provide office ergonomics training for office employees meanwhile 65 respondents reported that their companies did provide office ergonomics training for their employees.

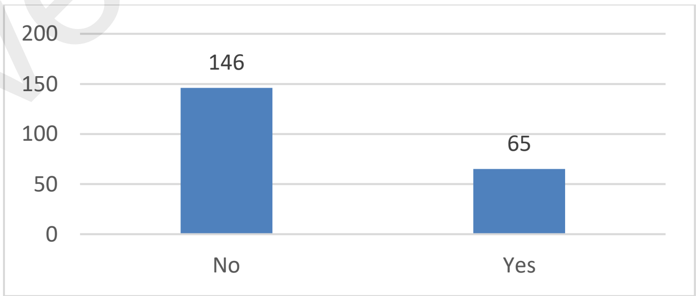

Figure 4.5: Provision of Office Ergonomics Training by Company

Research suggests that ergonomics training and workstation design can prevent or reduce musculoskeletal injuries in an office environment. Office ergonomics interventions contribute to enhanced worker health and well-being as well as to organizational effectiveness. Improved education and training regarding computer use

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have significant impact on posture care among computer users. While using computers in this era of technology and digitalization, people often forget that their bodies need care regarding appropriate posture and timings to use these devices. In the study by Robertson, M. M., & O'Neill, M. J. (2003), the findings reported that office ergonomics training was beneficial and that they could apply the information to their work environment. The knowledge gained from office ergonomics training and workplace design, workers were able to appropriately change and adjust their workstation and chair setup as well as use the workplace facility more ergonomically and effectively. The results suggests that the provision of ergonomic skills, in the form of training, allows individuals to make appropriate workstation changes, thus reducing musculoskeletal risks and discomfort associated with computer work. It is important to create awareness about the importance of having a proper workstation among homeworking employees who are computer. Employers or organizations need to ensure employees have proper knowledge of office ergonomics prior to apply it not only at the office but also when working at home. In the study conducted by Mahmud, N., Kenny, D. T., Zein, R. M., & Hassan, S. N. (2011), it was found that the office ergonomics awareness among office workers in Universiti Teknologi Malaysia was low and there was a high prevalence of musculoskeletal symptoms especially in the neck, shoulder and back region. Therefore, it is recommended for organizations to provide proper training of office ergonomics to their employees to prevent potential musculoskeletal disorders from developing. It brings benefit not only to the individual itself but also to the organization.

4.1.6 Respondent's Satisfaction Towards Their Home Workstation Setup

In this study, job satisfaction was meant for the employee's total positive feeling about their workstation setups when working from home. In Figure 4.6, it was observed

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that 159 respondents were dissatisfied with their home workstation setup, followed by 52 respondents were satisfied with their home workstations.

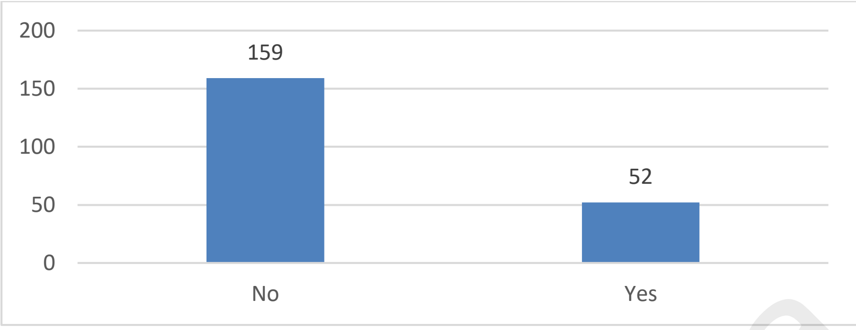

Figure 4.6: Respondent's Satisfactory Towards Their Workstation Setup

Among the dissatisfied work from home employees, the main reasons for dissatisfaction were obtained through survey. It was found that 79 respondents reported that there is no furniture allowance given by the company to setup a proper workstation prior to homeworking, 57 respondents expressed that it is not necessary to setup a proper ergonomically computer workstation at home because homeworking is assumed only temporary, 15 respondents mentioned that there is limited space to setup proper ergonomically computer workstation or not enough space to locate a new furniture in their homes and 7 respondents stated that insufficient furniture allowance given by the company (Figure 4.7).

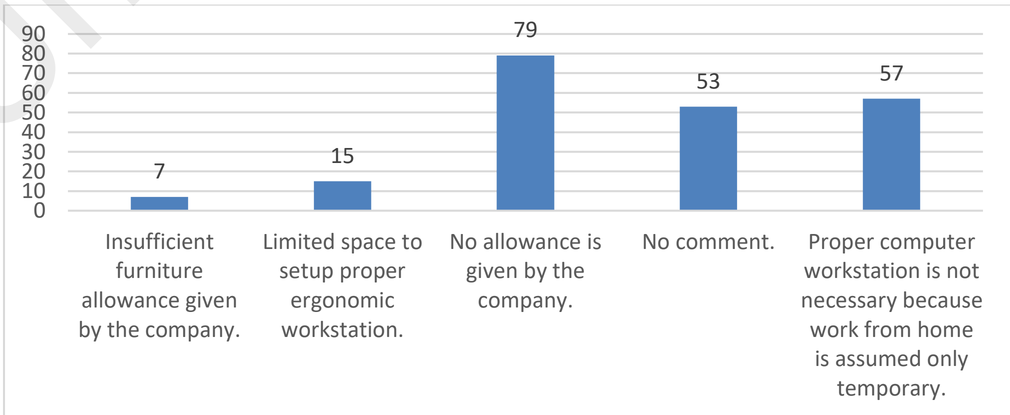

Figure 4.7: Reasons for Dissatisfaction

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As working from home continues to become accepted as a new norm, organizations will want to encourage their employees to stay healthy which ultimately drives more self-satisfaction and greater productivity. Organizations or employers have a duty to ensure employees have the appropriate equipment to carry out any work from home. There are costs associated with working from home such as stable broadband access, proper ergonomic furniture, monitors, electricity, cell phone usage including proper ergonomic furniture. Organizations are recommended to provide employees by offering home office set-up reimbursement or furniture allowance. They can also consider negotiating discount arrangements with retailers to allow staff to personalize their home offices to optimize individual productivity. This does not necessarily mean the organizations are required to provide new laptop, table or chair. It can also be suggested to small companies with limited budget to allow their employees to bring home company's personal furniture or equipment for employees' temporary needs at home. It is also the responsibility of an employer to carry out a risk assessment on home office environment to offer guidance on setting up a healthy, ergonomic work environment at home or even provide one-on-one evaluations of home workspaces to evaluate ergonomics or health and safety risks. This may help homeworking employees to avoid musculoskeletal discomforts that arise from poorly set up work environments. The current pandemic has reinforced the importance of organizational culture and values in helping employees be productive and find purpose in their work. It is key to build confidence and trust among management and staff by providing inductions, trainings, and regular refreshers on how to effectively work remotely as well as how to best manage a mobile workforce. Also, to provide employees with necessary information concerning work practices, mental and physical wellbeing issues. This can be achieved through daily interactions, collaborations, spontaneous gathering, and face-to-face meetings. In addition, employers should establish clear protocols for communicating flexible work

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schedules, including guidance on the best channels to use to notify a point person and policies about when this needs to be communicated.

4.2 Associations Among Individual Variables

i. There were negative correlations between number of respondents' who were satisfied with their home workstation setup with number of reported neck pain, shoulder pain, upper back pain and lower back pain.

Correlations

		Employee satisfactory toward their home computer workstation setup	Neck pain
Employee satisfactory toward their home computer workstation setup	Pearson Correlation	1	-.484**
	Sig. (2-tailed)		<.001
	N	211	211
Neck pain	Pearson Correlation	-.484**	1
	Sig. (2-tailed)	<.001	
	N	211	211

Correlations

		Employee satisfactory toward their home computer workstation setup	Shoulder pain
Employee satisfactory toward their home computer workstation setup	Pearson Correlation	1	-.468**
	Sig. (2-tailed)		<.001
	N	211	211
Shoulder pain	Pearson Correlation	-.468**	1
	Sig. (2-tailed)	<.001	
	N	211	211

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Correlations

		Employee satisfactory toward their home computer workstation setup	Upper back pain
Employee satisfactory toward their home computer workstation setup	Pearson Correlation	1	-.563**
	Sig. (2-tailed)		<.001
	N	211	211
Upper back pain	Pearson Correlation	-.563**	1
	Sig. (2-tailed)	<.001	
	N	211	211

Correlations

		Employee satisfactory toward their home computer workstation setup	Lower back pain
Employee satisfactory toward their home computer workstation setup	Pearson Correlation	1	-.602**
	Sig. (2-tailed)		<.001
	N	211	211
Lower back pain	Pearson Correlation	-.602**	1
	Sig. (2-tailed)	<.001	
	N	211	211

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ii. There were negative correlations between number of respondents' who practiced work surface adjusted at elbow height with number of reported shoulder pain, elbow pain, lower arm pain, wrist pain and hand pain.

Correlations

		Is your work surface adjusted at your elbow height?	Shoulder pain
Is your work surface adjusted at your elbow height?	Pearson Correlation	1	-.415**
	Sig. (2-tailed)		<.001
	N	211	211
Shoulder pain	Pearson Correlation	-.415**	1
	Sig. (2-tailed)	<.001	
	N	211	211

Correlations

		Is your work surface adjusted at your elbow height?	Elbow pain
Is your work surface adjusted at your elbow height?	Pearson Correlation	1	-.730**
	Sig. (2-tailed)		<.001
	N	211	211
Elbow pain	Pearson Correlation	-.730**	1
	Sig. (2-tailed)	<.001	
	N	211	211

Correlations

		Is your work surface adjusted at your elbow height?	Lower arm pain
Is your work surface adjusted at your elbow height?	Pearson Correlation	1	-.595**
	Sig. (2-tailed)		<.001
	N	211	211
Lower arm pain	Pearson Correlation	-.595**	1
	Sig. (2-tailed)	<.001	
	N	211	211

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Correlations

		Is your work surface adjusted at your elbow height?	Wrist pain
Is your work surface adjusted at your elbow height?	Pearson Correlation	1	-.556**
	Sig. (2-tailed)		<.001
	N	211	211
Wrist pain	Pearson Correlation	-.556**	1
	Sig. (2-tailed)	<.001	
	N	211	211

Correlations

		Is your work surface adjusted at your elbow height?	Hand pain
Is your work surface adjusted at your elbow height?	Pearson Correlation	1	-.222**
	Sig. (2-tailed)		.001
	N	211	211
Hand pain	Pearson Correlation	-.222**	1
	Sig. (2-tailed)	.001	
	N	211	211

iii. There were negative correlations between number of respondents' who practiced chair adjusted at appropriate height with number of reported thigh pain, knee pain, calf pain and ankle pain.

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Correlations

		Is your chair adjusted at appropriate height with your feet flat on the floor or fully supported by a footrest?	Thigh pain
Is your chair adjusted at appropriate height with your feet flat on the floor or fully supported by a footrest so your thighs are horizontal with a 90 to 110 degree angle at the hip?	Pearson Correlation	1	-.301**
	Sig. (2-tailed)		<.001
	N	211	211
Thigh pain	Pearson Correlation	-.301**	1
	Sig. (2-tailed)	<.001	
	N	211	211

Correlations

		Is your chair adjusted at appropriate height with your feet flat on the floor or fully supported by a footrest?	Knee pain
Is your chair adjusted at appropriate height with your feet flat on the floor or fully supported by a footrest so your thighs are horizontal with a 90 to 110 degree angle at the hip?	Pearson Correlation	1	-.264**
	Sig. (2-tailed)		<.001
	N	211	211
Knee pain	Pearson Correlation	-.264**	1
	Sig. (2-tailed)	<.001	
	N	211	211

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Correlations

		Is your chair adjusted at appropriate height with your feet flat on the floor or fully supported by a footrest?	Calf pain
Is your chair adjusted at appropriate height with your feet flat on the floor or fully supported by a footrest so your thighs are horizontal with a 90 to 110 degree angle at the hip?	Pearson Correlation	1	-.240**
	Sig. (2-tailed)		<.001
	N	211	211
Calf pain	Pearson Correlation	-.240**	1
	Sig. (2-tailed)	<.001	
	N	211	211

Correlations

		Is your chair adjusted at appropriate height with your feet flat on the floor or fully supported by a footrest?	Ankle pain
Is your chair adjusted at appropriate height with your feet flat on the floor or fully supported by a footrest so your thighs are horizontal with a 90 to 110 degree angle at the hip?	Pearson Correlation	1	-.260**
	Sig. (2-tailed)		<.001
	N	211	211
Ankle pain	Pearson Correlation	-.260**	1
	Sig. (2-tailed)	<.001	
	N	211	211

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iv. There were negative correlations between number of respondents' who practiced lower back supported by backrest with number of reported upper back pain and lower back pain.

Correlations

		Is you lower back supported by a backrest so that it promotes the natural curve of the lower back?	Upper back pain
Is you lower back supported by a backrest so that it promotes the natural curve of the lower back?	Pearson Correlation	1	-.506**
	Sig. (2-tailed)		<.001
	N	211	211
Upper back pain	Pearson Correlation	-.506**	1
	Sig. (2-tailed)	<.001	
	N	211	211

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Correlations

		Is you lower back supported by a backrest so that it promotes the natural curve of the lower back?	Lower back pain
Is you lower back supported by a backrest so that it promotes the natural curve of the lower back?	Pearson Correlation	1	-.589**
	Sig. (2-tailed)		<.001
	N	211	211
Lower back pain	Pearson Correlation	-.589**	1
	Sig. (2-tailed)	<.001	
	N	211	211

v. There were negative correlations between number of respondents' who practiced chair with armrests with number of reported shoulder pain, elbow pain, lower arm pain, wrist pain and hand pain.

Correlations

		Does your chair have armrests so your upper arms and shoulders should be relaxed?	Shoulder pain
Does your chair have armrests so your upper arms and shoulders should be relaxed?	Pearson Correlation	1	-.511**
	Sig. (2-tailed)		<.001
	N	211	211
Shoulder pain	Pearson Correlation	-.511**	1
	Sig. (2-tailed)	<.001	
	N	211	211

Correlations

		Does your chair have armrests so your upper arms and shoulders should be relaxed?	Elbow pain
Does your chair have armrests so your upper arms and shoulders should be relaxed?	Pearson Correlation	1	-.322**
	Sig. (2-tailed)		<.001
	N	211	211
Elbow pain	Pearson Correlation	-.322**	1
	Sig. (2-tailed)	<.001	
	N	211	211

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Correlations

		Does your chair have armrests so your upper arms and shoulders should be relaxed?	Lower arm pain
Does your chair have armrests so your upper arms and shoulders should be relaxed?	Pearson Correlation	1	-.915**
	Sig. (2-tailed)		<.001
	N	211	211
Lower arm pain	Pearson Correlation	-.915**	1
	Sig. (2-tailed)	<.001	
	N	211	211

Correlations

		Does your chair have armrests so your upper arms and shoulders should be relaxed?	Wrist pain
Does your chair have armrests so your upper arms and shoulders should be relaxed?	Pearson Correlation	1	-.817**
	Sig. (2-tailed)		<.001
	N	211	211
Wrist pain	Pearson Correlation	-.817**	1
	Sig. (2-tailed)	<.001	
	N	211	211

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Correlations

		Does your chair have armrests so your upper arms and shoulders should be relaxed?	Hand pain
Does your chair have armrests so your upper arms and shoulders should be relaxed?	Pearson Correlation	1	-.295**
	Sig. (2-tailed)		<.001
	N	211	211
Hand pain	Pearson Correlation	-.295**	1
	Sig. (2-tailed)	<.001	
	N	211	211

vi. There were negative correlations between number of respondents' who practiced placement of computer monitor directly in front with an arm's length distant with number of reported neck pain and shoulder pain.

Correlations

		Does the placement of your computer monitor is directly in front of you with an arm length between the monitor and you?	Neck pain
Does the placement of your computer monitor is directly in front of you with an arm length between the monitor and you?	Pearson Correlation	1	-.363**
	Sig. (2-tailed)		<.001
	N	211	211
Neck pain	Pearson Correlation	-.363**	1
	Sig. (2-tailed)	<.001	
	N	211	211

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Correlations

		Does the placement of your computer monitor is directly in front of you with an arm length between the monitor and you?	Shoulder pain
Does the placement of your computer monitor is directly in front of you with an arm length between the monitor and you?	Pearson Correlation	1	-.334**
	Sig. (2-tailed)		<.001
	N	211	211
Shoulder pain	Pearson Correlation	-.334**	1
	Sig. (2-tailed)	<.001	
	N	211	211

vii. There were negative correlations between number of respondents' who practiced adjustment of the topline of the computer monitor slightly below eye level with number of reported neck pain and shoulder pain.

Correlations

		Is the top line of the computer monitor adjusted at or slightly below eye level for a comfortable head and neck upright posture?	Neck pain
Is the top line of the computer monitor adjusted at or slightly below eye level for a comfortable head and neck upright posture?	Pearson Correlation	1	-.723**
	Sig. (2-tailed)		<.001
	N	211	211
Neck pain	Pearson Correlation	-.723**	1
	Sig. (2-tailed)	<.001	
	N	211	211

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Correlations

		Is the top line of the computer monitor adjusted at or slightly below eye level for a comfortable head and neck upright posture?	Shoulder pain
Is the top line of the computer monitor adjusted at or slightly below eye level for a comfortable head and neck upright posture?	Pearson Correlation	1	-.736**
	Sig. (2-tailed)		<.001
	N	211	211
Shoulder pain	Pearson Correlation	-.736**	1
	Sig. (2-tailed)	<.001	
	N	211	211

viii. There were negative correlations between number of respondents' who practiced computer screen free from glare without having to bend their head or body to read screen with number of reported neck pain, shoulder pain, back pain and lower back pain.

Correlations

		Is your computer screen free from noticeable glare that might cause you to bend your head or body to read screen?	Neck pain
Is your computer screen free from noticeable glare that might cause you to bend your head or body to read screen?	Pearson Correlation	1	-.601**
	Sig. (2-tailed)		<.001
	N	211	211
Neck pain	Pearson Correlation	-.601**	1
	Sig. (2-tailed)	<.001	
	N	211	211

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Correlations

		Is your computer screen free from noticeable glare that might cause you to bend your head or body to read screen?	Shoulder pain
Is your computer screen free from noticeable glare that might cause you to bend your head or body to read screen?	Pearson Correlation	1	-.635**
	Sig. (2-tailed)		<.001
	N	211	211
Shoulder pain	Pearson Correlation	-.635**	1
	Sig. (2-tailed)	<.001	
	N	211	211

Correlations

		Is your computer screen free from noticeable glare that might cause you to bend your head or body to read screen?	Upper back pain
Is your computer screen free from noticeable glare that might cause you to bend your head or body to read screen?	Pearson Correlation	1	-.683**
	Sig. (2-tailed)		<.001
	N	211	211
Upper back pain	Pearson Correlation	-.683**	1
	Sig. (2-tailed)	<.001	
	N	211	211

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Correlations

		Is your computer screen free from noticeable glare that might cause you to bend your head or body to read screen?	Lower back pain
Is your computer screen free from noticeable glare that might cause you to bend your head or body to read screen?	Pearson Correlation	1	-.537**
	Sig. (2-tailed)		<.001
	N	211	211
Lower back pain	Pearson Correlation	-.537**	1
	Sig. (2-tailed)	<.001	
	N	211	211

ix. There were negative correlations between number of respondents' who practiced placement of keyboard flat on worksurface and directly in front of you with wrists straight when typing with number of reported lower arm pain and wrist pain.

Correlations

		Does the placement of your keyboard is directly in front of you and flat on the work surface with your wrists fairly straight when typing?	Lower arm pain
Does the placement of your keyboard is directly in front of you and flat on the work surface with your wrists fairly straight when typing?	Pearson Correlation	1	-.595**
	Sig. (2-tailed)		<.001
	N	211	211
Lower arm pain	Pearson Correlation	-.595**	1
	Sig. (2-tailed)	<.001	
	N	211	211

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Correlations

		Does the placement of your keyboard is directly in front of you and flat on the work surface with your wrists fairly straight when typing?	Wrist pain
Does the placement of your keyboard is directly in front of you and flat on the work surface with your wrists fairly straight when typing?	Pearson Correlation	1	-.576**
	Sig. (2-tailed)		<.001
	N	211	211
Wrist pain	Pearson Correlation	-.576**	1
	Sig. (2-tailed)	<.001	
	N	211	211

x. There were negative correlations between number of respondents' who practiced operating mouse as close as possible to keyboard with elbow close to body and wrists straight on work surface with number of reported shoulder pain, upper back pain, lower arm pain and wrist pain.

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Correlations

		Is your mouse located as close as possible to the keyboard with your elbow close to the body and your wrists are fairly straight on the work surface?	Shoulder pain
Is your mouse located as close as possible to the keyboard with your elbow close to the body and your wrists are fairly straight on the work surface when operating it?	Pearson Correlation	1	-.407**
	Sig. (2-tailed)		<.001
	N	211	211
Shoulder pain	Pearson Correlation	-.407**	1
	Sig. (2-tailed)	<.001	
	N	211	211

Correlations

		Is your mouse located as close as possible to the keyboard with your elbow close to the body and your wrists are fairly straight on the work surface?	Upper back pain
Is your mouse located as close as possible to the keyboard with your elbow close to the body and your wrists are fairly straight on the work surface when operating it?	Pearson Correlation	1	-.525**
	Sig. (2-tailed)		<.001
	N	211	211
Upper back pain	Pearson Correlation	-.525**	1
	Sig. (2-tailed)	<.001	
	N	211	211

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Correlations

		Is your mouse located as close as possible to the keyboard with your elbow close to the body and your wrists are fairly straight on the work surface?	Lower arm pain
Is your mouse located as close as possible to the keyboard with your elbow close to the body and your wrists are fairly straight on the work surface when operating it?	Pearson Correlation	1	-.642**
	Sig. (2-tailed)		<.001
	N	211	211
Lower arm pain	Pearson Correlation	-.642**	1
	Sig. (2-tailed)	<.001	
	N	211	211

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Correlations

		Is your mouse located as close as possible to the keyboard with your elbow close to the body and your wrists are fairly straight on the work surface?	Wrist pain
Is your mouse located as close as possible to the keyboard with your elbow close to the body and your wrists are fairly straight on the work surface when operating it?	Pearson Correlation	1	-.602**
	Sig. (2-tailed)		<.001
	N	211	211

Wrist pain	Pearson Correlation	-.602**	1
	Sig. (2-tailed)	<.001	
	N	211	211

xi. In this study, there were no significant correlations between number of reported body discomforts with age group as the numbers of body discomforts suffered by the respondents were equal across all age groups (Table 4.3). There were also no significant correlations between number of reported body discomforts with total hour spent in front of computer per day because not only respondents who spent 7 hours and above daily on computer workstation who suffered body discomforts, but even respondents who worked only minimum of 3 to 4 hours suffered body discomforts (Table 4.4). Furthermore, there were no significant correlations between number of body discomforts with number of respondents who acknowledged office ergonomics because although a huge number of respondents claimed that they acknowledged what office ergonomics was, but through observation on respondents' work practices in Table 4.5, poor work postures were still common among work from home employees.

4.3 Proposed Model of Ergonomics Basic When Working from Home

Ergonomics is commonly associated only with office-based settings. As many employees start to work remotely, the importance of good ergonomics when working from home is becoming more apparent. Having appropriate furniture and equipment allows the individual to improve the set up at their workstation, increase comfort and reduce potential injury. Seating should support postures that can be changed frequently within a comfortable range throughout the day. It should accommodate the work being done, the visual demands and workers' individual differences. Table 4.6 and Figure 4.2.1 below illustrate acceptable sitting position at the workstation. It allows well supported

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postures that can be changed within a comfortable range throughout the day (Jefferelli, S. B., Hanizah, M. Y., & Norbrilliant, M., 2016).

Table 4.6: Recommendations for working comfortably at workstation.

Chair & Table	• Adjust armrest and the keyboard to a level where the top surface of the armrest and the bottom surface of the keyboard are the same to allow forearms resting on the work surface. • Adjust the seat height so your feet are flat on the floor and your knees equal to, or slightly lower than, your hips. Use a footrest if your feet dangle. • Adjust the back of the chair to 100-to-110-degree reclined angle. Make sure your upper and lower back are supported. • Advisable to have chair with supportive headrest, armrests and comfortable padding on the back and the seat.
Keyboard	• Position the keyboard directly in front of your body. • Adjust the keyboard height to same level as your armrests so your forearms rest on the work surface with your shoulders are relaxed, your elbows a slightly open position (100-to-110 degree), and wrists straight when typing. • Wrist-rests can help to maintain neutral postures and pad hard surfaces. However, the wrist-rest should only be used to rest the palms of the hands between keystrokes. Resting on the wrist-rest while typing is not recommended. Avoid using wrist-rests that are higher than the space bar of your keyboard.
Screen, document & telephone	• Centre the screen directly in front of you. Position the top of the screen to be set at eye level or 0-to-30 degree below eye level to reduce visual fatigue. • Sit at least an arm's length away from the screen. • Reduce glare by careful positioning of the screen. • Position source documents directly in front of you or adjacent to the screen using a document holder. • The desk should ideally be positioned parallel to window to prevent direct glare from outside. • Install blinds or window shades on the windows as an additional measure. • Place your telephone within easy reach or use a headset or speaker phone to eliminate cradling the phone.
Pauses and breaks	• Once you have correctly set up your computer workstation to good work habits, no matter how perfect the environment is, prolonged and static postures will inhibit blood circulation and take a toll on your body. • Take short 1 to 2 minutes stretch breaks every 20 to 30 minutes. • After each hour of work, take a break or change tasks for at least 5 to 10 minutes. Keep changing postures throughout the day.

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	• Avoid eye fatigue with 20-20-20 rule: Basically, every 20 minutes spent using screen, you should try to look away at something that is 20 feet away from you for a total of 20 seconds.

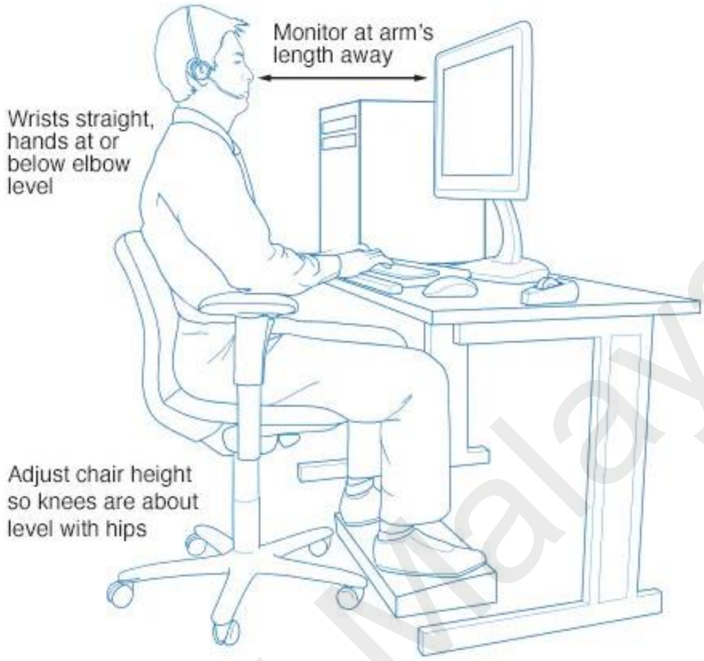

Figure 4.8: Acceptable sitting position.

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CHAPTER 5: CONCLUSION

The passed findings had shown that poor ergonomics at the workplace attributed to work-related musculoskeletal injuries. However, the current issue of pandemic outbreak had transitioned majority of white-collar workers to tele-work, and it was found that work from home environment had led to many adverse working conditions. Majority of homeworking employees suffered poor body postures due to poor workstation and work practice at home. The results from this study illustrate that apparently work from home employees experienced many physical discomforts in body regions specifically in the neck (n=147, 69.7%), shoulder (n=148, 70.1%), upper back (n=139, 65.9%) and lower back (n=135,64%) brought about by the on-going working from home. Therefore, employers or organization should provide ergonomics skills, in the form of e-training (the delivery of learning and training through electronic platform) which allows individuals to make appropriate workstation changes, thus reducing musculoskeletal risks and discomfort associated with computer work. In an ergonomic workplace, it is important to design the tasks and tools to fit individual capabilities and limitations so people can carry out their jobs without being injured, as good ergonomics emphasized on “designing the job to fit the workers, instead of forcing the worker to fit the job”.

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CHAPTER 6: RECOMMENDATIONS

A proper chair is the vital part in office ergonomics. It is important for prolonged hours of deskbound computer and routine works. One's comfort in the office is enhanced when he or she uses an ergonomic chair. It drastically improves postures, reduce body discomforts, and improve productivity. However, many people are facing with problems of insufficient budget to purchase proper chairs with ergonomics features. Followings are a few recommendations of potential fixes for the chair that could be helpful for the homeworking employee:

i. Place a pillow on the seat to elevate the seat height.
ii. Place a pillow behind the back for back support.
iii. Swaddle a thick towel behind the back to provide lumbar support.
iv. Bundle up towel around the armrests when they are low and not adjustable for comfort alike padding.
v. Push the chair closer to the desk or table to encourage having the back in contact with the backrest.
vi. Practice rotation between a poor sitting workstation and a standing workstation. Makeshift of standing workstations available in the home by implementing the use of an ironing board, a kitchen countertop or even the top surface of a piano.

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