THE PREVALENCE OF MUSCULOSKELETAL PAIN AND ASSOCIATED RISK FACTORS AMONG MALAYSIAN UNIVERSITY STUDENTS DURING THE COVID-19 PANDEMIC

UGESWARAN A/L JEGANATHEN

A project report submitted in partial fulfilment of the requirements for the award of the degree of Bachelor of Science (Honours) Environmental, Occupational Safety and Health

Faculty of Engineering and Green Technology
Universiti Tunku Abdul Rahman

June 2022

DECLARATION

I hereby declare that this project report is based on my original work except for citations and quotations, which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at UTAR or other institutions.

Signature : ______________________

Name : UGESWARAN A/L JEGANATHEN

ID No. : 18AGB00401

Date : 07 SEPTEMBER 2022

APPROVAL FOR SUBMISSION

I certify that this project report entitled **"THE PREVALENCE OF MUSCULOSKELETAL PAIN AND ASSOCIATED RISK FACTORS AMONG MALAYSIAN UNIVERSITY STUDENTS DURING THE COVID-19 PANDEMIC"** was prepared by **UGESWARAN A/L JEGANATHEN** has met the required standard for submission in partial fulfilment of the requirements for the award of Bachelor of Science (Hons) Environmental, Occupational Safety and Health at Universiti Tunku Abdul Rahman.

Approved by,

Signature : ______________________

Supervisor: Ts. Chin Yik Heng

Date : 19/09/2022

Signature : ______________________

Co-Supervisor: ChM. Ts. Chin Kah Seng

Date : 19/09/2022

Specially dedicated to
my beloved grandparents, parents, and siblings.

ACKNOWLEDGEMENTS

I would like to thank everyone who had contributed to the successful completion of this project. I would like to express my gratitude to my research supervisor, Ts. Mr. Chin Yik Heng, who read my numerous revisions and helped make some sense of the confusion, for his invaluable advice, guidance, and his enormous patience throughout the development of the research. The completion of this research was made possible by his guidance, inspiration, encouragement, and immense patience. Thank you very much!

A special thank you goes to Dr Putri Anis Syahira binti Mohamad Jamil, who was there for me when I needed emotional and moral support to complete this project.

Lastly, I would like to express my gratitude to my parents and siblings, who have supported and encouraged me through their genuine encouragement, understanding, and love.

THE PREVALENCE OF MUSCULOSKELETAL PAIN AND ASSOCIATED RISK FACTORS AMONG MALAYSIAN UNIVERSITY STUDENTS DURING THE COVID-19 PANDEMIC

ABSTRACT

Background: Musculoskeletal pain (MSP) are the leading cause of chronic, severe pain and physical disability. The emergence of COVID-19 prompted Malaysian students to decrease their daily activities and increase their total sitting time, generating a sedentary mindset that was exacerbated by online teaching and learning, which led to musculoskeletal pain. There have been reports of a high prevalence of musculoskeletal pain among university students worldwide. However, little is known about the magnitude of the problem among Malaysian university students. Therefore, this study aimed to investigate the prevalence and identify the related risk factors of MSP among Malaysian university students, as well as to assess the students' perceptions regarding the significance of practising ergonomics during the pandemic.

Methods: A self-administered online survey was distributed to students at the University Tunku Abdul Rahman (UTAR), Kampar Campus. The survey gathered information regarding demographics, physical activity levels, and total sitting time that were maintained prior to and during the social restrictions that followed the pandemic, as well as the prevalence of neck, low back, and shoulder pain, pain onset posture, and daytime window for the pain. Additional, ergonomic factors practiced by the students during the pandemic were also documented. SPSS v.25 was used to conduct descriptive analysis, Spearman's rank correlation, and simple linear regression.

Results: The distribution of 800 questionnaires yielded 640 valid responses. The most prevalent MSP among university students during the pandemic were neck pain (55.6%), low back pain (47.2%), and shoulder pain (48.3%). More students engaged in light or no physical exercise (78.3%) than moderate or strenuous activity (21.7%).

More participants (82.5%) sat for eight hours or more than those who sat for less than eight hours (17.5%). Physical activity intensity level and neck pain, low back pain, and shoulder pain among university students had no association ($p > .05$), however, total sitting time was correlated ($p < 0.001$). Additionally, the general student population sadly undervalues the significance of ergonomics.

Conclusion: There was no concrete evidence on the subject of the connection between sitting time, physical activity level, and neck, low back, and shoulder pain. Results, however, indicate that the pandemic and online classes have caused students to engage in less physical activity and spend more time sitting down. Therefore, specific prevention interventions should be designed and implemented to lower the risk of MSP in students who are susceptible owing to a lack of physical activity and prolonged sitting.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS / ABBREVIATIONS

c	confidence level,
E	the margin of error, and
N	population size,
n	sample size,
r	fraction of responses that the researcher is interested in,
Z(c/100)	critical value for the confidence level, c.
COVID-19	Coronavirus Disease 2019
ERF	Ergonomic Risk Factor
LBP	Low Back Pain
MSD	Musculoskeletal Disorder
MSP	Musculoskeletal Pain
MVPA	Moderate or Vigorous-Physical Activity
NP	Neck Pain
ODL	Online Distance Learning
OTL	Online Teaching and Learning
PA	Physical Activity
SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
SP	Shoulder Pain
ST	Sitting Time
TST	Total Sitting Time
SPSS	Statistical Package for the Social Sciences

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that causes coronavirus disease 2019 (COVID-19) was detected for the first time in late December 2019 in Wuhan, China. Since then, it has spread throughout the world and has emerged as a major threat to public health in all countries. Several nations, including Malaysia, have undertaken public health security measures emphasising social isolation, the usage of anti-infection masks, and lockdown restrictions in response to the pronouncement of the COVID-19 pandemic by the World Health Organization (WHO) on March 11, 2020 (Roggio et al., 2021). Malaysia was subjected to a nationwide movement control order beginning in March 2020 as a result of the COVID-19 outbreak. Many segments of the public were astonished by the government's decision to implement a countrywide lockdown to protect Malaysians against the COVID-19 pandemic (Tang, 2020). As a sort of cordon sanitaire, all commercial establishments in Malaysia were closed, and mass movements or gatherings were prohibited in any part of the country (Prime Minister's Office of Malaysia, 2020). In the midst of the pandemic, the majority of people were compelled to embrace many of their cultural norms, including daily routines and behaviours extending from interpersonal to organisational and outdoor or public activities (Al-Kumaim et al., 2021).

Although many individuals were affected by the COVID-19 outbreak, one of the most significant organisations that had to cope with it was the higher education sector, as it is one of the most vital service sectors and its students represent the future workforce (Al-Kumaim et al., 2021). This is because, under the MCO, educational institutions of all types and at all levels were required to close to prevent the transmission of the virus (Prime Minister's Office of Malaysia, 2020). Since the COVID-19 pandemic, educational institutions have been closed in 188 nations, affecting 91.3 percent of the global student population (1.6 billion youths and adolescents). It was estimated that over 60.2 million professors and lecturers were no longer working in the classrooms of educational institutions. Schools in Malaysia were closed, affecting 8 million pupils across the country (UNESCO, 2020). Owing to the lockdown, e-learning became the only feasible alternative for students. Academic staff members were using pre-recorded lectures in addition to registering profiles on video sharing and conferencing services, including Microsoft Teams, Google Classroom, Skype, and Zoom, to communicate with students (Jahangeer, 2020). These extreme measures led to a change in lifestyle, especially in terms of students' access to education. Students who were confined to their homes or dormitories accessed these materials via computers, laptops, tablets, and mobile phones. As a result of the announcement of the lockdown and the directive to students to attend courses remotely, sales of laptops, tablets, and other technology products increased significantly in Malaysia (Hassan, 2021). In an interview with Mr. Zed Li, the senior manager for business development at the Malaysian e-commerce platform Shopee, it was revealed that demand for consumer electronics such as smartphones, personal computers, and accessories had increased threefold since the COVID-19 outbreak shut down the country's schools and businesses, causing Malaysians to adopt a new norm of working and studying remotely (Azuar, 2021). Ninety percent of students at the University of Hyderabad own a smartphone, according to recent data. Nevertheless, 63 percent of them could only occasionally or never access online classes (Mahajan, 2020). There were a number of concerns regarding online education, with 40% noting unreliable connectivity and 30% identifying high data costs as major obstacles. Notably, 10% of those surveyed expressed concern about the reliability of their electricity supply (Jahangeer, 2020). Students who attend online courses usually access these materials on their smartphones or laptops for prolonged periods of time due to inadequate electrical supplies and unstable internet connectivity. According to a Department of Statistics Malaysia (DOSM) survey on the utilization and accessibility of information and communications technology (ICT), computer use in remote regions appears to be underperforming at 54%, compared to 77.3% among urban Malaysians (Azahar, 2020). One noteworthy instance is the account of a university student from the furthest regions of the Malaysian state of Sabah who risked her life by climbing a tree to make sure she had a steady internet connection so she could take her exams online (Lee, 2020). Since a significant portion of these students come from low-income backgrounds, they frequently lack the necessary furnishings and space for a private room in their residences (Kumar, 2020). As a result, they are constrained to use these electronic devices in settings that put the general youth population at risk for musculoskeletal diseases (MSD). Low back pain, which is the leading cause of disability in 160 countries, is the biggest contributor to impairment globally (WHO, 2021).

According to the International Classification of Diseases, MSP are "conditions comprising of over 150 diagnoses affecting a person's locomotion system, that is, their muscles, spine, bones, joints, and related tissues such as tendons and ligaments" (WHO, 2021). People with musculoskeletal diseases frequently experience pain and restrictions in mobility, agility, and functional capacity, which can have a negative impact on their mental health. On a bigger scale, these factors have an impact on community prosperity. While certain MSP may appear suddenly, such as just after an accident, the majority of them emerge gradually as a result of repeated or protracted exposure; they are cumulative. According to Kloimüller (2021), MSP can be acute or chronic. MSD patients frequently experience pain in their back, neck, and shoulders. Musculoskeletal pain (MSP) is another prevalent health issue that affects both the adult and young populations (Obembe et al. 2013).

According to current thinking, the emergence of MSP in students is complex and caused by the synthesis of several risk factors known as ergonomic risk factors (ERF) (Wami et al., 2020; Algarni et al., 2017). Repetitive motions of a particular body part, prolonged standing, bending, or sitting, ergonomic pressure, underlying disease, and poor posture are some of the most frequently mentioned risk factors for MSP (Dianat et al., 2013). In addition to the factors mentioned above, OSHA (2018) claims that MSP can also be brought on by violent movements, static posture, direct pressure, vibration, high temperatures, noise, and stress at work. MSP, which affects the foot, neck, shoulder, lower back, and other areas, is strongly correlated with a higher Body Mass Index (BMI) (Butterworth et al., 2012). Other studies have found strong associations between the female sex (Stienen et al., 2011), older age (McLean et al., 2010), and smoking (Worsted, Hanvold, and Veiersted, 2010) in relation to neck pain; however, the same associations have not been seen in regard to low-back pain (Stienen et al. 2011). Numerous studies have connected MSP to sitting in front of a computer for lengthy periods (Kanchanomai et al., 2012; Angelone A et al., 2011). Furthermore, other studies have shown that MSP among undergraduate students at various universities are related to mental stress, past trauma, frequent usage of computers, insufficient physical activity, fatigue, age, academic year, and physiological state (Nor Azlin Mohd Nordin, Devinder Kaur Ajit Singh, and Lim, 2014). Psychosocial factors are also a significant factor (Brink et al., 2015). MSP patients may endure depression, other psychosomatic symptoms, and reduced quality of life (Dajpratham et al., 2010).

The association between online education and MSP among students during the COVID-19 outbreak is a growing field of study today. A study by Sagát et al. (2020) indicated that this drastic lifestyle shift increased the prevalence of LBP and neck pain in the 18-to-64-year-old population of Riyadh. When the pandemic caused Turkey to go into lockdown for three months, Toprak Celenay et al. (2020) looked into individuals who stayed at home and those who went to work, and they discovered that those who stayed at home had worse MSP symptoms. MSP are induced by rapid or sustained physical exertion or exposure, such as protracted, energetic, low-amplitude, recurrent usage of mobile phones, according to a different study by Amjad et al. (2020). In a study that looked at potential subjective risks related to mobile phone use, Mahaba, Saed, and Alelyani (2017) found that students' wrists were significantly affected by mobile phone use.

1.2 Problem Statement

Numerous students have cumulative musculoskeletal overload as a result of sitting in unsupportive chairs for extended periods of time and adopting improper postures while completing their education (Caromano et al., 2015). Additionally, they adopt improper postures when studying and engaging in leisure activities on computers and cellphones, which results in musculoskeletal alterations and pain, especially to the spine and neck (Queiroz et al., 2018). In Karachi, Pakistan, Haroon et al. (2018) found that university medical students had a high prevalence of MSP and that the likelihood of neck pain rose when using a laptop for more than three hours per day. A significant prevalence of MSP, particularly in the low back and neck, has been found in numerous studies, including those involving university students (Lim et al., 2012; Vujcic et al., 2018; Kędra et al., 2017). Nursing students (Moodley, Ismail, and Kriel, 2020), dental students (Noor Sam Ahmad et al., 2020), students of the performing arts (Cruder and al., 2020), school students (Grimes and Legg, 2004), and other academic students, in general, have all been the subject of a number of studies on MSP. In addition, several studies indicate that students' use of computers and mobile devices on a regular basis may contribute to MSP (Amjad et al., 2020).

Following the shift from traditional methods of instruction to virtual ones during the COVID-19 period, many students attending online courses encountered challenges, including insufficient Internet access, unreliable electricity supplies, and a lack of furniture or a place to study (Jahangeer, 2020). Furthermore, tight lockdown procedures entail the prohibition of outdoor activities. Students have had to commit more time to online learning than they would have in the past, given that the whole learning and teaching approach is now conducted online. Additionally, studies have revealed that students believe online learning to be uninspiring and dull. It was found that students were unprepared to balance their online education with their jobs, families, and social lives (Dhawan, 2020). Consequently, students during COVID-19 are spending more time than in the past on OTL-related activities, which may raise health problems (Adedoyin and Soykan, 2020). Excessive online time endangers students' mental and physical health since it diverts attention from extracurricular activities and sports and promotes a more sedentary lifestyle (Roggio et al., 2021). Medical professionals assert that students who slouch or strain their backs, shoulders, and neck muscles for extended periods of time when studying are prone to experience excruciating pain in these regions (Karingada and Sony, 2021).

Online education is the technique of learning via the use of technology, resources, and the Internet (Means et al., 2011). Some individuals dispute if online learning is as beneficial as face-to-face instruction because it creates less personal touch between students, lecturers, and tutors (Joshi et al., 2020). A difference must be established between well-devised online learning experiences and programmes delivered online in reaction to the crisis. During this circumstance, online education is delivered as "emergency remote teaching" rather than as a well-devised endeavour (Hodges et al., 2020).

Nonetheless, there is a paucity of data indicating a connection between online learning and MSP during the COVID-19 pandemic among Malaysian university students. Therefore, this research sought to examine the link between the symptoms of MSP and online teaching and learning among Malaysian university students during the COVID-19 pandemic in order to help educators plan online courses with the impact of MSP on their students in mind.

1.3 Research Significance

The COVID-19 pandemic and movement restrictions compelled all educational institutions to adopt education. As a result, many students enrolled in online classes were impacted. Students had to devote more time in front of their electronic devices to study as the entire teaching and learning process was conducted online. Numerous studies have found that students' prolonged computer use and sitting can result in a variety of health problems, including musculoskeletal diseases. Therefore, this research enables organisations and educators to develop effective online learning strategies while taking MSP into account, reducing the emergence of musculoskeletal pain among students brought on by prolonged sitting and virtual learning.

Second, the majority of students with musculoskeletal pain are oblivious to the underlying causes of their pain. Since students are unaware of these risk factors, they frequently repeat the same mistakes, thereby worsening the condition. This also has an indirect effect on the education of the students. This research identifies the key contributors to the pandemic prevalence of musculoskeletal pain among students. This knowledge will help students become more aware of the risk factors that contribute to their musculoskeletal pain and will allow them to devise appropriate preventative actions to avoid experiencing musculoskeletal pain in the future.

Lastly, there is a dearth of research investigating the prevalence of musculoskeletal pain and the factors that predispose individuals to them, especially among Malaysian university students. Therefore, this study will benefit other researchers by providing essential information needed to conduct further research on this topic, enabling favourable conditions to be created to aid in lowering the prevalence of MSP among university students.

1.4 Conceptual Framework

Figure 1.1 depicts the conceptual framework underlying this study. The construction of this framework was based on an evaluation of the existing research on online education and the prevalence of MSPs among university students during the COVID-19 pandemic. This concept suggests that in order to attain good health and well-being (social sustainability) for individuals, it is significant to pay greater attention to the activities performed as a result of online learning and the ergonomic risk factors established as a result of these activities, as well as their impact on MSPs and their relationship.

As seen in Figure 1.1, the three (3) primary components of the conceptual framework development are the health issues associated with online education, the relationship between ergonomic risk factors and MSP, and the outcome and societal benefit. The variables highlighted in blue were the primary focus of this research.

The research framework created by Nor Suzila, Izatul Farrita, and Nor Atiqah (2021) served as a template for the conceptual framework designed in this study.

i. Component 1: Issues of Health Related to Online Learning During The COVID-19 Pandemic.

The framework begins by outlining the problems with online education from hostels or hostels during the COVID-19 pandemic. The literature review found that higher education students were the population that was most adversely affected. These students were expected to participate in online teaching and learning via the online distance learning (ODL) system by the relevant university authorities and the government even though the entire country was subject to a movement restriction order to prevent the transmission of the COVID-19 virus. The deployment of this ODL has been proceeding over the past two years, since March 2020. In this sense, a thorough literature review was conducted to determine the health problems experienced by students during the pandemic crisis.

ii. Component 2: The Relationship Between Ergonomic Risk Factors and MSP.

This step comprised of determining the behaviours that university students engaged in while taking part in online distance learning (ODL) using gadgets such a laptops, smartphone, and tablets that influenced the development of musculoskeletal pain in them. In addition to determining the tasks involved in participating in ODL, this stage involved identifying the ergonomic risk factors affiliated with those tasks. The identification of ERF is critical for determining the root causes of MSP in students. The relationship between activities, ERF, and MSP will be utilised in the development of future ergonomic risk models. Understanding how these factors interact will enable the affected individual to take the necessary measures to avoid and alleviate musculoskeletal pain.

iii. Component 3: Outcome and Social Benefits

The future ergonomic risk model will aid in the enhancement and maintenance of the health and quality of life of university students, as well as their general health and well-being. This conceptual framework is particularly important because it forms the basis for the creation of the ergonomic risk model, which will enhance the health and welfare of university students who must take part in online distance learning.

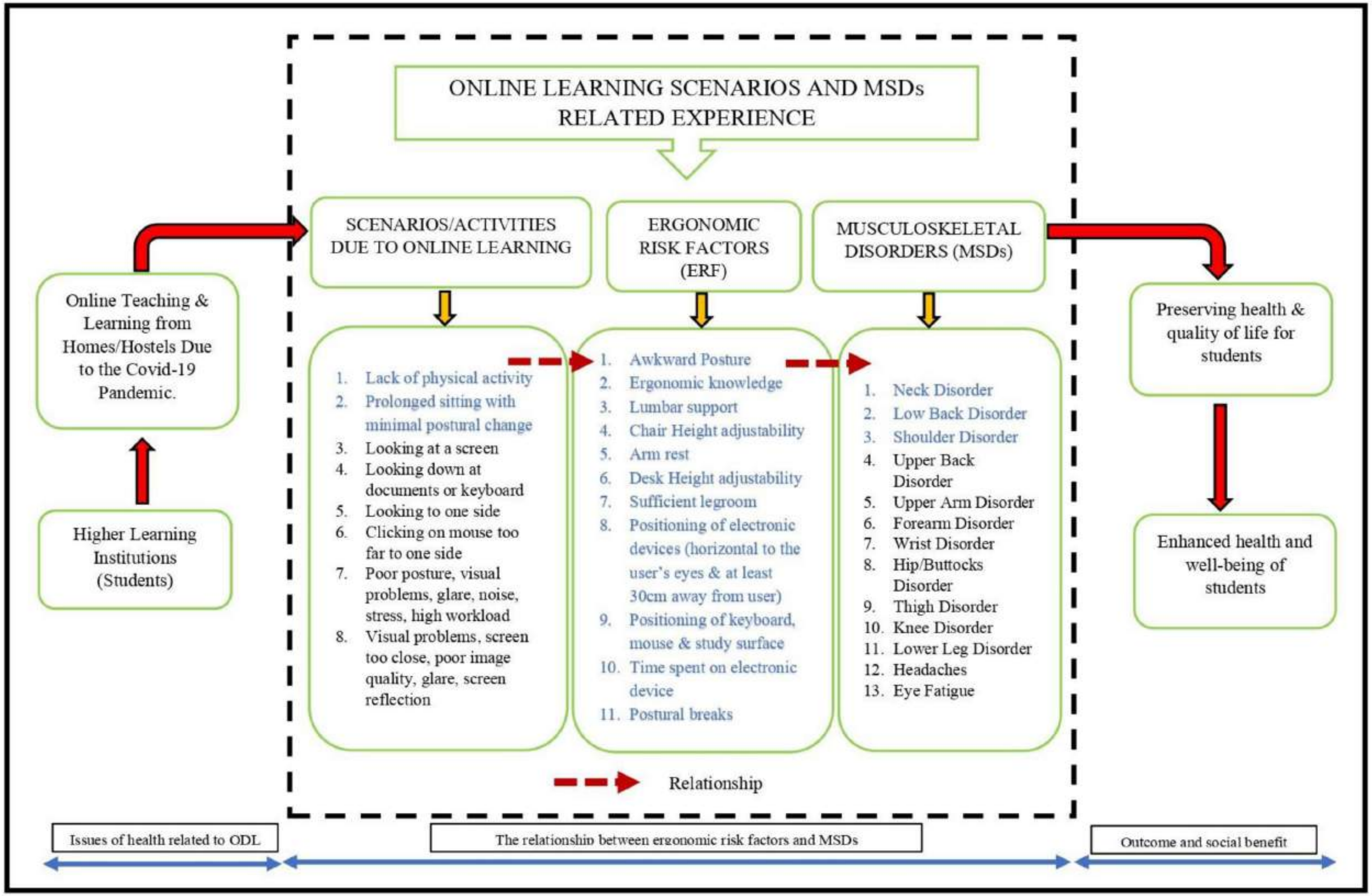

Figure 1.1: A Conceptual Framework for the Interactions Between Online Learning Activities, ERFs, & MSP

1.5 Research Aim & Objectives

Aim:

The primary aim of this research is to understand the symptoms and impact of MSP and analyse the association between MSP and online learning among Malaysian university students during the COVID-19 pandemic. The following are the supportive objectives to be accomplished in this study:

Objectives:

i. Identify the MSP suffered by students due to sedentary behaviours & ergonomic risk factors because of social restrictions following the pandemic.
ii. Identify the symptoms of MSP related to sedentary behaviours & ergonomic risk factors
iii. Survey the physical activity levels, total sitting time, and ergonomic risk factors that were maintained before and during the social restrictions following the pandemic
iv. Analyse the sedentary behaviours and ergonomics risk factors correlated to MSP.
v. Provide appropriate recommendations to limit or eradicate the prevalence of MSP among students due to online learning in the aftermath of the pandemic.

CHAPTER 2

LITERATURE REVIEW

2.1 Human Musculoskeletal System

The human musculoskeletal system (Figure 1.2), sometimes referred to as the human locomotor system, is a component of the human body that allows individuals to move by employing both their skeletal and muscular systems. The musculoskeletal system provides the body with a structure, support, stability, and mobility (Sendi, 2015). It is separated into two major categories:

i. **The muscular system** comprises all types of bodily muscles. Skeletal muscles, in particular, are responsible for movement by acting on bodily joints. In addition to muscles, the muscular system also includes the tendons that connect muscles to bones (Sendić, 2015).
ii. **The skeletal system** primarily consists of bones. The bones articulate with one another and create the joints, giving our bodies a strong yet flexible skeleton. The skeletal system's accessory structures, including articular cartilage, ligaments, and bursae, support the integrity and functionality of the bones and joints (Sendić, 2015).

The skeleton of a human provides structural support for the muscles and other soft tissues. Collectively, they sustain the weight of the human body, maintain its posture, and facilitate movement (Cleveland Clinic, 2020).

2.1.1 Musculoskeletal System Components

Humans use their musculoskeletal system to help them stand, sit, walk, run, and move. In an adult body, there are 206 bones and more than 600 muscles that are connected by ligaments, tendons, and soft tissues (Cleveland Clinic, 2020).

The musculoskeletal system is composed of several parts:

i. **Bones:** Different-sized bones support the body, protect organs and tissues, store calcium and fat, and create red blood cells. The hard exterior of a bone encases a spongy inside. The bones give the body structure and form. They assist in movement alongside muscles, tendons, ligaments, and other connective tissues.

ii. **Cartilage:** Cartilage, a form of connective tissue, cushions the bones in the joints, along the spine, and in the ribs. Bones are prevented from rubbing against one another by a firm, springy cartilage. Additionally, cartilage is present in the nose, ears, pelvis, and lungs.

iii. **Joints:** Joints are formed by the joining of bones. Some joints, like the ball-and-socket shoulder joint, have a wide range of motion. Other joints, such as the knee, permit back-and-forth movement of the bones but not rotation.

iv. **Muscles:** Thousands of flexible fibres make up each muscle. These muscles enable an individual to move, maintain an upright posture, and keep a steady position. Some muscles enable individuals to lift, dance, and run. Individuals require help from others in order to speak, swallow, fasten a button, and write their names.

v. **Ligaments:** Ligaments, which connect bones and strengthen joints, are made of strong collagen fibres.

vi. **Tendons:** Muscles and bones are connected by the tendon. Tendons, which are composed of collagen and fibrous tissue, are strong but not particularly flexible (Cleveland Clinic, 2020).

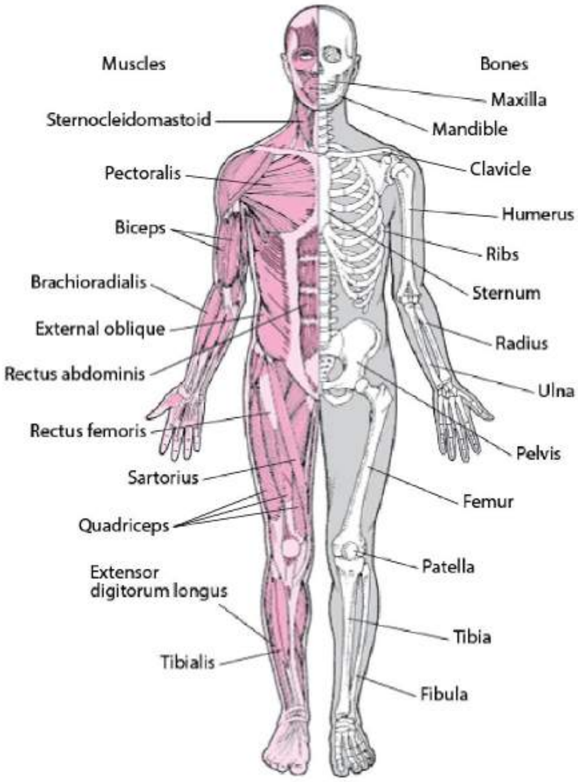

Figure 1.2: Human Musculoskeletal System

2.2 Physical Inactivity

Physical inactivity is defined by the World Health Organization (WHO) (2010) as failing to log at least 150 minutes of moderate physical activity, 75 minutes of intense physical activity, or a mix of the two intensities each week.

Adults who did not report engaging in any sessions of mild to leisurely physical activity that is at least 10 minutes long per day and can be either moderate or vigorous were categorised as inactive in the 2008 U.S. National Health Interview Survey. According to that metric, 36% of American adults reported not engaging in any recreational physical activity and were classified as sedentary or inactive (Pleis, Lucas, and Ward, 2009). The National Population Health Surveys of Canada provide alternative meaning of being physically inactive or sedentary. If individuals only engage in leisure-time physical activities that burn less than 1.5 kcal/kg/day, they are deemed inactive (Canizares and Badley, 2018). This is the same as taking about 3000 steps or a little more than 1.3 miles (2 kilometres) of walking. That is a walk of no more than 25 minutes for most people (Bumgardner, 2021). Inactive or sedentary people are classified as such by pedometer researcher Tudor-Locke et al. (2011) if they log fewer than 5,000 steps per day. This is compatible with the previous definitions, as most people will count 2,000 steps just by performing daily activities around the house, such as walking from the bedroom to the kitchen to the living room, etc. (Bumgardner, 2021).

2.3 Physical Activity

Any movement of the body resulting from the contraction of skeletal muscles that causes an increase in energy consumption over the resting metabolic rate is referred to as physical activity (WHO, 2010; Caspersen, Powell, and Christenson, 1985). It can be identified by its mode, intensity, duration, frequency, and practise setting (Caspersen, Powell, and Christenson, 1985).

There are two major categories of physical activity. One is exercise, which is a planned, intentional activity carried out to enhance health and fitness advantages. It entails systematic and repetitive physiological motions. The second is non-exercise or incidental physical activity, which is unplanned and typically the consequence of daily tasks performed at home, at work, or while travelling, such as standing when travelling to and from work or school, performing household duties, or engaging in occupational labour (Strath et al., 2013; Caspersen, Powell and Christenson, 1985). Both exercise and non-exercise physical activity can be further categorised by intensity as low, moderate, or vigorous. Whilst strenuous exercise such as jogging might improve physical fitness and burn more calories per hour than moderate exercise such as brisk walking, performing a light exercise such as strolling about the house is still preferable to doing nothing at all (Department of Health | The Government of the Hong Kong Special Administrative Region, 2011).

Low-intensity exercises include stretching, mild walking, lifting hand weights, and push-ups against a wall. The low-intensity non-exercise physical activities include standing, dishwashing, laundry, cooking, and playing piano. Brisk strolling, water aerobics, tennis (doubles), biking on flat ground, and sports requiring catch and throw, such as volleyball and baseball, are examples of moderately intense physical activity. The moderately strenuous non-exercise physical activities include stair climbing, light to moderate housework, carrying young children, mopping the floor, cleaning the bathtub, washing the car, general gardening, dancing, and home exercise. Jogging, quick swimming, fast dancing, jumping rope, tennis (singles), basketball, and soccer are examples of physical activities with a high level of intensity. The Department of Health | The Government of the Hong Kong Special Administrative Region (2011) lists heavy gardening, such as continuous digging or hoeing , as one of the vigorous level non-exercise physical activities.

2.3.1 Dimensions of Physical Activity

The four aspects of physical activity include mode or type of activity, frequency of performance, duration of the performance, and intensity of the performance. According to Strath et al. (2013), each of the dimensions is defined as follows. Mode is any particular activity is undertaken, such as walking, gardening, or cycling. Physiological and biomechanical demands and types, such as aerobic versus anaerobic activity, resistance or strength training, balance, and stability training, can also be used to determine the mode. Frequency refers to the number of sessions per day or per week. In the context of health-promoting physical exercise, frequency is sometimes defined as the number of sessions (bouts) of $\geq$10 minutes in duration/length. Duration is the length of the activity bout (in minutes or hours) over a predetermined period of time (e.g., day, week, year, past month). Intensity refers to the pace of energy consumption. The intensity of an activity is a measure of its metabolic demand. It can be quantitatively measured using physiological indicators like oxygen consumption, heart rate, and respiratory exchange ratio, subjectively evaluated using perceptual traits like the walk-and-talk test or measured using body movement (e.g., stepping rate, 3-dimensional body accelerations).

2.3.2 Quantifying Units of Measure Indicative of Physical Activity Level

Physical exercise increases energy expenditure above resting levels, and the rate of increase is directly proportional to the intensity of the physical activity. Among the three factors that make up total daily energy expenditure, physical activity accounts for just 1 of them. The most variable component of total daily energy expenditure is physical activity-related energy expenditure (PAEE) (Strath et al., 2013).

The energy used during physical activity is typically measured in kilocalories or as the metabolic equivalent tasks (MET) of the activity. Calculating how much time a person spends in various physical activity intensity categories on a given day or during a given week is another popular technique (Strath et al., 2013).

2.3.2.1 Kilocalories

The amount of energy required to consume one litre of oxygen is roughly equal to 5 kcal (Morris et al., 1953). All the various physical activities carried out on a particular day would be added up to generate the daily PAEE. The amount of body mass moved during ambulatory physical activity directly increases energy expenditure. As a result, the amount of energy used in relation to body weight is commonly stated as kilocalories per kilogramme of body mass per minute ($kcal \cdot kg^{-1} \cdot min^{-1}$) (Strath et al., 2013).

2.3.2.2 Metabolic Equivalent

Exercise intensity is typically expressed using the MET unit. One MET, which is frequently defined as 3.5 mL $O_2 \cdot kg^{-1} \cdot min^{-1}$ or ≈250 mL/min of oxygen used and corresponds to the average value for a normal 70-kg individual, denotes the resting energy expenditure during quiet sitting. Kilocalories can be derived from METs (1 MET=1 kcal·kg−1·h−1). Due to the influence of sex, age, and body composition on measures of resting energy expenditure, these values are estimates, and actual MET values may differ (Katch, Mcardle, and Katch, 2011).

As physical activity intensity rises, so does oxygen demand. Thus, using multiples of resting energy expenditure is a straightforward method for assessing the intensity of physical activity. For instance, 3 METs are comparable to undertaking an activity that demands an oxygen intake of 10.5 mL O2·kg−1·min−1 (i.e., three times the resting level). Therefore, it is possible to estimate physical activity volume, or total physical activity level, by multiplying the dimensions of intensity, duration, and frequency over a specific time period, usually one day or one week (Strath et al., 2013).

Regular physical exercise has been linked to a number of health advantages (Bauman, 2004), and these benefits are not only correlated with overall energy expenditure but also with the potential intensity of physical activity (Haskell et al., 2007). As a result, it is crucial to calculate physical activity intensities accurately.

There are various recommendations for thresholds at the moment, based both on absolute intensities (which ignore individual traits) and relative intensities (which do) (Garber et al., 2011). The use of METs as reference criteria for absolute intensities (light, <3.0 METs; moderate, 3.0–5.9 METs; vigorous ≥ 6.0 METs) has been suggested by guidelines (Haskell et al., 2007). Further definitions can be found in Harvard T.H. Chan School of Public Health's (2019) classification of 1.6-3.0 METs as light intensity and usage of 1.5 METs or less as sedentary, which includes activities like leisurely walking or waiting in line.

High physical intensity is defined as 6 METs and above, while moderate physical intensity is defined as the exercise intensity corresponding to 3 to 5.9 METs (van der Ploeg and Hillsdon, 2017). When an adult is at rest, one MET is equal to an oxygen uptake of 3.5 mL/kg/min and 1 kcal/kg/hr of energy consumption. The range of physical activities classified as moderate (3 to 5.9 METs) and high intensity (above 6 METs) is wide, although the high intensity is nearly twice as intense as the moderate level (Fletcher et al., 2001).

2.3.3 Global Recommendations on Physical Activity for Health for Adults Aged 18–64 Years

Guidelines for physical activity for Americans were published by the US Department of Health and Human Services in 2018. It is a modified version of the World Health Organization's (WHO) 2010 Physical Activity Guidelines and the 2008 Physical Activity Guidelines for Americans by the U.S. Department of Health and Human Services in 2008. The Malaysian Dietary Guidelines also contain information on physical activity similar to this (Ministry of Health of Malaysia, 2010, pp.38–62).

WHO (2010) recommends that individuals between the ages of 18 and 64 perform at least 150 minutes of moderate-intensity aerobic physical activity each week, at least 75 minutes of vigorous-intensity aerobic physical activity each week, or an equivalent combination of moderate- and vigorous-intensity activity. The duration of each bout of aerobic exercise should be at least 10 minutes. Adults should raise their weekly moderate-intensity aerobic physical activity to 300 minutes, or 150 minutes of weekly vigorous-intensity aerobic physical activity, or an equivalent combination of the two for extra health advantages. Major muscle groups should be used in muscle-strengthening exercises at least twice per week.

According to the most recent US recommendations, moderate aerobic exercise should last 150 to 300 minutes. This implies that increasing to 300 minutes as much as possible, rather than just 150 minutes per week, should be the minimum objective. Additionally, it said that engaging in moderate physical exercise for more than 300 minutes had numerous health advantages (Yang, 2019). Based on the recommendations made by the WHO, a study by van der Ploeg et al. (2012) divided physical activity into four categories: no physical activity (0 min/week), some physical activity but not at recommended levels (1–149 min/week), meeting the minimum but doing less than twice as much as recommended (150–299 min/week), and doing at least twice as much as recommended (≥300 min/week). According to the students' level of physical activity per week, Roggio et al. (2021) divided the physical activity intensity level into four categories: no activity (0 minutes/week), light activity (<140 minutes/week of PA), moderate activity (≈150 minutes/week of PA), and high activity (>200 minutes/week of PA). According to Stamatakis et al. (2019), there are four categories of weekly physical activity: no physical activity (inactive), 1 to 149 minutes (insufficiently active), 150 to 299 minutes (sufficiently active at the lower Australian physical activity recommendations limit), 300 to 419 minutes (sufficiently active at the upper limit), and ≥420 minutes (corresponding to roughly 35.5 MET-h/week, which has previously been identified as the threshold that eliminates the mortality risks associated with sitting).

The physical activity intensity level classification and values published by the WHO, which have also been used by many researchers around the world to measure physical activity level, were utilised to categorise the physical activity level of the participants in this study. The participants' physical activity was categorised into four categories: no physical activity (0 min/week), some physical activity but not at suggested levels (1-149 min/week), meeting the minimum but less than twice the amount of the WHO guideline (150-299 min/week), and meeting at least twice the minimum recommended amount (≥300 min/week). These are the levels of physical activity that were listed in the questionnaire for the students to select in order to indicate their weekly levels of personal physical activity both before and during the COVID-19 pandemic. Table 2.1 below provides an overview of the classification of the physical activity intensity level for simpler comprehension.

Table 2.1: Classification of Physical Activity Intensity Level

Physical Activity Intensity Level	Duration (minutes per week)
No activity	0
Light	1-149
Moderate	150-299
Vigorous	≥ 300

2.4 Sedentary Behaviour

Research on sedentary behaviours has expanded quickly and steadily in recent years. The word "sedentary behaviours" has several different explanations. Sedentary behaviour, according to Owen et al. (2000), is defined as having a MET value between one and 1.5, for instance, being equivalent to sitting or lying down. According to Salmon et al. (2003), it has MET <2.0, making it comparable to sitting or lying down. According to Biddle et al. (2004), it is a unique class of behaviours distinguished by low energy consumption. Sedentary behaviour, according to Jans, Proper, and Hildebrandt (2007), consists primarily of sitting or lying down while engaging in activities with very low energy expenditure (1.0–1.8 MET). Pate, O'Neill, and Lobelo (2008) define sedentary behaviour as activities that do not significantly increase energy expenditure above the resting level. Sedentary behaviour includes sleeping, sitting, lying down, watching television, and other screen-based entertainment. Operationally, sedentary behaviour encompasses actions that require 1.0–1.5 METs of energy expenditure. Sedentary activities like watching TV, using a computer, or driving typically consume between 1.0 and 1.5 METs of energy (multiples of the basal metabolic rate), according to Owen et al. (2010). Therefore, sedentary behaviours are those that include sitting and little energy expenditure. According to Owen et al. (2010), it consists of lying down and using very little energy (between 1.0 and 1.5 METs). It is defined by Chastin and Granat (2010) as simply "non-upright actions." Tremblay et al. (2010) identify sedentary behaviours as those requiring ≤1.5 METs. It is defined as time spent sitting or lying down by Chastin et al. (2011). According to Thorp et al. (2011), the term "sedentary behaviour" (derived from the Latin word sedere, "to sit") refers to a group of activities that involve sitting while commuting, at work and home, and during leisure and require low levels of energy expenditure in the range of 1.0-1.5 METs (multiples of the basal metabolic rate). Since there was significant disagreement over the definition of sedentary behaviour, the Sedentary Behaviour Research Network (SBRN), a network uniting sedentary behaviour researchers and health professionals from around the world engaged in sedentary behaviour research, published a letter suggesting a definition aimed at clarifying the accurate meaning of the term 'sedentary behaviour' in 2012. They described it as "any awake behaviour characterised by an energy expenditure of ≤1.5 METs while seated or reclined." This correction, written by 52 SBRN members, has gained widespread approval and is currently the most popular definition of sedentary behaviour (Sedentary Behaviour Research Network, 2012). Reading, playing board games (Smith, Hamer and Gardner, 2018), watching television, playing video games, using a computer (together referred to as "screen time"), desk-based employment, sitting at school or work, and sitting while commuting (Park et al., 2020) are common forms of sedentary behaviour.

The 2011 Compendium of Physical Activities defines MET as the difference between the conventional resting metabolic rate (RMR) of 1 kcal/(kg/h) and the metabolic work rate (MET). The RMR, or energy cost, for a person at rest is one MET. Physical activities can be quantitatively divided into sedentary behaviour (1.0-1.5 METs), light intensity (1.6-2.9 METs), moderate intensity (3-5.9 METs), and vigorous intensity (≥6 METs) (Ainsworth et al., 2011).

Lack of appropriate spaces for exercise increased occupational sedentary behaviours such as office and college labour, and the increased penetration of television and video devices are contributing to the global expansion of inactive lifestyles (Park et al., 2020). Consequently, the corresponding health issues are getting worse. A growing sedentary lifestyle is positively connected to watching television, watching videos, and using a cell phone (Fennell, Barkley, and Lepp, 2019). Based on this sociocultural context, it is anticipated that sedentary behaviours will continue to increase (Park et al., 2020). The general health of the world's population is significantly impacted by sedentary lifestyles. Sedentary behaviour is widespread throughout the world, and the prevalence of the relevant non-communicable diseases is rising (WHO, 2010). Although inactivity provides a similar danger to health and increases the prevalence of many diseases, the majority of physical activity-related teaching in clinical practise places more emphasis on raising physical activity levels and less on reducing inactivity (Park et al., 2020).

The two primary indicators used to measure the amount of time spent engaging in sedentary behaviours are often screen time and sitting time (Thivel et al., 2018). There is a definite necessity to take into account the specifics of each sedentary behaviour that may not have equivalent physiological effects from an energetic and biological standpoint. In fact, sedentary tasks requiring mental effort promote higher cortisol levels, glycaemic instability, increased calorie intake, and a decline in the parasympathetic/sympathetic balance (Chaput et al., 2008). Given that sedentary behaviours involving cognitive tasks (mental activity) have the profile of activity with very little movement and a component of neurogenic stress, such physiological effects must be taken into account (Chaput et al., 2008; Chaput and Tremblay, 2010; Chaput et al., 2011).

2.4.1 Screen Time

The amount of time spent using a screen-equipped device is referred to as screen time. It includes time spent playing on video game consoles, computers, laptops, smartphones, and other handheld electronic devices, as well as watching TV or watching movies (Kaneshiro, 2019). These gadgets are frequently utilised while lying down or sitting still, which greatly increases the number of time individuals of all ages spend sitting down. Screen time frequently prevents people from being active or enjoying the outdoors. Low amounts of physical activity can have an adverse effect on their health over time (Kaneshiro, 2019). In the US, adults used their screens an average of 11 hours each day just a few years ago. This number has increased dramatically since the lockdown to an astounding 19 hours each day during the pandemic (Howard, 2022). According to another study, college-age students in the US may use their smartphones for 8 to 10 hours every day on average (Roberts, Yaya, and Manolis, 2014).

Digital screen use duration is directly correlated with musculoskeletal pain (Queiroz et al., 2018; Sekiguchi et al., 2017; Silva et al., 2016; Suris et al., 2014; Hakala et al., 2012; De Vitta et al., 2011). The values utilised as a starting point for the characterization of the high periods of time for using electronic devices in these articles range from 2 to 5 hours per day. Therefore, it may be assumed that a significant amount of time was spent utilising digital screens during the evaluated research. Previous research has shown that teens can use digital displays for anywhere between 80 and 840 minutes in a given week. The degree of technological and economic progress in a particular nation or region can account for this difference (Soares Da Silva et al., 2020). According to a study by Hakala et al. (2012), for instance, using digital displays for 14 hours or more per week (about ≥ 2 hours per day) is linked to moderate to severe pain, which has an impact on adolescents' everyday lives as well as their quality of life. On the other side, the study by Queiroz et al. (2018) claims that screen use causes musculoskeletal pain and that using two displays at once makes this pain worse (computer, internet, electronic games, television). These findings are supported by the Suris et al. (2014) study, which claims that using screens concurrently for more than four hours a day leads to musculoskeletal pain. Musculoskeletal pain can therefore vary in intensity and anatomical location according to the type of mesh and its frequency. According to a study by Sekiguchi et al. (2017), there is a correlation between the occurrence of musculoskeletal pain and watching television for more than 4 hours or playing video games for more than 3 hours. 11.1% experienced pain at a single anatomical site, 6.9% at two sites, and 7.5% at three or more sites. A study by Silva et al. (2015) found a correlation between the occurrence of cervical and low back pain with the use of computers and electronic games (usage of over 28.6 hours per week and over 9.7 hours per week, respectively). The thoracolumbar spine (46%), upper limbs (20%), cervical spine (18.5%), and scapular region (15.8%) are the areas with the most pain. According to a study by Saueressig et al. (2015), there is no correlation between excessive computer and video game use and musculoskeletal pain. Thoracolumbar spine pain accounts for 42.1% of cases, followed by cervical and scapular spine pain (36.2%). According to a 2011 study by De Vitta et al., watching television for longer than two hours was linked to musculoskeletal pain. 19.5% of people have reported lumbar pain.

Screen-based sedentary behaviour refers to activities like watching television, playing video games, and using a computer. Adolescent overweight, obesity, and metabolic risk are all positively correlated with screen-based behaviours, according to several studies (Elgar et al., 2005). It has been theorised that screen-based sedentary behaviours affect health by diverting time from physical activity that might otherwise be done (Biddle, Gorely, and Stensel, 2004). While many studies have looked into the connection between sedentary behaviours and physical activity, the majority of them, including a significant meta-analysis by Marshall and colleagues, have found that the amount of time spent engaging in sedentary behaviours is largely unrelated to physical activity (Marshall et al., 2004).

Many nations, including the US and Australia, have released 24-hour movement guidelines (Kastelic et al., 2021). Adolescents should limit their daily recreational screen usage to two hours or less, per the 24-Hour Movement Guidelines (Ross et al., 2020). However, a study by Melkevik et al. (2010) demonstrates that engaging in screen-based sedentary behaviour for longer than 2 hours per day is not consistently linked to lower levels of physical activity among adolescents, despite the fact that these recommendations were included in their national efforts to increase physical activity among adolescents.

2.4.2 Sitting Time

The time spent sitting while performing a specific task is known as sitting time. A prominent indicator of sedentary behaviour is the amount of time spent sitting (Healy et al., 2011a; 2011b). Office jobs, driving, taking public transportation, and screen time are a few examples of sitting time.

There is mounting evidence that excessive periods of sitting might contribute to musculoskeletal pain (Kett, Milani, and Sichting, 2021). Recent studies link prolonged durations of sitting to musculoskeletal conditions, including increased muscle stiffness (Kett and Sichting, 2020), weariness (Callaghan and McGill, 2001; van Dieën, De Looze, and Hermans, 2001), pain (Sammonds, Fray and Mansfield, 2017), and, at worst, low back pain (Lunde et al., 2017).

According to a study by Caromano et al. (2015), students complained of severe pain, which may be attributed to spending a lot of time sitting down. The head, the cervical area, the shoulder, the trapezius muscle, and the lumbosacral spine were the body parts where people complained of pain the most frequently. This study showed that the frequency of pain complaints increased with the amount of time spent sitting.

The amount of time spent sitting each day can be broken down into four groups, according to van der Ploeg (2012): 0 to less than 4 hours, 4 to less than 8 hours, 8 to less than 11 hours, and 11 or more hours. Low risk is indicated by sitting for less than 4 hours per day. Four to eight hours a day of sitting suggests a modest risk. Sitting for eight to eleven hours a day raises the risk. Over 11 hours of sitting each day suggest very high risk. Pavey, Peeters, and Brown (2012) classified total sitting time as <4, 4-<8, 8-<11, ≥11 hours per day in their study.

On the other hand, Roggio et al. (2021) categorised sitting time into four categories: less than four hours (low risk), four to less than eight hours (medium risk), eight to less than twelve hours (high risk), and twelve hours or more per day (very high risk). In their research, Stamatakis et al. (2019) classified daily sitting time into ranges of <4, 4 to <6, 6 to 8, and >8 hours. A 2008 study by Inoue et al. classified daily sitting time as <3, 3-<8, 8+ hours per day. Matthews et al. (2012) characterised the total sitting duration in their study as <3, 3-4, 5-6, 7-8, and 9+ hours per day. Chau et al. (2013) classified the overall sitting duration in their study as <4, 4-<7, 7-<10, and 10+ hours per day.

This study utilised van der Ploeg's (2012) widely accepted categorisation of total sitting time per day. The amount of time spent sitting was divided into four categories: 0 to less than 4, 4 to less than 8, 8 to less than 11, and 11 or more hours per day for the purposes of this study. Low risk is indicated by sitting for less than 4 hours per day. Four to eight hours a day of sitting suggests a modest risk. Sitting for eight to eleven hours a day raises the danger. Over 11 hours of sitting each day suggest very high risk. For easier comprehension, a summary of this information is provided in table 2.2 below.

Table 2.2: Classification of Total Sitting Time and the Associated Risk Level

Total Sitting Time (hours per day)	Risk Level
<4	Low risk
4 - <8	Medium risk
8 - <11	High risk
≥11	Very high risk

2.5 Difference Between Physical Inactivity and Sedentary Behaviour

There is a distinction between someone who is sedentary and someone who is physically inactive, claims Knight (2012). Insufficient physical exercise is referred to as being "physically inactive." In other words, failing to adhere to the WHO's recommendations for physical activity. Sedentary, on the other hand, is defined as spending a lot of time sitting or lying down. Therefore, even if a person reaches the necessary amounts of physical activity, they may still be considered sedentary if they spend most of their waking hours sitting or lying down at work, at home, while learning, while commuting, or just unwinding.

According to another study by van der Ploeg and Hillsdon (2017), it is obvious that inactivity and sedentary behaviour are two distinct constructions by going back to the definitions of the terms "physical inactivity" and "sedentary behaviour," as stated in the paragraph above. Here is an illustration showing how they differ from one another. Nicole commutes to work every morning, spends the entire day at her desk and in meetings, then returns home and spends most of the evening with her family watching television. Nicole had a very sedentary day. Nonetheless, it was not an inactive day, as she also ran for thirty minutes, putting her on track to achieve the WHO's physical activity recommendation. Nicole spent the day both quite sedentarily and physically active. The inverse is also conceivable. For instance, those who work at a fixed job (such as a hairdresser or a salesperson) will spend minimal time sitting down yet may not engage in any moderate or vigorous-intensity exercise (MVPA). They are, therefore, not sedentary, just inactive. In other words, sedentary behaviour and inactivity are, in fact, two different concepts, and sedentary behaviour and MVPA are not mutually exclusive.

2.6 Assessment of Sedentary Behaviours (Sitting Time) And Physical Activities

2.6.1 Physical Activity

The decline in physical activity caused by the growth of personal transportation (cars, motorcycles, etc.), increasing access to the internet, and the rise in the prevalence of sedentary lifestyles are becoming global issues (Deliens et al., 2015). In accordance with the WHO's (2020a; 2020b) recommendations for physical activity and sedentary behaviour, each week should include at least 150 minutes of moderate-intensity PA. Based on PA adherence, the students who report MSP are split into two groups in accordance with these recommendations. Anyone who engages in physical exercise for less than 150 minutes per week would be considered physically inactive, while anyone who engages in physical activity for 150 minutes or more per week would be considered physically active (Roggio et al., 2021). However, as was previously stated, failing to meet the required amount of physical activity is not the same as engaging in sedentary behaviour (Knight, 2012).

Sedentary behaviour and physical exercise (including active transportation) have a significant impact on students' overall health (Crombie et al., 2009; Keating et al., 2005). A large amount of research shows that fewer health risks are linked to higher levels of physical activity (Warburton, 2006; Jakicic and Davis, 2011). There is also accumulating evidence that excessive participation in sedentary behaviours, such as television viewing, computer use, and sitting for work/study, is related to an increased risk of health problems, regardless of diet and physical activity behaviour (Miller, 2010; Owen et al., 2010; Must and Tybor, 2005; Hu, 2003). Investigating sedentary behaviour and physical activity as two separate behavioural patterns that affect weight and health separately is crucial (Owen et al., 2000). Although Rouse and Biddle (2010) concluded that physical activity and sedentary behaviours among college students appear to be mostly uncorrelated, other research has demonstrated a negative correlation between sedentary behaviours and physical activity among college students (Buckworth and Nigg, 2004; Romaguera et al., 2011).

The International Physical Activity Questionnaire evaluates moderate- and vigorous-intensity physical activity, and its validity and reliability have been examined using unbiased measurement instruments (Hagströmer, Oja, and Sjöström, 2006). High physical activity was outlined as engaging in vigorous or vigorous-intensity physical activity for more than 150 minutes, or a mix of both (1 minute of high-intensity activity is equal to 2 minutes of moderate-intensity activity), during the course of a week. Low physical activity was described as a decreased level of physical activity (Nelson et al., 2007; Garber et al., 2011).

2.6.2 Sedentary Behaviour

A sedentary lifestyle is one that involves little to no physical activity or exercise, as contrasted to an active lifestyle. A person who has a sedentary lifestyle frequently spends the majority of the day sitting or lying down while doing something like socialising, watching TV, playing video games, reading, using a mobile phone, or utilising a computer (Medline Plus, 2021; Sassos, 2020). Sedentary time can be calculated in three different ways: (1) in terms of certain behaviours (such as the amount of time spent watching TV); (2) the amount of sedentary time spent in a particular domain (such as work, leisure, domestic, or transportation); and (3) the total amount of sedentary time throughout the day (Healy et al., 2011a; 2011b). The two primary indicators used to measure the amount of time spent engaging in sedentary behaviours are often screen time and sitting time (Chaput et al., 2008).

The research by van der Ploeg (2012) on sitting time and activity levels, combined with an analysis of 13 studies (Laskowski, 2018), indicated that people who sat for more than eight hours a day with no physical exercise had a risk of dying similar to that posed by obesity and smoking. As a result, the 8-hour threshold serves as the upper limit for the suggested sitting time for adults. Students' sitting time, including time spent at a desk, reading, or lying down to watch television at home, must be monitored using a self-reported questionnaire in order to determine their sedentary time. How much time do you spend sitting or lying down during the day is an example of a question (Lee et al., 2019). This duration will then be divided into two groups: those who spend less than 8 hours a day sitting down and those who spend more than 8 hours a day sitting down. This means that any person will be considered highly sedentary if they spend 8 hours or more a day sitting or lying down (Tan, Tan and Tan, 2021).

2.7 Musculoskeletal Disorder (MSD)

According to the National Institute for Occupational Safety and Health (1997), musculoskeletal disorder (MSD) is an illness that harms the musculoskeletal system of the human body, which includes the bones, spinal discs, tendons, joints, ligaments, cartilage, nerves, and blood vessels.

MSD are prevalent, and the risk of having one increases with age. MSD can range widely in severity. They can occasionally create pain and pain that makes daily activities difficult. Early detection and intervention may reduce symptoms and enhance long-term prognosis. They range from acute, transient disorders like fractures, sprains, and strains to chronic illnesses that cause on-going pain and incapacity. Musculoskeletal conditions are typically characterised by pain (which is frequently persistent) and restrictions in mobility, dexterity, and functional ability. These limitations affect people's ability to work and participate in social roles, which has an effect on their mental wellbeing and, on a larger scale, has an impact on the prosperity of communities. Osteoarthritis, back and neck pain, fractures linked to bone fragility, fibromyalgia, tendinitis, carpal tunnel syndrome, traumas, and systemic inflammatory diseases like rheumatoid arthritis (RA) are the most prevalent and incapacitating musculoskeletal illnesses (IOMC, 2022). The elbows, forearms, wrists, hands (Buckle and Devereux, 2002), low back, neck, and shoulder (Algarni et al., 2017) are often the body parts of the student population that are most frequently afflicted. However, issues with the lower extremities are likewise becoming more and more important (Adegbehingbe et al., 2009).

2.7.1 Symptoms of MSD

Musculoskeletal symptoms can be caused by joints, bones, muscles, ligaments, tendons, or bursae and are fairly prevalent. Musculoskeletal symptoms frequently manifest as pain, weakness, stiffness, creaking or clicking joints, and reduced range of motion. Every musculoskeletal system, including the neck, shoulders, wrists, back, hips, legs, knees, and feet, can be significantly impacted. The symptoms of MSD might occasionally make it difficult to do simple tasks like typing or walking. One can encounter restricted movements or struggle to do daily duties (Villa-Forte, 2021; CCOHS, 2014).

Lorusso, Bruno, and L'Abbate (2009) conducted a cross-sectional survey to estimate the prevalence of musculoskeletal symptoms among university students who use personal computers and to look into the characteristics of occupational exposure and the prevalence of symptoms over the course of the study. At the conclusion of the study, it was discovered that university students who used computers often for extended periods of time had a significant prevalence of musculoskeletal problems. The most frequent complaint (69% of reports) was neck pain, which was followed by hand/wrist (53%), shoulder (49%) and arm (8%) pain. Another study by Kanchanomai et al. (2012) sought to determine the prevalence of musculoskeletal symptoms at the spine among undergraduate students at a public university in Thailand over a 3-month period and to find biopsychosocial factors linked to the prevalence. According to the final findings from 2,511 respondents, college students frequently have spinal symptoms. The most often reported symptoms were cervical (22.3%), followed by thoracic (11%) and lumbar (10.7%). Similar research was done by Schlossberg et al. (2004) with the aim of determining the risk factors connected to upper extremity and neck pain in 206 engineering graduate students at a major public university. The study found that graduate students frequently reported upper extremity pain. A mean pain severity score of 4.5 was reported by 60% of respondents who said they had upper extremity or neck pain.

In addition, a study by Obembe et al. (2013) examined the prevalence of musculoskeletal pain among laptop-using undergraduate students at Obafemi Awolowo University (OAU), Ile-Ife. In a survey including 376 students, it was shown that shoulder pain was the most often reported musculoskeletal pain among undergraduate laptop users in OAU. The most frequent musculoskeletal symptom was shoulder pain, which was reported by 268 participants (75.7%). The least frequent complaint among the 132 (37.3%) participants was elbow pain. The prevalence of computer vision syndrome (CVS) and ergonomic behaviours among students in the Faculty of Medical Sciences at The University of the West Indies (UWI), Jamaica, was then investigated by Mowatt et al. (2017). According to research, university students frequently have CVS symptoms such neck pain, eye strain, and burning. The most prevalent CVS symptoms were neck pain (75.1%), eye strain (67%), shoulder pain (65.5%), and eye burn (61.9%). The least frequent symptoms were dry eyes (26.2%), double vision (28.9%), and hazy vision (51.6%). In a study conducted by Haroon et al. (2018) at a public sector university in Karachi, Pakistan, on musculoskeletal pain and its risk factors among medical students, they also discovered a considerable risk of musculoskeletal pain. The most common sites of musculoskeletal pain were the neck, shoulders, or lower back.

Study by Hashim et al. (2021), which examined the prevalence of postural musculoskeletal problems among dentistry students in the United Arab Emirates, produced similar findings. It was discovered that dental students in the UAE frequently experience MSP, such as neck, shoulder, and low-back pain. Next, Roggio et al. (2021) investigated how sedentary behaviour affected 1654 Italian university students' levels of physical activity and musculoskeletal pain. 43.5% of respondents said they had neck pain, and 33.5% said they had low back pain, according to the study. After that, Senarath, Thalwaththe, and Tennakoon (2021) conducted a study to determine the prevalence of musculoskeletal problems among students at the University of Peradeniya's faculty of Allied Health Sciences. It was discovered that 73.6% of people had musculoskeletal problems in any anatomical location. The most common region to be impacted by most variables was the neck, followed by the lower back and ankle/foot. The wrist and hand were the least common. The prevalence and patterns of musculoskeletal pain among undergraduate physiotherapy and occupational therapy students at a South African institution were researched by Ogunlana, Govender, and Oyewole in 2021. They discovered that the pattern of MSP showed that neck pain was most common (66.2%) and low back pain was second (64.4%).

2.8 Musculoskeletal Pain (MSP)

The most prevalent symptom of the majority of musculoskeletal pain is pain. Pain ranges from mild to severe, acute and short-term to chronic and long-lasting, and can be localised or broad (diffuse). Disorders of the bones, joints, muscles, tendons, ligaments, bursae, or a combination of these can result in musculoskeletal pain. The most common reason for pain is injuries. A pain that has substantial local origins, such as tumours, fractures, or infections, as well as systemic and neurological reasons, is excluded from the criteria (Villa-Forte, A., 2021).

Bone pain, joint pain, muscle pain, tendon and ligament pain, and bursal pain are the most typical forms of musculoskeletal pain. The symptoms may differ depending on the aetiology of the musculoskeletal pain. Muscle aches and stiffness, exhaustion, muscle spasms, pain that gets worse with movement, and sleep disruptions are all common signs of musculoskeletal pain (Cleveland Clinic, 2014).

Typically, bone pain is subtle, deep, or both. Injury to the musculoskeletal system is a typical cause. Stiffness and inflammation are frequently present alongside joint pain. Joint pain frequently gets better with rest and goes worse with activity. Although it can be quite painful, muscle pain is frequently less severe than bone pain. Examples of it include injuries, cramps, and muscle spasms. Strong bands of tissue called tendons and ligaments unite the joints and bones (Villa-Forte, A., 2021). Pain in ligaments and tendons is frequently less severe than pain in bones. Tendon or ligament pain can result from strains, sprains, and overuse accidents. It is frequently described as "sharp" and gets worse when the strained or shifted tendon or ligament is involved. Rest usually makes it go away. Trauma and overuse are two things that might hurt the bursae. Bursae are tiny sacs filled with fluid that act as a cushion around joints. Pain is usually exacerbated by bursa-related movement and eased by rest. The afflicted bursa may enlarge (Cleveland Clinic, 2014).

2.8.1 Neck Pain

Neck pain typically originates from issues with the musculoskeletal system, specifically the spine and the muscles and ligaments that support it. The spine includes the backbones, or vertebrae, as well as other supporting bones. Due to its flexibility, the neck is prone to damage and injuries that cause it to be overextended. Additionally, the neck plays a crucial role in supporting the head upright. This task is made more challenging by poor posture. Neck pain is therefore common (Moley, 2020b).

The cervical spine refers to the portion of the spine that is located in the neck. It is made up of seven back bones (vertebrae), which are divided by cartilage and jelly-like discs. The spinal cord is located in the cervical spine. Spinal nerves emerge from gaps between the vertebrae throughout the length of the spinal cord and connect to other bodily nerves. The spinal nerve root is the portion of the spinal nerve closest to the spinal cord. Neck ligaments and muscles support the spine (Moley, 2020b).

A synchronised network of nerves, bones, joints, and muscles makes up the neck, also known as the cervical spine. It performs the crucial task of giving the head support and mobility, yet it can occasionally hurt. Neck pain can be brought on by a variety of issues. Pain in the shoulder, head, arm, and/or hand can result from irritation along the nerve pathways in the neck. Additionally, pain in the legs and other places below the neck might result from irritation of the spinal cord. The majority of the time, neck pain subsides within a few days or weeks, but pain that lasts for months may indicate a medical issue that needs to be treated (Curtis, 2019).

2.8.1.1 Common Symptoms of Neck Pain

Neck pain can range from mild and easily ignored to agonising and interfering with daily tasks such as dressing, concentrating, and sleeping. A stiff neck and a decreased range of motion can occasionally result from neck pain. Neck pain is frequently divided into three categories: acute, subacute, and chronic. Acute pain is defined as lasting less than four weeks. Subacute pain is defined as lasting four to twelve weeks. Pain that is chronic lasts three months or more (Curtis, 2019).

Neck pain may be severe and localised to a single point, or it may be less severe and widespread. At times, the pain may be sent upward to the head or occur concurrently with a headache. Muscle spasms in the neck, upper back, or the area around the shoulder blade may also accompany it at other times. Less frequently, tingling or pain similar to a shock may extend into the hand, arm, or shoulder (Curtis, 2019).

Usually, neck pain comes with one or more symptoms. Neck stiffness, acute pain, general soreness, radicular pain, cervical radiculopathy, difficulty holding or lifting items, headaches, and general soreness are typical symptoms of neck pain. A stiff neck makes moving the neck painful and challenging, especially when attempting to turn the head side to side. Sharp pain may only be felt in that one area and may feel stabbing or stinging. Usually, the lower neck is where this kind of pain develops. Uncomfortably, general soreness is often felt in a larger neck area or region. It is regarded as soft or achy rather than acute (Curtis, 2019). A neck nerve can cause radicular pain to travel to the shoulder and arm. This nerve pain may feel like it is burning or searing and its intensity can vary. Due to nerve root compression, cervical radiculopathy is a neurological condition where the arm may experience reflex, sensory, or strength issues. Radicular pain could potentially be a symptom of cervical radiculopathy. When the arm or fingers become numb or weak, it can be difficult to hold or lift objects. Last but not least, neck pain can sometimes cause headaches by affecting the head's muscles and nerves (Park and Rodway, 2020; Curtis, 2019; Meyler, 2019).

Sleeping may become challenging as neck pain symptoms worsen. Additionally, neck pain might make it difficult to do daily tasks like dressing or leaving for work, as well as any head-turning activities like driving (Curtis, 2019; Meyler, 2019).

2.8.2 Low Back Pain

The lumbar spine, also known as the low back, is a remarkable example of a well-engineered system, with interconnected bones, joints, nerves, ligaments, and muscles that all work to provide stability, strength, and flexibility (Peloza, 2017). The lower back (lumbar spine) is connected to the upper back (thoracic spine) and pelvis by the sacrum (sacrum). The lumbar spine offers strength for standing, walking, and lifting while being flexible enough to allow turning, twisting, and bending. As a result, practically all actions of everyday living include the lower back. However, because of its intricate anatomy, the low back is also prone to harm and pain. Numerous activities might be restricted by low back pain, which also lowers life quality (Moley, 2020a).

There are three main classifications of low back pain: acute, chronic, and neuropathic. The duration of acute pain, which is directly related to tissue injury, is often short (less than 3 to 6 months). When the pain lasts longer than three to six months or after the point at which the tissue recovers, it is considered chronic pain. The last type of pain is neuropathic pain, which has unique symptoms. There are no visible symptoms of the initial injury in neuropathic pain, and the pain is not connected to any observable conditions or injuries (Deardorff, 2019).

The majority of sudden low back pain is brought on by a muscle, ligament, joint, or disc injury. The inflammatory healing response is another way in which the body responds to injuries. While inflammation may appear to be small, it can cause considerable pain (Peloza, 2017).

2.8.2.1 Common Symptoms of Low Back Pain

Injury-related low back pain may start out acute but can develop into chronic pain. Early pain management can reduce the length of time that symptoms last as well as their intensity (Peloza, 2017).

A variety of symptoms, such as dull, aching pain, pain that radiates to the buttocks, legs, and feet, pain that gets worse after prolonged sitting, pain that feels better when changing positions, and pain that gets worse after waking up and better after moving around, are typical characteristics of low back pain (Peloza, 2017).

Axial pain, which is described as dull and aching rather than searing, stinging, or acute, persists in the low back. Hip and pelvic pain, reduced movement, and mild to severe muscular spasms can also accompany this type of pain (Peloza, 2017).

A sharp, stinging, tingling, or numbing pain that radiates down the thighs and into the low legs and feet is referred to as pain that goes to the buttocks, legs, and feet. Sciatica is another name for it. Sciatica is a condition that typically affects one side of the body and is brought on by inflammation of the sciatic nerve (Peloza, 2017).

Long durations of sitting increase pressure on the discs, making the pain worse, which makes low back pain worsen after extended sitting. Walking and stretching can temporarily relieve low back pain, but if individuals sit down again, the symptoms might come back (Peloza, 2017).

Pain that disappears when individuals change positions. Some positions will be more pleasant than others, depending on the underlying source of the pain. For instance, walking normally may be uncomfortable and difficult for someone with spinal stenosis, but pain may be lessened by leaning forward into something like a shopping cart. Understanding how symptoms alter when in different postures can assist locate the pain's origins (Peloza, 2017).

Pain that is worse when you first wake up and gets better when you move around. Many people with low back pain claim that their symptoms are worst in the morning. However, symptoms disappear after standing up and moving around. The stiffness brought on by prolonged periods of relaxation, the reduced blood flow during sleep, and perhaps even the quality of the mattress and pillows utilised are the causes of morning pain (Peloza, 2017).

Of course, there are various ways in which low back pain might manifest itself. The feeling of low back pain differs from person to person, and a variety of factors, such as exercise and activity level, financial stress, and mental and emotional well-being, can affect the intensity of pain (Peloza, 2017).

2.8.3 Shoulder Pain

The shoulder is a multi-component, intricate, and highly dynamic structure. The glenohumeral joint and the acromioclavicular joint are the two joints. The glenohumeral joint is where the shoulder blade and upper arm bone (humerus) meet (scapula). The acromioclavicular joint connects the tip of the shoulder blade to the collarbone (clavicle). The shoulder capsule is made of sturdy connective tissue. This maintains the humerus's position in the joint socket. A synovial membrane lines the joint capsule. Synovial fluid, which is produced by it, lubricates and nourishes the joint. The shoulder is stabilised and supported by strong tendons, ligaments, and muscles (Musculoskeletal Australia (MSK), 2018).

2.8.3.1 Common Symptoms of Shoulder Pain

There are numerous reasons why shoulders hurt, and each one has its own own set of signs and symptoms. Deep-seated pain in the shoulder joint, decreased range of motion, shoulder weakness, pins-and-needles and scorching pain sensations, and immobility following a shoulder dislocation are some of the usual symptoms of shoulder pain. Deep shoulder joint pain may also radiate to the front or rear of the shoulder and the upper arm. The shoulder ache may occasionally be described as "catching pain." The structure generating the pain is probably related to the pain's location and nature (Versus Arthritis, 2018). The next sign would be restricted movement and shoulder pain. Additionally, the upper arm and shoulder would be weakened. Depending on the situation, the shoulder may feel like it is slipping out of its socket and back into it. It may even become fully displaced (dislocated). The feeling of pins and needles (tingling) and scorching pain are other symptoms. The neck's nerves are more likely to be involved in this than the shoulder joint itself. Last but not least, after a shoulder dislocation, there won't be any movement. Pain generally causes this. Both complete rotator cuff tears and axillary nerve damage make it difficult to lift the arm away from the body. These conditions necessitate a comprehensive clinical evaluation (Musculoskeletal Australia (MSK), 2018).

2.9 Musculoskeletal Pain Among University Students

MSP are musculoskeletal pain that result in symptoms like pain in various body parts such the neck, shoulders, wrists, hips, knees, and heels owing to injury to the nerves and blood vessels in those areas (Cho, Cho, & Han, 2016). Multiple factors that can also exacerbate MSP contribute to their occurrence (Batham & Yasobant, 2016). According to certain studies, individual risk factors and ergonomic risk factors both contribute to the development of MSP.

Lorusso, Bruno, and L'Abbate (2009) carried out a cross-sectional survey to gauge the prevalence of musculoskeletal problems among college students. It was discovered that students, especially fourth-year students, were considerably more exposed to risk factors such daily and prolonged computer use, time spent at the computer without breaks, and duration of mouse use. Another study by Kanchanomai et al. (2012) looked into the prevalence of musculoskeletal complaints at the spine in undergraduate students at a public institution in Thailand over the course of three months. It was discovered that a high prevalence of cervical symptoms was substantially related with daily computer use of more than three hours. Study by Schlossberg et al. (2004) , which looked into the risk factors for upper extremity and neck pain in engineering graduate students, discovered a substantial correlation between the students' musculoskeletal pain and the number of years and hours they spent using computers. The prevalence of musculoskeletal pain among undergraduate students at Obafemi Awolowo University (OAU), Ile-Ife, was determined in a different study by Obembe et al. (2013). According to their research, laptop users had the highest rate of musculoskeletal complaints.

The usage of a computer or laptop for more than three hours per day was revealed to be one of the contributing risk factors for the musculoskeletal pain in a study by Haroon et al. (2018) on the condition's risk factors among medical students at a public sector university in Karachi, Pakistan. Lack of exercise is one of the main causes of musculoskeletal pain, according to a United Arab Emirates study by Hashim et al. (2021) that sought to ascertain the prevalence of postural musculoskeletal symptoms among dental students there. Next, study by Roggio et al. (2021), which sought to determine the prevalence of musculoskeletal pain among Italian students before, during, and after social restrictions imposed in response to the COVID-19 outbreak, found that a reduction in daily activities, sedentary attitude/behavior, and low levels of physical activity were a few of the key factors that were linked to the onset and worsening of musculoskeletal pain in the students. Then, in a subsequent study by Senarath, Thalwaththe, and Tennakoon (2021), it was determined that factors like the student's study style, materials, participation in extracurricular activities, sports, and physical activity levels are some of the contributing factors in determining the prevalence of musculoskeletal pain among students at the faculty of Allied Health Sciences, University of Peradeniya. Last but not least, a study by Ogunlana, Govender, and Oyewole (2021) examining the prevalence and patterns of musculoskeletal pain among undergraduate occupational therapy and physiotherapy students at a South African university has found that MSP among health science undergraduates is significantly associated with sedentary postures and inadequate participation in structured physical activity.

2.9.1 Risk Factors Associated with Neck Pain

One of the major contributors to disability globally is neck pain, a common musculoskeletal pain (Hoy et al., 2014). Neck pain might result in reduced working hours, limited participation in recreational activities, and disturbed sleep (Long, Johnston and Bogossian, 2012). According to research, a lot of new neck pain episodes start when people are in college and continue long after they graduate (Croft et al., 2001; Hoving et al., 2004).

Small sample size (Obembe et al., 2013; Yeun and Han, 2017) or a lack of representative samples from various undergraduate programmes (Algarni et al., 2017; Smith, Leggat and Clark, 2006) prevented earlier studies from fully examining the risk factors for neck pain in undergraduate students. It makes sense that both general and program-specific factors could contribute to neck pain in undergraduates. These variables might have varying mediating effects on the prevalence of neck pain among students in various undergraduate programmes (Moreno-Betancur et al., 2017). The following discussion includes a review of several literatures that have pinpointed the contributing risk variables linked to students' neck pain that are pertinent to this study.

Physical activity level, usage of computers and cell phones, and location of colleges attended by young adults in the metropolitan region and in Gangwon province in South Korea were identified as major risk factors contributing to neck pain in a study by Yeun and Han (2017). Computer use was found to carry some risk in a different study by Smith, Leggat, and Clark (2006) on upper body musculoskeletal pain in Australian occupational therapy students. Students who used computers for more than 5 hours per week had a higher risk of neck MSP. In a study by Kanchanomai et al. (2011) to identify the risk factors for the beginning and persistence of neck pain in undergraduate students, it was suggested that using a computer for enjoyment accounted for 70% of all computer usage time and that students who were in their second year of studies had the highest risk factors. Then, Chan et al. (2020) did a study to assess the prevalence of neck pain and related risk factors among undergraduate students, and they discovered that concurrent low back pain, being in their senior year of college, and prolonged smartphone use were substantially connected with the existence of neck pain.

In a similar manner, Jahre et al. (2020) investigated the risk factors for non-specific neck pain in young persons between the ages of 18 and 29. According to the findings, there is a connection between neck pain, physical activity, and computer use time. However, their investigations had a moderate to high risk of bias, and the overall strength of the evidence was very poor. As a result, the findings were deemed inconsistent. According to a study by Ayanniyi et al. (2010) that examined the prevalence and features of neck pain among Nigerian university undergraduates, there was a higher prevalence of neck pain among the students after entrance to the university than before (68.6 vs. 28.7%). As study level grew, neck pain increased as well. Next, Ayhualem et al. (2021) did a study to determine the prevalence and risk factors for neck pain among University of Gondar students who use smartphones. 47.4% of smart phone users reported having neck pain at some point in the previous 12 months. Regular activity, using a smartphone for more than six hours per day without taking a break, using other devices, utilising social media frequently, and attending fifth and sixth years were all strongly linked to neck pain. After that, Hasan et al. (2018) did a study to determine the prevalence of musculoskeletal pain among undergraduate students and associated factors. According to reports, non-medical students have a significant quantity of evidence linking prolonged study sessions and laptop/computer use to musculoskeletal pain.

Moving on, analysis by De Vitta et al. (2020) of the prevalence of neck pain and factors associated among university students in Portugal found that factors like watching TV for more more than three hours per day, using a computer for more than three hours per day, playing video games for more than three hours per day, holding a tablet more than 20 cm away from the eye, and using a tablet for two or more hours per day were still associated with the condition. Deivendran Kalirathinam et al. (2017) sought to ascertain the frequency of neck and upper extremities symptoms among college students who used smartphones for internet browsing and online studying. At the conclusion of the study, it was hypothesised that there is a correlation between the prevalence of neck problems and smartphone use for e-learning. In addition, Almalki, Algarni, and Almansouri's (2017) study, which sought to determine the relationship between non-specific neck pain and the use of smartphones, iPads, laptops, and computers by university students, discovered that a large proportion of students reported neck pain symptoms that were significantly associated with the use of smartphones, iPads, and other small portable devices for studying. A study by Daher and Halperin (2021b) that examined the influence of the COVID-19 pandemic and lockdown on the prevalence of and risk factors for neck pain among college students came to the conclusion that students were negatively impacted by the switch from on-campus learning to online learning. It markedly enhanced the tension associated with studying and the onset of neck pain. Last but not least, a study by Huey and Sharmila Gopala Krishna Pillai (2021) that examined the frequency of neck pain among university students in Kuantan, Pahang, during the COVID-19 pandemic, as well as its risk factors, concluded that the number of hours students spend using computers and smartphones each day has a significant impact on the prevalence of neck pain among them.

2.9.2 Risk Factors Associated with Low Back Pain

Low back pain (LBP) is a global social and economic health issue affecting people of all ages (Nor Azlin Mohd Nordin, Devinder Kaur Ajit Singh and Lim, 2014). According to studies, between 12 and 80 percent of the younger population, predominantly students, suffer with LBP (Korovessis, Repantis, and Baikousis, 2010; Pellisé et al., 2009; Smith and Leggat, 2007; Jones and Macfarlane, 2005; Burton et al., 1996). Functional impairment caused by LBP may not be the primary issue in a younger group. However, enduring it earlier in life may increase the risk of developing chronic LBP (Brattberg, 1994) and recurrent LBP (Harreby et al., 1995) later in life. There is a wealth of knowledge available regarding the frequency of LBP among university students, many of whom are pursuing careers in the health sciences. Reviewing the risk factors for LBP among these students revealed a variety of risk variables (Smith & Leggat, 2007). General health status, length of computer use, levels of physical activity, and past LBP history are some of the identified LBP risk variables that are pertinent to this study (Smith & Leggat, 2007).

Numerous research has suggested that sedentary habits and physical inactivity are strongly linked to low back pain. Physical fitness and the number of hours spent sitting each day were found to be associated with low back pain (LBP) among health science students, according to a study by Nor Azlin Mohd Nordin, Devinder Kaur Ajit Singh, and Lim (2014) on low back pain and associated risk factors among undergraduates of a major public university. Similar research by Yucel and Torun (2016) in Turkey found strong associations between the onset of low back pain and traits like the propensity for physical activity, changes in body weight over the previous six months, daily hours spent watching TV and using a computer, a history of spinal trauma, and a family history of disease. According to a study by Taspinar et al. (2013), university students are at risk for developing nonspecific low back pain due to factors like working periods spent sitting straight (television, computer, seminar, etc.), working periods spent bending at a table (reading, writing, etc.), using lumbar support while sitting, and physical activity habits.

In a similar fashion, Atiković et al. (2017) observed associations between regular physical activity (PA) and low back pain (LBP) among undergraduate students in Bosnia and Herzegovina. The study sought to determine the prevalence and risk factors of low back pain. Next, a recent study by Sany, Tanjim, and Hossain (2022) on low back pain and associated risk factors among medical students in Bangladesh identified some of the most significant risk factors for students, including low to moderate physical activity frequency, spending more than 6 hours per day sitting, and inadequate rest. Following that, physical inactivity was identified as one of the risk factors in a study by Issa et al. (2016) on low back pain among undergraduate students at Taif University in Saudi Arabia. The students' level of physical activity and computer use are included as risk factors for LBP in a study by Imdad et al. (2016) that examined the prevalence of low back pain among undergraduate students at Isra University's Karachi Campus. Last but not least, physical activity and sedentary behaviour were significant risk factors for low back pain among students at Yenepoya University in Mangaluru, India, according to a study by Pais, Meman, and Kalal (2017).

2.9.3 Risk Factors Associated with Shoulder Pain

One common musculoskeletal issue that is recognised as being debilitating and having a significant financial impact is shoulder pain. The pain and impairment caused by shoulder pain can significantly affect a person's daily life, capacity to work, and relationships with their family, community, and healthcare system. It is the third most frequent musculoskeletal issue that physiotherapy patients report with (Kooijman et al., 2013; Barrett, 2016). A review of multiple literatures pertinent to this study on the associated risk factors of shoulder pain in undergraduate students is provided below.

Bina et al. (2013) conducted a study at Tabriz University of Medical Sciences to identify the prevalence and risk factors of neck and shoulder pain among medical students. They discovered that daily routine, sleep duration, and computer use were significant variables. The prevalence of musculoskeletal pain among undergraduate students at Obafemi Awolowo University (OAU), Ile-Ife, was then established by a study done by Obembe et al. (2013). According to their research, the most common musculoskeletal complaint among students (75.7%) was shoulder pain, with carrying single-strap laptop bags and using laptops as the main contributors to the problem. In a similar manner, Noreen et al. (2016) conducted a study to ascertain the prevalence of computer vision syndrome and its associated risk factors among undergraduate medical students in urban Karachi, Pakistan. 67.2% of respondents reported having shoulder pain linked with CVS, which was substantially correlated with computer usage duration (240 min/4 hours). Next, a study by Dighriri et al. (2019) looking at the prevalence and risk factors of neck, shoulder, and low-back aches among medical students at Jazan University in Saudi Arabia identified factors including exercise frequency per week and daily computer use as risk factors for the shoulder pain.

In a similar vein, Mustafa Ahmed Alshagga et al. (2013) undertook a study to identify the prevalence and risk factors for neck, shoulder, and low back symptoms in medical students at a Malaysian Medical College. They discovered that factors including daily computer use and hours are strongly associated with MSP on the shoulder. Moving ahead, a study by Deivendran Kalirathinam et al. (2017) to investigate the prevalence of neck and upper extremity complaints found that university students were more likely to have right shoulder symptoms (13.93%) than left shoulder symptoms (11.07%) due to the use of smartphones for internet browsing and e-learning. The prevalence of computer vision syndrome (CVS) and its risk variables among undergraduate medical students were investigated in a study by Noreen et al. (2020). The frequency of CVS symptoms was higher among users of desktop/laptop computers and mobile phones. The students' shoulder pain was discovered to be related to these activities. After that, a study by Rakhadani, Goon, and Mandeya (2017) at the University of Venda in South Africa found a significant occurrence of musculoskeletal conditions among the students, with the shoulder being the most common area of concern and being linked to extended computer use. Last but not least, a study by Hasan et al. (2018) that examined the prevalence of musculoskeletal pain and related factors among undergraduate students discovered that prolonged study sessions and frequent laptop use were linked to an increase in MSP, particularly in the shoulder area.

2.10 Ergonomics

Ergonomics (also known as human factors) is a scientific field devoted to understanding the interactions between humans and other parts of a system, as well as a profession that uses theory, concepts, data, and methodologies to design in order to optimise human well-being and total system performance. The term ergonomics is derived from the Greek words "ergon" (labour) and "nomos" (rules). In essence, it is the "science of work" or "laws of labour". A workspace that is well-designed for ergonomics eliminates worker and task incompatibilities and produces the best working conditions. Ergonomics draws on a variety of disciplines to improve how the workplace and the worker interact (International Ergonomics Association, 2020). A brief definition of ergonomics would be that it seeks to design tools, technological systems, and tasks in a way that enhances human performance, safety, health, and comfort (Dul and Weerdmeester, 2003, p.1).

Ergonomics places the individual at the centre of the design of work and everyday living settings. By taking into account human physical and psychological capabilities and limitations, unsafe, unpleasant, uncomfortable, or inefficient situations at work or in daily life are avoided (Dul and Weerdmeester, 2003, p.1).

Ergonomics takes into account a variety of aspects, such as body positioning and movement (such as sitting, standing, lifting, pushing, and pulling), environmental factors (such as noise, vibration, lighting, and chemical substances), information and operation (such as information obtained visually or through other senses, controls, and the relationship between displays and controls), and organisational factors at work (appropriate tasks, interesting jobs). These elements greatly influence daily living and work-related safety, health, comfort, and productivity (Dul and Weerdmeester, 2003, p.1).

Anthropometrics, biomechanics, physiology, psychology, toxicology, mechanical engineering, industrial design, information technology, and industrial management are just a few of the human sciences and technology domains that inform ergonomics. From these domains, it has gathered, picked out, and integrated pertinent knowledge. Methods and tactics particular to this expertise are employed. Because of its interdisciplinary approach and applied focus, ergonomics stands apart from other fields. The ergonomic approach has a wide range of applications because of its interdisciplinary nature. Due to its practical nature, the ergonomic approach leads to the adaption of the workplace or environment to fit people rather than the other way around (Dul and Weerdmeester, 2003, p.1).

2.10.1 Ergonomics In Educational Settings

The majority of ergonomics studies and application are focused on the workplace, particularly office settings, with less focus on ergonomics in educational settings. Excessive repetition, duration, force, and awkward posture are risk factors for the development of musculoskeletal pain (MSP) connected to the workplace, and exposure to combinations of these factors raises the risk even further (NIOSH, 1997).

Numerous research, including some prospective studies, have discovered relationships between MSP and aspects of computer-related employment (Gerr, Marcus and Monteilh, 2004; Gerr et al., 2002; Bergqvist et al., 1995a; Bergqvist et al., 1995b; Bernard et al., 1994).

According to studies, ergonomic stressors include non-neutral postures, static posture, repetitive motion, heavy lifting, vibration, uncomfortable posture, temperature, vigorous exertions, and contact stress, as well as exposure to combinations of these factors, have a substantial connection with MSP (Batham and Yasobant, 2016; Padmanathan et al., 2016; Punnett, 2014). This is so that the afflicted area will be the same and the body will carry out the same task in the same manner. The area will be less effective due to exhaustion if it is subjected to the same force every day (Wiitavaara, Fahlström, and Djupsjöbacka, 2016).

Studying computer user pain must go beyond the traditional working settings and into the educational setting because computers are now a crucial component of preparing the next generation of workers. The existing research shows that students, especially college students (Noack-Cooper, Sommerich and Mirka, 2009; Noack, 2003; Katz et al., 2000), as well as those in high school and elementary school (Jacobs and Baker, 2002; Harris and Straker, 2000), frequently experience musculoskeletal pain linked to computer use.

2.10.2 Ergonomic Risk Factors Associated with MSP

Musculoskeletal pain in working populations has been the subject of extensive research in the past, first in relation to typing and later in relation to computer use. Recently, there has been an increased focus on MSP in college students and how this is related to both their increased use of computers and their earlier exposure to them than previous generations of students (Cooper, Campbell-Kyureghyan and Sommerich, 2008).

One of the early assessments of students' understanding of computer ergonomics was undertaken by Alexander (1997). Alexander was one of the first to realise the potential for future workers (students) to join the workforce wounded and/or with limited knowledge of correlations between computer use and MSP. The study had certain flaws, but overall it showed that students didn't know much about computer ergonomics. The individuals' history of MSP was not questioned in the study (Cooper, Campbell-Kyureghyan and Sommerich, 2008).

Through surveys, observational field studies, and laboratory-based studies, subsequent research has revealed details about the prevalence of MSP in students, the impact of MSP on students' functioning, and the exposure to risk factors. These studies demonstrate that college students' risk factor exposure and MSP prevalence are somewhat similar to that of office employees (Cooper, Campbell-Kyureghyan and Sommerich, 2008).

A study on upper extremity musculoskeletal complaints and functional impairment related to computer use among college students was conducted by Hupert et al. in 2004. On any given day, 10% of a sample of students reported having upper extremity pain an hour after beginning computer use. Next, a study by Chang et al. (2007) discovered that among male students who used computers for more than 3-3.5 hours per day, there was an increase in musculoskeletal complaints, but no such association was discovered for the group of female individuals. Then, Lorusso, Bruno, and L'Abbate (2009) conducted a survey to estimate the prevalence of musculoskeletal symptoms among university students. They discovered that elements like the length of time spent using a mouse and poor workstation ergonomics are significantly linked to musculoskeletal pain in the students. Long-term smartphone and computer use appears to increase the likelihood of developing neck pain, according to a study by Chan et al. (2020) that looked at the prevalence of neck pain and related risk factors among undergraduate students. Then, a study by Noreen et al. (2020) discovered that using a desktop or laptop at a distance shorter than the forearm, keeping a mobile phone less than 12 inches away, taking shorter breaks, and not utilising an ergonomic chair were all substantially associated with MSP symptoms. Next, a study by Deivendran Kalirathinam et al. (2017) found a strong correlation between upper extremities and neck symptoms and poor ergonomics of smartphones, uncomfortable postures/positions while using mobile devices, and sitting in chairs without armrests or back supports. Moving on, a study by Kanchanomai et al. (2011) found that prolonged computer use, an improper mouse position, an elevated keyboard, and an unlevel computer screen were all factors in the development of neck pain.

Similar to this, a study by Mowatt et al. (2017) discovered a strong correlation between MSP symptoms and ergonomic variables such using handheld devices and seeing computers at eye level rather than holding them at an angle or looking down. The findings point to a connection between not taking active breaks, stretching, and the neck; using a laptop and the eyes, shoulders, and left elbow; not using a mouse and the elbow, hand, and right wrist; and not supporting the forearm on the table, and the lower back. Then, a study by Dimate-Garcia and Rodrguez-Romero (2021) indicates a connection between MSP symptoms and elements like eye level while using a laptop, mouse use, and forearm support on a table. Next, a study by Osama, Ali, and Malik (2018) found a positive correlation between musculoskeletal pain and prolonged computer use, as well as the type of posture used when using a computer or laptop, such as sitting on a chair or sofa with knees flexed and a laptop or tablet on the lap, long sitting with knees extended and a laptop or tablet on the lap, supported sitting on a chair with a computer or laptop on a desk, using a computer

In addition, Tullar et al. (2007) discovered that computer-related ergonomic risks are associated with musculoskeletal complaints. It was discovered that college students were exposed to nine potential postural strains, including: arms not beside while keying or mousing; lower back not supported; lack of chair attachments; computer monitor not adjustable; mouse too high or low; hand/wrist/forearm in touch with the desk edge; lack of wrist support; and lack of adjustable keyboard. After that, a study conducted in 2016 by Fatin Nasuha Abdul Rahim and Shamsul Bahri Mohd Tamrin revealed that pupils' levels of pain were generally high. The frequency of pain includes the chair's height, the length of the seat pan, the angle of the back support, the height of the monitor, and the placement of the keyboard and mouse. Other factors that were linked to musculoskeletal pain included the students' awkward torso posture, which included bending forward, leaning, sitting, and twisting, their computer-related workstations, and the mismatch between their bodies' dimensions and the furniture's dimensions (popliteal height and seat height; buttock-popliteal length and seat depth; knee height and table clearance; and elbow rest height and table height). Additionally, a study by Wami et al. (2020) revealed that university students in Ethiopia were more likely to experience musculoskeletal pain if their sitting chair was inadequately built. The frequency of MSP among undergraduate students at a South African institution was shown to be strongly correlated with ergonomic work hazards, such as extended sitting and repetitive movements, according to a study by Ogunlana, Govender, and Oyewole (2021). Lastly, flexed neck position has been linked to neck diseases, according to a study by Namwongsa et al. (2018) that looked into musculoskeletal pain (MSP) in smartphone users in Thailand.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Study Design

A quantitative cross-sectional study was carried out (Roggio et al., 2021) to evaluate the prevalence of musculoskeletal pain and their related risk factors among university students during the COVID-19 pandemic. This study utilized a self-administered online questionnaire via the Google Forms web survey platform (Google LLC, Mountain View, CA, USA) (Roggio et al., 2021).

3.2 Study Location

The study was carried out at the Kampar Campus of the University Tunku Abdul Rahman (UTAR).

3.3 Study Population

The study was designed for students at Universiti Tunku Abdul Rahman (UTAR), Kampar Campus.

3.4 Study Duration

The research was conducted for three weeks during the month of July 2022, from July 4th to July 24th, while Malaysia was still fighting to contain the spread of COVID-19 and reduce the number of daily cases.

3.5 Sampling Method and Procedure

This study employed convenience sampling, with respondents selected according to the inclusion criteria. The size of the study population of 12000 was gathered from the UTAR Department of Student Affairs. After determining the size of the study population, a sample size was calculated. Then, a request was submitted to UTAR's Scientific and Ethical Review Committee in order to receive the required ethical permission for this research. In the meantime, the face validity of the survey questionnaire was assessed with the help of two lecturers from the Faculty of Engineering and Green Technology. The self-administered online survey questionnaire was sent to university students via multiple online platforms after getting ethical approval. The number of responses received met the minimum required for the sample size. The data was then cleansed prior to being submitted to SPSS for further analysis. Once the software's output was collected, it was analysed, interpreted, and discussed. Figure 3.1 below illustrates the research procedure.

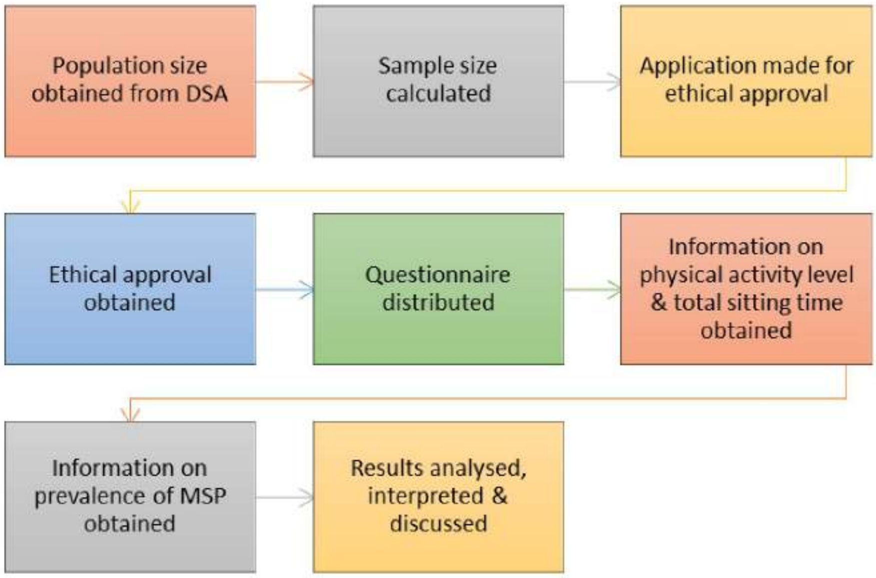

Figure 3.1: Flowchart of Research Process

3.6 Sample Selection

3.6.1 Inclusion Criteria

All candidates who met the criteria for inclusion were selected. Participation in the study required the following: (1) enrollment at University Tunku Abdul Rahman, Kampar Campus; (2) age between 18 and 29; (3) enrollment as a full-time student; (4) gender (male or female); (5) active participation in online teaching and learning during the period of lockdown and restrictions caused by the COVID-19 pandemic in Malaysia (that is, between March 20, 2020 and July 24, 2022); and (6) completion of all survey questions, (7) provided voluntary participation, and (8) provided informed consent to participate in the research study in accordance with the Personal Data Protection Statement - UTAR.

3.6.2 Exclusion Criteria

This study eliminated participants who were younger than 18 years old and older than 29 years old, who did not provide informed consent to participate in the study, and who provided inadequate or partial responses to the questionnaire's questions.

3.7 Study Variables

The dependent variables of this investigation were the prevalence of musculoskeletal pain, particularly neck pain, low back pain, and shoulder pain, that the student experienced during the COVID-19 pandemic.

The levels of physical activity students participated in each week, the total amount of time they spent sitting each day, and additional ergonomic risk factors that students were exposed to as a result of the COVID-19 pandemic served as the independent variables in this study.

3.8 Sample Size

The sample size for this study was determined using an online Raosoft sample size calculator (Raosoft, Inc., Seattle, WA, USA), in a manner similar to that of some earlier researchers, such as Althomali et al. (2021), who did the same for their research.

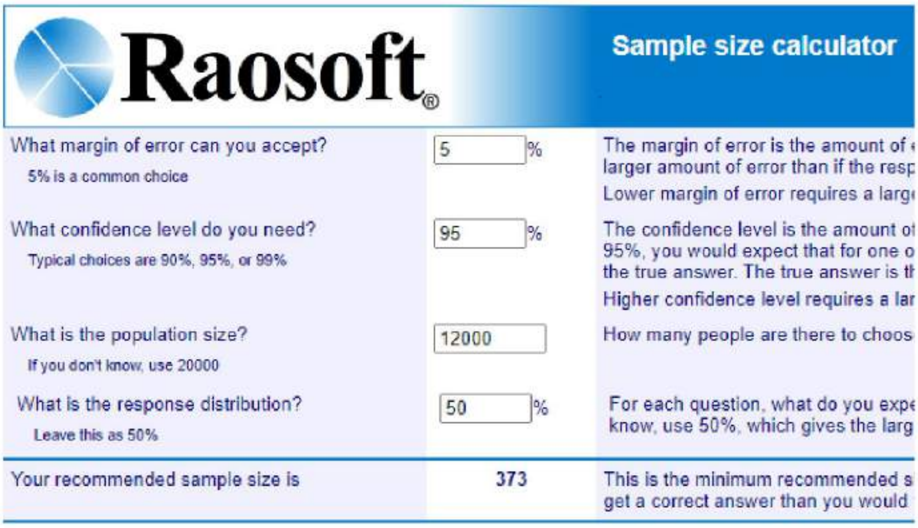

Figure 3.2: Screenshot of the Sample Size Calculated for this Study by the Raosoft Sample Size Calculator

The software (Figure 3.2) calculated the sample size based on the values entered into the required calculator columns using the formula given below,

$$x = Z\,(c/100)^2 r(100-r) \tag{3.1}$$

$$n = N\,x/((N-1)E^2 + x)$$

$$E = E = \mathrm{Sqrt}[(N - n)x/n(N-1)]$$

where,

N = population size,

n = sample size,

r = fraction of responses that the researcher is interested in,

c = confidence level,

E = the margin of error, and

Z(c/100) = critical value for the confidence level, c.

The sample size for this study was calculated with a margin of error (confidence interval) of 5%, a response distribution value of 50%, and a confidence interval of 95%. The population estimate of 12,000 from Kampar Campus was received from the UTAR Department of Student Affairs for the purpose of calculating the sample size. A required sample size of 373 was obtained using the online Raosoft sample size calculator after entering all of these parameters (Raosoft, Inc., Seattle, WA, USA).

According to Fan and Yan (2010), one of the main issues for survey researchers is the reduced response rate in web surveys. There is always a chance of sample errors or other concerns, such as incomplete questionnaires, which lowers the response rate to a survey. This may increase the margin of error in the study. In order to avoid this, it was advised that the sample size for this study be expanded by 20% (Nayak, 2010) so that any error or difficulty resulting from an insufficient response rate could be addressed in advance and the requisite sample size could be reached. The sample size for this investigation was determined to be 373. Additional tweaks and an expansion of 20% increased the total sample size to 448. Nonetheless, 80.3% of the 800 questionnaires distributed were responded, meaning that 642 completed survey questionnaires were received within the designated data collecting period, and 640 (80%) were deemed to be valid.

3.9 Data Collection

The data was collected electronically via a Google form after acquiring the participants' informed consent. A self-reported, anonymous questionnaire was given to each participant. Prior to participation in the study, all individuals were required to submit informed, voluntary consent using the same questionnaire. After agreeing to participate in the study, the students completed the questionnaire, which took around 5 minutes. The online survey questionnaire was delivered to students using UTAR's official online teaching and learning platform, Microsoft Teams, and UTAR webmail. Other social media sites, including Instagram, Facebook, Telegram, and WhatsApp, were also utilised to distribute the survey to students. Two reminders were sent at three-day intervals to boost the response rate.

The questionnaire was developed with the aid of earlier research and contained all pertinent questions. To assess the validity of the questionnaire, a pilot study was conducted. 10 random students from the Faculty of Engineering and Green Technology who were the representative sample of this study's target population, were asked to fill in the survey questionnaire. Then adequate improvements were made where necessary based on their feedback.

3.10 Questionnaire Design

The online questionnaire attempted to determine the symptoms and effects of MSP, as well as the relationship between MSP and online learning among Malaysian university students during the COVID-19 pandemic. A total of four sections made up the questionnaire.

The first (1) section consisted of demographic data such as gender, age range, and weight.

The second (2) segment consisted of physical activity and sitting time, which included questions regarding PA levels before and during the COVID-19 pandemic, as well as the number of hours spent seated per day owing to online distance learning before and during the COVID-19 pandemic. There were four possible responses for the physical activity question: no activity (0 minutes per week), light activity (150 minutes per week), moderate activity (150–299 minutes per week), and vigorous activity (> 300 minutes per week). Those who selected no activity or light activity were classed as not meeting the WHO physical activity recommendation (150 minutes/week), whereas those who selected moderate or vigorous activity were defined as fulfilling the WHO physical activity recommendation (150 minutes/week) (World Health Organization, 2010).

For total sitting time, the participants had four options: <4 hours/day (Low risk), 4 - <8 hours/day (Medium risk), 8 - <11 hours/day (High risk), and ≥11 hours/day (Very high risk). Those who selected <4 hours/day and 4 - <8 hours/day were considered to meet the sitting time guideline (<8 hours/day) and were at lower risk than those who selected 8 - <11 hours/day and ≥11 hours/day, who were assessed to not meet the sitting time guideline (≥8 hours/day) and were at greater risk (Roggio et al., 2021; van der Ploeg, 2012; Pavey, Peeters and Brown, 2012).

The third (3) section consisted of questions concerning musculoskeletal pain, including neck pain, low back pain, and shoulder pain. The questions aimed to determine whether the pupils had ever suffered musculoskeletal pain before the pandemic, or if the pain began during the pandemic. Students were required to choose between strongly disagree, disagree, neither agree nor disagree, agree, and strongly agree. Those who selected 'strongly disagree' and 'disagree' were deemed not to be experiencing MSP, while those who selected 'agree' and 'strongly agree' were deemed to be experiencing MSP. The responses of those who chose "neither agree nor disagree" were deemed inconclusive.

Under the third (3) segment, students were additionally questioned about the moment of day and posture in which they experienced pain.

The fourth (4) section explored ergonomic risk factors that may contribute to the occurrence of musculoskeletal pain among university students. The questions comprised common ergonomic risk factors associated with musculoskeletal pain produced by online learning, and the students were only required to select between yes or no to the aspects that associated with them.

3.11 Ethical Considerations

All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional research committee. Ethical approval was obtained from the Scientific and Ethical Review Committee of

Universiti Tunku Abdul Rahman (Re: U/SERC/126/2022). Informed consent was included in the online form before the main survey questions began. The answers to the survey questions were anonymous, and the collected data were kept confidential.

Participants were informed of the purpose and objectives of the study, as well as the confidentiality, anonymization, and protection of their personal information. Participants were informed that their participation in this survey was completely voluntary and that their responses would be kept anonymous and confidential. In addition, they were told that no information from their responses would be disclosed, and that the data would be utilised strictly for research reasons. Students were also informed that this study complied with all established ethics and rules for this type of research and had gotten ethical approval from IPSR, UTAR. Prior to participation, individuals were asked to provide informed consent by selecting yes or no to the following declaration: "I hereby consent to my voluntary participation in this survey, which will be conducted anonymously" (in accordance with the Personal Data Protection Statement - UTAR).

3.12 Data Analysis

3.12.1 Statistical Software: Statistical Package of the Social Sciences (SPSS)

The data acquired via online questionnaire were retrieved as a Microsoft Excel spreadsheet from the online Google form (version 16.33). In accordance with the recommendations of the American Association for Public Opinion Research (2016), a data cleansing procedure was used to remove invalid data. The data was then exported to the Statistical Package for the Social Sciences (SPSS) version 25 statistical software suite (SPSS, Inc., Chicago, IL, USA). The obtained raw data were statistically analysed using the statistical software suite SPSS in order to identify relationships between two variables, quantify such relationships, and generate predictions. For all of the statistical tests used in this investigation, a value of $p < 0.05$ was established as the criterion for statistical significance.

The SPSS software suite was developed to handle and analyse social science data statistically. Researchers of all stripes utilise it for sophisticated statistical data analysis. A number of statistical techniques can be used in SPSS, including descriptive statistics (frequencies, cross-tabulation, and descriptive ratio statistics), bivariate statistics (means, correlation, and nonparametric tests), numerical outcome prediction (linear regression), and prediction for group identification (cluster analysis and factor analysis). This robust analytical tool offers numerous methods, such as ad hoc analysis, hypothesis testing, and reporting, to make it simpler to organise data, choose and carry out analyses, and communicate your findings (IBM, 2021). Similar survey studies conducted by Roggio et al. (2021), Karingada and Sony (2021), Amjad et al. (2020), Wami et al. (2020), Chan et al. (2020), Haroon et al. (2018), and Algarni et al. (2017) have utilised this statistical software (2017). It simplifies and facilitates the statistical computations for this study. Analysis techniques were chosen based on how well each variable fit each other.

3.12.2 Descriptive Analysis

A descriptive analysis of all study variables was performed by computing the number of valid responses, frequencies, and percentages.

3.12.3 Spearman's Rank-Order Correlation Analysis

A Spearman's rank-order correlation was performed to assess the link between the independent factors (physical activity level and total sitting time of university students during the COVID-19 pandemic) and the dependent variables (neck pain, low back pain, and shoulder pain experienced by university students during the COVID-19 pandemic) of this study. The strength and direction of the monotonic association between two ranked variables in this study were determined using a correlation analysis.

Spearman rank correlation is utilised when the study variables are categorical, and the researcher wishes to examine the relationship between two categorical variables. Spearman rank correlation was also used for this study since this study also incorporates categorical variables and seeks to determine whether the two variables covary; that is, whether as one variable increases, the other tends to increase or decrease.

3.12.4 Linear Regression Analysis

A simple linear regression model was also used to examine the relationship between the independent variables (physical activity level and total sitting time of university students during the COVID-19 pandemic) and the dependent variables (neck pain, low back pain, and shoulder pain experienced by the university students during the COVID-19 pandemic). A simple linear regression analysis was utilised to estimate the parameters of a linear equation that could be used to predict the values of the dependent variables based on the independent variables of this study.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Demographic Data

4.1.1 Response Rate of Survey Questionnaire

For the purpose of this study, 800 randomly selected students at the University Tunku Abdul Rahman Kampar Campus were asked to complete an online questionnaire survey via online platforms. Response rates of approximately 60 percent should be the target for the majority of research, as this is the expectation of the Editor and Associate Editors of the Journal (Fincham, 2008). In this study, 642 (80.3%) of 800 completed survey questionnaires were received within the allotted time frame for data collection, and 640 (80%) of these were certified to be legitimate. The remaining questionnaires with incomplete responses were discarded. The following data analysis were based on the valid responses.

4.1.2 Gender of Respondents

Personal information about the respondents, including their gender, was gathered through this survey questionnaire. A total of 640 responses from UTAR students were gathered, as shown in Table 4.1, with 391 (61.1%) female respondents and 249 (38.9%) male respondents. The majority of the respondents to this study were female students, as illustrated in Figure 4.1.

Table 4.1: Gender of the Respondents

Gender	N	%
Female	391	61.1
Male	249	38.9
Total:	640	100

Note: N = number of respondents, % = percentage

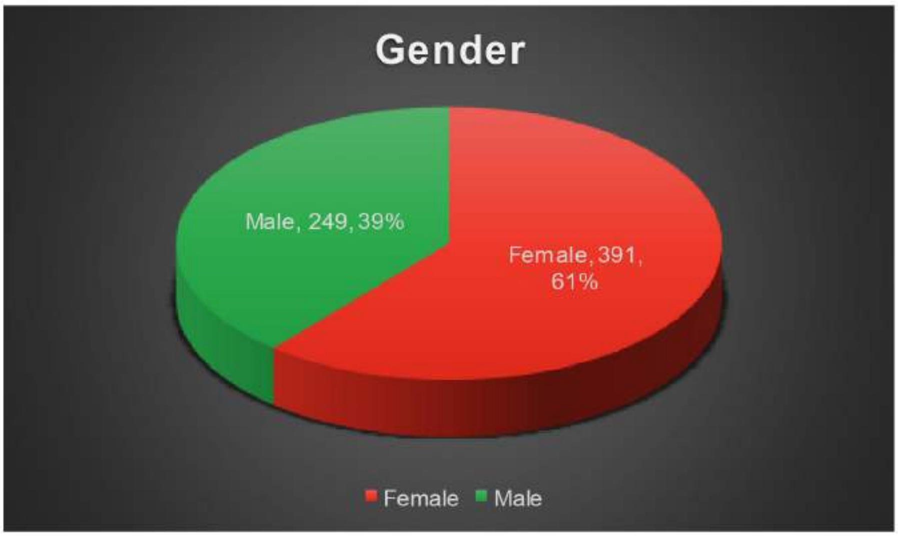

Figure 4.1: A Pie Chart Showing the Distribution of Respondents by Gender.

4.1.3 Age Range of Respondents

In addition to the gender of respondents, their age range was also recorded. According to Table 4.2 below, 420 (65.6%) of the respondents were between the ages of 18 and 20, followed by 187 (29.2%) respondents who were between the ages of 21 and 23. 30 (4.7%) respondents were between the ages of 24 and 26, while 3 (0.5%) respondents were between the ages of 27 and 29. Lastly, no answers were received from students aged 30 or older. Figure 4.2 below provides an illustration of this information.

Table 4.1: Age Range of the Respondents

Age Range	N	%
18-20	420	65.6
21-23	187	29.2
24-26	30	4.7
27-29	3	0.5
≥ 30	0	0
Total:	640	100

Note: N = number of respondents, % = percentage

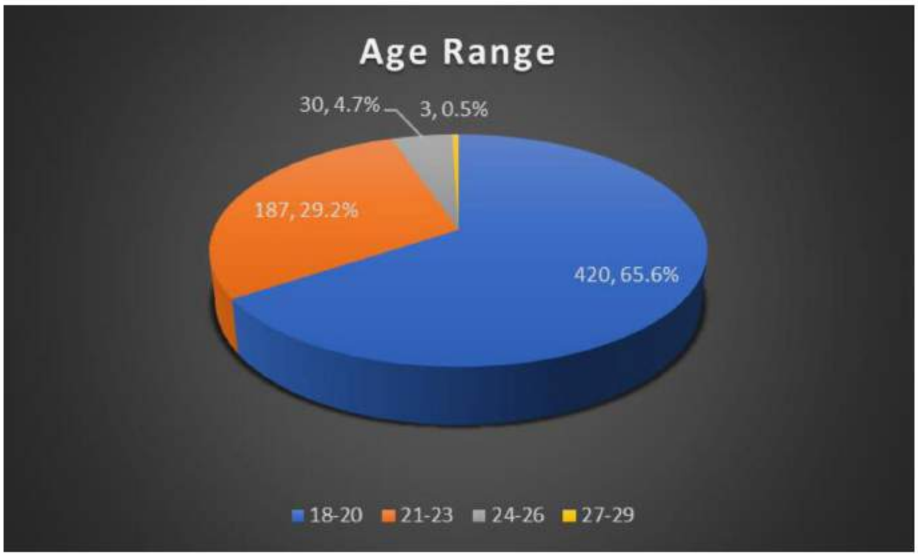

Figure 4.2: A Pie Chart Showing the Distribution of Respondents by Their Age Range

4.1.4 Weight Range of Respondents

In addition to the age range of the respondents, information regarding their weight was also collected. Table 4.3 shows that 12 (1.9%) respondents were between the weights of 30 and 39 kilograms, whereas 191 (29.8%) were between the weights of 40 and 49 kilogrammes. 209 (32.7%) respondents weighted between 50 and 59 kilogrammes, whereas 123 (19.2%) respondents weighed between 60 and 69 kg.

Among the respondents, 65 (10.2%) weighted between 70 and 79 kilogrammes, 19 (3%) weighed between 80 and 89 kilogrammes, and 11 (1.7%) weighed between 90 and 99 kilogrammes. Finally, 10 (1.6%) individuals had a body mass of 100 kg or over. Figure 4.3 below provides an illustration of this information.

Table 4.3: Weight of the Respondents (in kg)

Weight (in kg)	N	%
30-39	12	1.9
40-49	191	29.8
50-59	209	32.7
60-69	123	19.2
70-79	65	10.2
80-89	19	3
90-99	11	1.7
≥ 100	10	1.6
Total:	640	100

Note: N = number of respondents, % = percentage

Figure 4.3: A Pie Chart Showing the Distribution of Respondents by Their Weight

4.2 Physical Activity Levels of Respondents Before and During the COVID-19 Pandemic

According to the findings, 178 (27.8%) respondents said they did no physical activity at all before the pandemic, while 296 (46.3%) said they did some light activity. Then, 112 (17.5%) of the respondents claimed they engaged in moderate physical activity, while only 54 (8.4%) said they engaged in vigorous activity prior to the pandemic. During the pandemic, however, 177 (27.7%) respondents reported engaging in no physical activity all, while 324 (50.6%) reported engaging in light physical activity. Subsequently, 98 (15.3%) of the respondents reported engaging in moderate physical activities, while just 41 (6.4%) engaged in vigorous physical activities during the pandemic. The results of quantifying the physical activity intensity of university students prior to and during the COVID-19 pandemic are summarised in Table 4.4 and Figure 4.4.

Table 4.4: Physical Activity Levels of Respondents Before and During the COVID-19 Pandemic

		Before Pandemic		During Pandemic	
Intensity	**Duration (minutes per week)**	**N**	**%**	**N**	**%**
No activity	0	178	27.8	177	27.7
Light	1-149	296	46.3	324	50.6
Moderate	150-299	112	17.5	98	15.3
Vigorous	≥ 300	54	8.4	41	6.4

Note: N = number of respondents, % = percentage

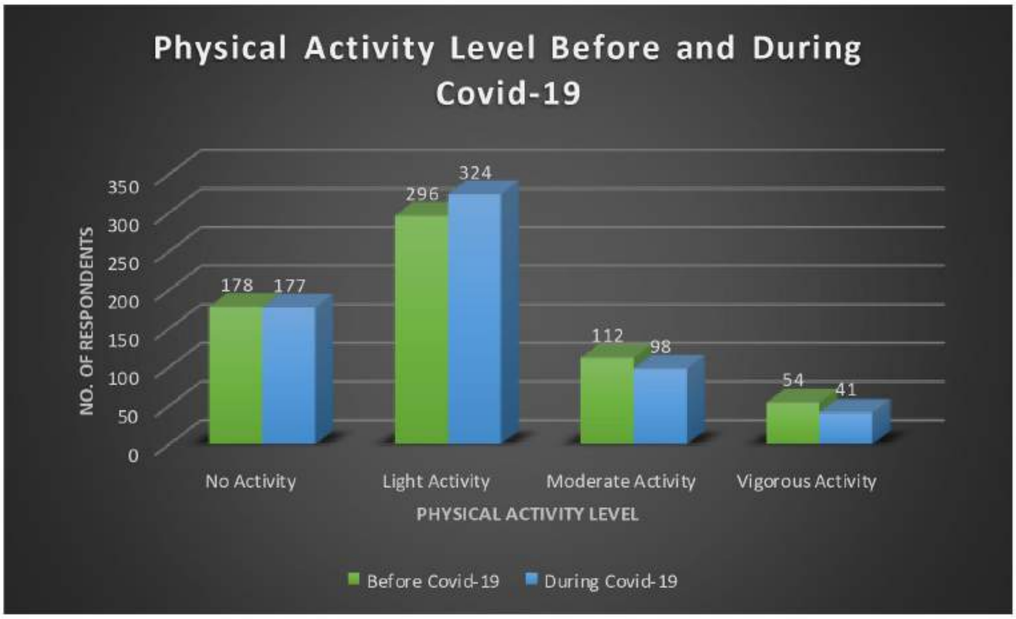

Figure 4.4: A Bar Graph Depicting the Physical Activity Level of the Respondents Before and During the Pandemic

Collecting data on the physical activity levels of participants prior to the COVID-19 pandemic (prior to March 2020) and during the COVID-19 pandemic (from March 2020 to July 2022) allowed this present study to determine if the pandemic had increased or decreased the physical activity levels of university students. In this study, it was discovered that university students engaged in slightly fewer physical activity during the pandemic than they did before. During the pandemic, the proportion of students who engaged in moderate and vigorous activities fell by 2.2% and 2%, respectively. Contrarily, the proportion of students who engaged in light exercise during the pandemic grew by 4.3%, while the proportion of those who did not exercise at all increased by 0.1%. The time spent in MVPA was divided into categories according to whether it complied with the PA guideline (≥150 minutes/week) or not (<150 minutes/week) (World Health Organization, 2010). Nonetheless, the pattern of results from this study reveals that throughout the pandemic, an increasing number of students began to shift from higher intensity levels of physical activity (moderate and vigorous) to lower intensity levels of physical activity (light and no activity). With only a 0.1% decrease in the number of students who did not engage in any physical activity, the increase in the number of students engaging in light activity during the pandemic suggests that approximately 4.3% of students who belonged to the moderate and vigorous activity categories prior to the pandemic collectively dropped into the light activity category during the pandemic. These findings are consistent with those of earlier research regarding the changes in physical activity among university students during the COVID-19 pandemic (Rizal and Wibowo, 2022; Ferrara et al., 2022; Sara Avinna et al., 2021; López-Valenciano et al., 2021).

This pattern of decreased physical activity among students during the pandemic was to be expected, given that everyone's movement was constrained due to the spread of the COVID-19 virus. Due to the rising number of COVID-19 instances, the Malaysian authorities implemented a movement control order throughout the entire country (Sara Avinna et al., 2021). This movement restriction prevented people from engaging in any outside physical activity, as the majority of people were required to stay indoors or adhere to isolation rules to prevent viral spread. Even after the constraints were loosened, there were still few possibilities for individuals to engage in any physical activity because most gyms and athletic venues were required to remain closed (Yiswaree Palansamy, 2021), and people were also forbidden from utilising public parks or practise fields (Nadiah Zamlus, 2021), where people often spend time exercising or playing sports. Due to the lack of suitable facilities, these pupils were unable to continue their regular training schedules in a variety of sports, which likely had an impact on their total PA.

Additionally, the introduction of online programmes could explain the decline in moderate-to-vigorous physical activity during the pandemic. In order to prevent the spread of the virus, the government ordered the temporary closure of all educational institutions, causing institutions to transition to online teaching and learning. Due to the virtual nature of university events and the closure of sports facilities during the early pandemic, physically active students would have had less possibilities to walk between locations to engage in sports. The frequency with which students engaged in physical activities such as walking, jogging, swimming, and sports decreased as a result. These have also been discussed in related study by Rizal and Wibowo (2022), Ferrara et al. (2022), and López-Valenciano et al. (2021).

During university closures, the focus of instruction was also on the disciplines that are typically taught in the classroom. There were no physical education classes available. Although the university emailed students with recommendations and suggestions for physical activities at home, the university had limited control over the student's participation in these activities (Greier et al., 2021).

In addition, increased social isolation (Arora and Grey, 2020), changes in psychosocial aspects due to prolonged confinement and residency, such as distance to the university (Van Dyck et al., 2015), and greater time demands, such as work and class time (Calestine et al., 2017), contributed to the decline in PA levels among students during the pandemic.

Collectively, these findings show the influence of enforced rules on social isolation and movement restrictions on adolescents' or students' PA, which might have an effect on their health and wellbeing. The adverse consequences of inadequate physical activity on a variety of health issues in teenagers and students have been extensively documented (Hansen et al., 2022; Renninger et al., 2019; Skrede et al., 2018). Even while a lockdown may have been necessary to minimise the transmission of a viral disease, such measures may have unintended repercussions as chronic diseases continue to pose a significant threat to future public health (Lozano et al., 2012; Murray et al., 2012).

4.3 Total Sitting Time of Respondents Before and During the COVID-19 Pandemic

Before the pandemic, 10% of respondents (64 out of 640) spent less than four hours a day seated (low risk), according to the collected data. Then, 307 (48%) respondents reported sitting for 4 to less than 8 hours per day (moderate risk), while 191 (29.8%) reported sitting for 8 to less than 11 hours per day (high risk). Lastly, 78 (12.2%) of respondents indicated that they sat for 11 hours or more per day (very high risk). Contrarily, 16 out of 640 (2.5%) respondents stated that they sat for fewer than 4 hours each day (low risk) throughout the pandemic. Following that, 96 (15%) of respondents reported sitting for 4 to 8 hours daily (medium risk). 300 respondents (46.9%) reported sitting for 8 to 11 hours per day (high risk), whereas 228 respondents (35.6%) reported sitting for 11 hours or more per day (very high risk). Table 4.5 and Figure 4.5 provides a summary of the overall sitting time of respondents prior to and throughout the pandemic.

Table 4.5: Total Sitting Time of Respondents Before and During the COVID-19 Pandemic

		Before Pandemic		During Pandemic	
Total Sitting Time (hours per day)	**Risk Level**	**N**	**%**	**N**	**%**
<4	**Low risk**	64	10	16	2.5
4 - <8	**Medium risk**	307	48	96	15
8 - <11	**High risk**	191	29.8	300	46.9
≥11	**Very high risk**	78	12.2	228	35.6

Note: N = number of respondents, % = percentage

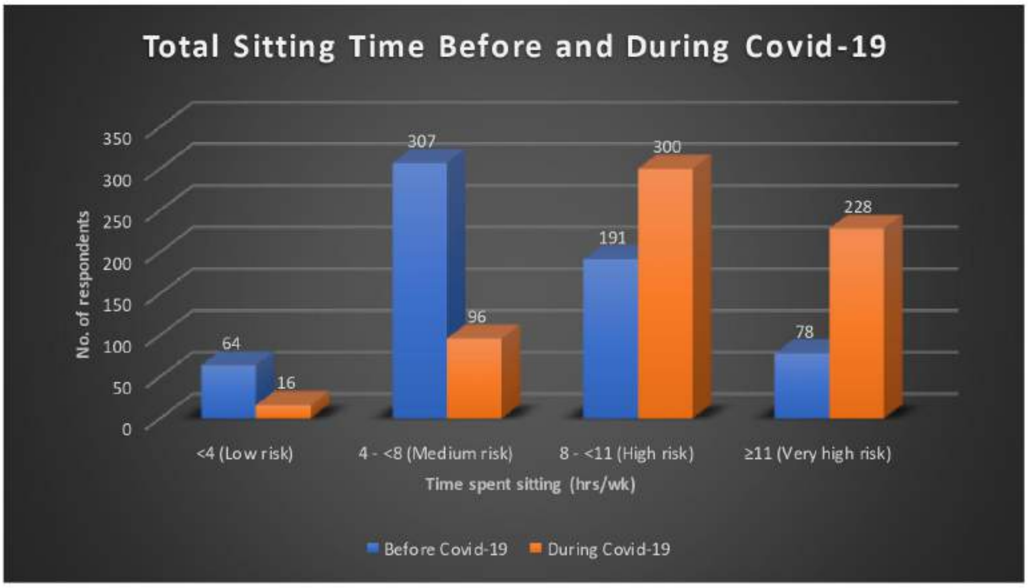

Figure 4.5: A Bar Chart Depicting the Total Sitting Time of Respondents Before And During the COVID-19 Pandemic

In addition to level of physical activity, information was collected on students' total sitting time before the COVID-19 pandemic (before March 2020) and during the COVID-19 pandemic (from March 2020 to July 2022) to evaluate if the pandemic increased or decreased total sitting time among university students and their associated risk level. According to the results of this study, university students spent significantly more time sitting during the pandemic than they did previously. There was an increase of 17.1% in the number of students who sat 8 to less than 11 hours per day, and a rise of 23.4% in the number of students who sat 11 hours or more per day. Conversely, there was a decrease of 7.5% in the number of students who sat for less than 4 hours per day and a decrease of 33% in the number of students who sat for 4 to less than 8 hours per day. Total sitting time time was calculated by categorising sitting time per day as either meeting the sitting time standard (<8 hours/day) or not meeting the sitting time guideline (≥8 hours/day) (Roggio et al., 2021; van der Ploeg, 2012; Pavey, Peeters and Brown, 2012). Nonetheless, the pattern of results from this study revealed that an increasing number of pupils sat for longer periods of time during the pandemic, so shifting from the low and medium risk category to the high and extremely high risk level. The number of pupils who sat for less than 4 hours per day and for 4 to less than 8 hours per day decreased by 7.5% and 33%, respectively. On the other hand, the number of students who sat for 8 hours to less than 11 hours per day and 11 hours or more per day increased by 17.1% and 23.4%, respectively. This type of significant change in university students' daily total sitting time is really concerning. This result of an increase in overall sitting time among students during the pandemic is consistent with findings reported by other researchers (DeYoung and Li, 2022; Hermassi et al., 2021; Romero-Blanco et al., 2020).

In addition to the drop in physical activity, participants in this study also reported an increase in sitting time throughout the pandemic. This pattern of increased overall sitting time among students throughout the pandemic was predictable and explicable. In addition to the lack of opportunities for PA, this change in behaviour can also be attributed to long hours of distance learning as a result of university closures, as well as an awkward sitting posture habit.

During the COVID-19 pandemic, the use of electronic devices such as desktop computers/laptop and tablets has expanded significantly among students due to the global shift to e-learning. Students and adolescents sat more during confinement, possibly due to the enforced e-learning environment, which promotes sedentary behaviour and lots of screen-based activities (King, Powell and Kraus, 2019). Students were needed to spend a significant amount of time at a computer to finish their work and/or assignments. During desktop/laptop or tablet use, the vast majority of students typically slouch forward in their chairs (Yaseen and Salah, 2021). Due to a lack of opportunities for social connections in a natural setting, the use of social media probably grew, which encouraged excessive screen time and sedentary behaviour. As demonstrated for PA, these results are consistent with those of research conducted in other nations (Rodrguez-Larrad et al., 2021; Chambonniere et al., 2021; Schmidt et al., 2020; Xiang, Zhang, and Kuwahara, 2020).

Given the independent relationship between prolonged sitting and numerous health outcomes, this may raise the likelihood of future health issues (Veerman et al., 2012). The onset of musculoskeletal pain (MSP) problems is adversely affected by prolonged periods of sedentary behaviours (Dzakpasu et al., 2021). Similar to Roggio et al. (2021) and other research, a 40.5% increase in total sitting time was seen in this study. Regular pauses of sedentary behaviours can reduce the negative consequences of prolonged sitting (Healy et al., 2011a, 2011b; Hamilton, Hamilton, and Zderic, 2004) and should be emphasised during times of movement constraints.

4.4 Prevalence of Musculoskeletal Pain

4.4.1 Prevalence of Neck Pain Among University Students Before and During the COVID-19 Pandemic

Participants were asked to report information on the onset of their neck pain, if any, before to the COVID-19 pandemic (before March 2020) and during the COVID-19 pandemic (from March 2020 to July 2022), to see if the pandemic had any effect on the prevalence of neck pain among university students. According to the collected data, 99 out of 640 (15.5%) respondents strongly disagreed with the statement that they experienced neck pain before the pandemic, while 187 (29.2%) respondents disagreed. 175 respondents (27.3%) claimed they were neither agreeing nor disagreeing that they had neck pain. Consequently, 154 (24.1%) of respondents agreed that they had neck pain, whereas just 25 (3.9%) respondents strongly agreed that they had neck pain prior to the pandemic. During the pandemic, however, 71 out of 640 respondents (11.1%) strongly disagreed with experiencing neck pain, and 91 out of 640 respondents (14.2%) disagreed with experiencing neck pain. 122 (19.1%) respondents were neither agreeing nor disagreeing that they experienced neck pain. Following this, 253 (39.5%) of respondents acknowledged to having neck pain, while 103 (16.1%) respondents strongly agreed to having neck pain during the pandemic. The findings on the prevalence of neck pain among university students both before and after the pandemic are compiled in Table 4.6 and Figure 4.6.

The majority of the 55.6% of people who reported having neck pain during the pandemic (Table 4.6; Agree & Strongly Agree) attributed it to long study sessions, which was to be expected given that they were required to attend classes for extended periods of time using electronic devices as a result of the restriction measures. Students may have been more exposed to physical stress and excessive usage of electronics during the lockdown since they spent more time seated in front of screens. Additionally, it has been noted that sitting for longer than three hours a day increases the likelihood of developing at least a moderate neck dysfunction (Daher and Halperin, 2021a; 2021b). The lockdown increased students' dependency on electronic devices for online connectivity, resulting in increased screen time and sitting time. Working in prolonged uncomfortable positions was found to be a risk factor for the development of NP in a recent systematic evaluation (Kim et al., 2018). According to Mowatt et al. (2017), neck pain is one of the most prevalent health issues among individuals who use electronic devices for multiple hours; particularly, 89.9% of undergraduate university students suffer from this condition (Reddy et al., 2013). Long periods of sitting owing to the usage of mobile phones, tablets, or computers to take online classes or engage in social media may significantly impact neck health (Al-Hadidi et al., 2019). In any case, this relationship has been supported by numerous epidemiological studies that found a strong correlation between the severity of neck pain and sedentary behaviour, such as prolonged sitting and screen time (Silva et al., 2016; Janwantanakul et al., 2009; Jacobs et al., 2009; Cagnie et al., 2006; Ortiz-Hernández et al., 2003). This study revealed that low levels of physical activity also contributes to the increased prevalence of neck pain among students during the pandemic. These results support the notion put forth by Scarabottolo et al. (2017) and Guddal et al. (2017) that those with low levels of PA are more likely to have neck pain.

Table 4.6: Prevalence of Neck Pain Among University Students Before and During the COVID-19 Pandemic

Neck Pain	Before Pandemic		During Pandemic	
	N	%	N	%
Strongly Disagree	99	15.5	71	11.1
Disagree	187	29.2	91	14.2
Neither Agree nor Disagree	175	27.3	122	19.1
Agree	154	24.1	253	39.5
Strongly Agree	25	3.9	103	16.1

Note: N = number of respondents, % = percentage

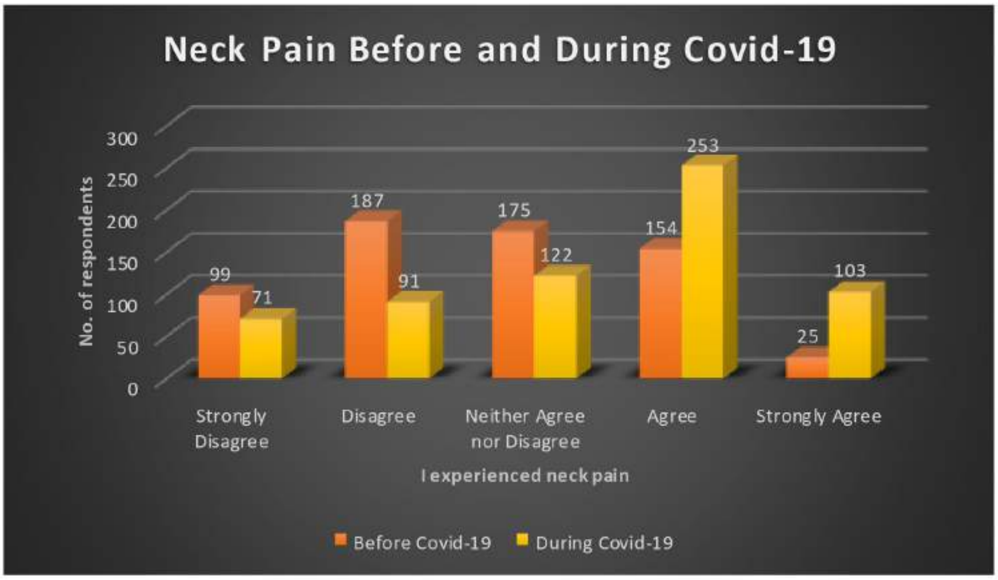

Figure 4.6: A Bar Chart Depicting the Prevalence of Neck Pain Among University Students Before and During the COVID-19 Pandemic

4.4.2 Prevalence of Low Back Pain Among University Students Before and During the COVID-19 Pandemic

Participants were asked to identify the onset of their low back pain, if any, before the COVID-19 pandemic (before March 2020) and during the COVID-19 pandemic (from March 2020 to July 2022) to evaluate whether the pandemic affected the prevalence of low back pain among university students. They were questioned if they had ever experienced low back pain before or if it had developed as a result of the pandemic. According to the data gathered, 102 out of 640 respondents (15.9%) strongly disagreed with having low back pain, and 195 (30.5%) simply disagreed with having any low back pain before the pandemic. 183 (28.6%) respondents did not agree or disagree with the statement that they had low back pain. Following this, 138 (21.6%) respondents agreed that they had low back pain, but just 22 (3.4%) respondents strongly agreed that they had low back pain prior to the pandemic. During the pandemic, however, 83 out of 640 (13%) respondents strongly disagreed with experiencing low back pain, while 120 (18.8%) simply disagreed. 135 (21.1%) individuals did not agree or disagree with the statement that they had low back pain.

Following this, 238 (37.2%) respondents acknowledged to having low back pain, whereas 64 (10%) respondents strongly agreed to having low back pain throughout the pandemic. The data on the prevalence of low back pain among university students both before and after the pandemic are summarised in Table 4.7 and Figure 4.7.

The 47.2% of students who suffered low back pain during the pandemic (Table 4.7; Agree & Strongly Agree) did so mostly as a result of long study sessions, as was to be expected given that they were required to attend classes using electronic devices as a result of the restriction measures. It was perhaps also due to an incorrect posture that was adopted during it. The introduction of distant learning and the implementation of socioeconomic measures, such as confinement (Ambrosio et al., 2020), have had a significant impact on the student population's social life and physical activity, with apparent effects related to decreased exercise and a predominately sedentary lifestyle (Zheng et al., 2020). Recent cross-sectional research on university students indicates that home confinement due to the COVID-19 pandemic has considerably increased sitting time and decreased physical activity, negatively influencing quality of life and life satisfaction (Hermassi et al., 2021). Students were required to attend classes for long periods of time using electronic devices as a result of restriction measures and universities' shift to online teaching and learning. According to Mowatt et al. (2017), low back pain is one of the most common health issues among people who use electronic devices for several hours, and 89.9% of undergraduate university students have a prevalence of these health issues (Reddy et al., 2013). Extended sitting time caused by the use of mobile phones, tablets, or computers to attend online classes or engage in social media may be detrimental to low back health (Al-Hadidi et al., 2019).

According to this study, students experienced a 22.2% rise in low back pain during the pandemic due to a decline in physical activity and an increase in sitting time. These findings are consistent with those of Wedderkopp et al. (2009) who found that students who were physically active were less likely to experience back pain. Similar findings were made by Guddal et al. (2017), who found a correlation between delayed LBP onset and moderate levels of PA. On the other hand, too high

PA levels may raise the risk of spinal pain since vigorous activities may promote poor posture and the development of pain (Aartun et al., 2016).

Table 4.7: Prevalence of Low Back Pain Among University Students Before and During the COVID-19 Pandemic

Low Back Pain	Before Pandemic		During Pandemic	
	N	%	N	%
Strongly Disagree	102	15.9	83	13
Disagree	195	30.5	120	18.8
Neither Agree nor Disagree	183	28.6	135	21.1
Agree	138	21.6	238	37.2
Strongly Agree	22	3.4	64	10

Note: N = number of respondents, % = percentage

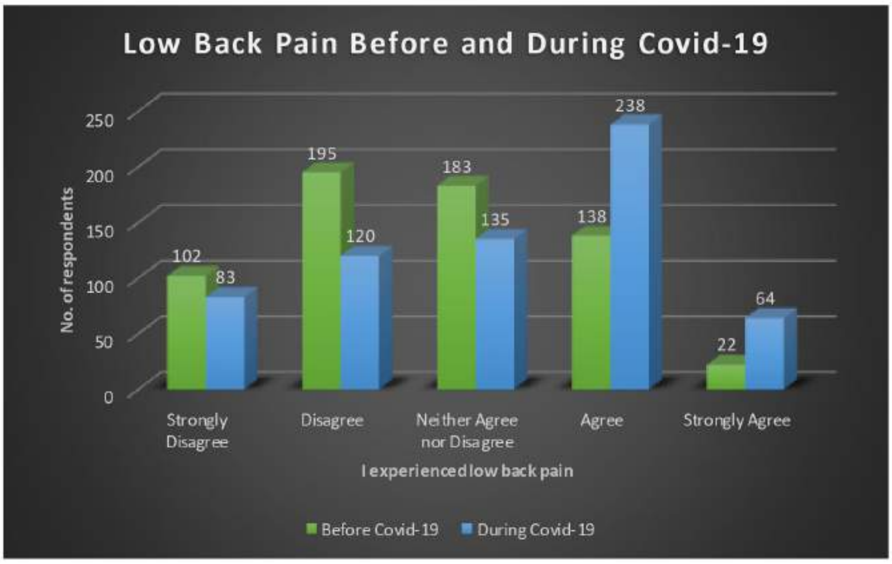

Figure 4.7: A Bar Chart Depicting the Prevalence of Low Back Pain Among University Students Before And During The COVID-19 Pandemic

4.4.3 Prevalence of Shoulder Pain Among University Students Before and During the COVID-19 Pandemic

Participants were requested to specify the onset of shoulder pain, if any. They were asked whether their shoulder problem began during the pandemic or if they had previously experienced shoulder pain. Table 4.8 and Figure 4.8 provides a summary of the data collected for this question. According to the collected data, 114 out of 640 respondents (17.8%) strongly disagreed with the statement that they had shoulder pain prior to the pandemic, whereas 159 respondents (24.8%) disagreed. 168 (26.3%) respondents did not agree or disagree that they experienced shoulder pain. Following then, 163 (25.5%) respondents agreed to having shoulder pain, whereas only 36 (5.6%) respondents strongly agreed to having shoulder pain before to the pandemic. During the pandemic, however, 98 of 640 respondents (15.3%) strongly disagreed and 106 (16.6%) disagreed with shoulder pain. 127 (19.8%) respondents said they neither agreed nor disagreed with the statement that they had shoulder pain. Following this, 218 (34,1%) of respondents admitted to shoulder pain, with 91 (14.2%) strongly admitting to shoulder pain during the pandemic.

Shoulder pain was experienced by 48.3% of students during the pandemic, primarily as a result of long hours of study, which may have been exacerbated by incorrect posture. Students had to spend a lot of time using electronic devices to attend classes because of restriction measures and universities' transition to online teaching and learning. According to Mowatt et al. (2017), computer vision syndrome, neck, shoulder, and back pain are the most common health issues among those who use electronic devices for numerous hours. In particular, 89.9% of undergraduate university students experience these issues often (Reddy et al., 2013). According to Caromano et al. (2015), prolonged sitting may be the cause of complaints of pain and/or pain in the shoulders. According to Yaseen and Salah (2021), using electronic devices for e-learning during the pandemic was linked to a number of student complaints, including shoulder pain.

In this study, a reduction in physical activity and an increase in sitting time resulted to a 17.2% rise in shoulder pain among students throughout the pandemic. This outcome is consistent with Yaseen and Salah (2021).

Table 4.8: Prevalence of Shoulder Pain Among University Students Before and During the COVID-19 Pandemic

Shoulder Pain	Before Pandemic		During Pandemic	
	N	%	N	%
Strongly Disagree	114	17.8	98	15.3
Disagree	159	24.8	106	16.6
Neither Agree nor Disagree	168	26.3	127	19.8
Agree	163	25.5	218	34.1
Strongly Agree	36	5.6	91	14.2

Note: N = number of respondents, % = percentage

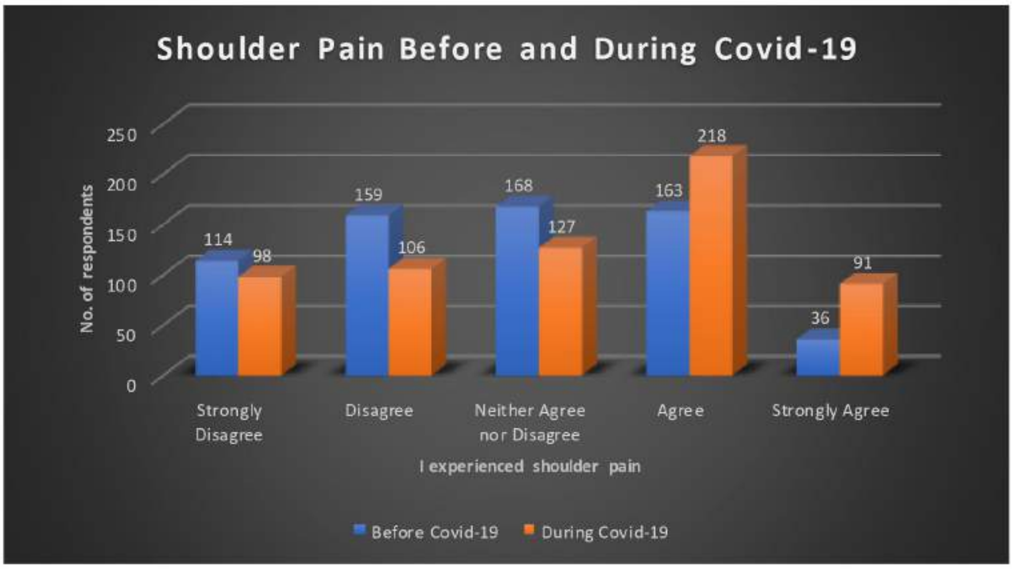

Figure 4.8: A Bar Chart Depicting the Prevalence of Shoulder Pain Among University Students Before and During the COVID-19 Pandemic

4.4.4 Daytime Window and Pain Posture Onset for Neck, Low Back, & Shoulder Pain

In addition to examining the onset of neck pain, low back pain, and shoulder pain, the participants were surveyed on a few additional aspects related to musculoskeletal pain, such as the particular time window of the day during which the participant experienced the most pain and the particular posture assumed by the participant that caused them the most pain, in order to better understand the prevalence of musculoskeletal pain among university students.

For neck pain, regarding the precise time window of the day, the majority of participants, 319 out of 640 (49.8%), reported suffering neck pain the most after many hours of study, while 56 (8.7%) reported experiencing it immediately after waking up in the morning. 35 (5.5%) participants reported neck pain in the late evening when sleeping, but 62 (9.7%) reported no difference in their neck pain throughout the day. 168 (26.3%) individuals claimed they had no pain (Table 4.9 & Figure 4.9).

In terms of the posture assumed by the participants that contributed most to their neck pain, 256 out of 640 respondents (40%) reported prolonged sitting as the primary cause of their neck pain. Household chores came in second with 53 (8.3%), followed by sports 11 (1.7%), standing 10 (1.6%), and walking 5 (0.8%). But 135 (21.1%) of the respondents said they did not have any particular situations that gave them neck pain, and 170 (26.6%) said they din't feel any pain. Table 4.9 and Figure 4.10 provides a summary of these information.

For low back pain, regarding the precise moment of day, the majority of respondents, or 234 out of 640 (36.6%) respondents, reported that lower back pain increased after several hours of studying, while 53 (8.3%) of respondents reported experiencing it in the late afternoon or evening when relaxing. Among the participants, 41 (6.4%) said they had low back pain as soon as they woke up in the morning, while 78 (12.2%) said they did not notice a difference between low back pain at night and during the day. 234 (36.6%) people claimed they had no pain (Table 4.9).

In terms of the posture that participants adopted that was most responsible for their low back pain, 181 out of 640 (28.3%) of respondents identified prolonged sitting as the primary cause of their low back pain. Following this were carrying out household tasks 60 (9.0%), standing 40 (6.3%), participating in sports 23 (3.6%), and walking 16 (2.5%). However, 96 respondents (15%) said there was no particular event that caused their low back pain to start, and 224 respondents (35%) said they had no pain. Table 4.9 and Figure 4.10 provides a summary of these findings.

For shoulder pain, regarding the precise time frame of the day, 37 out of 640 respondents, or 5.8%, reported shoulder pain upon awakening in the morning. However, 243 respondents (38%) felt shoulder pain following several hours of study. 34 (5.3%) of the participants said that their shoulder pain was at its worst in the evening while they were resting, while 82 (12.8%) reported no difference between daytime and nighttime shoulder pain.

In terms of the posture assumed by the participants that contributed most to their shoulder pain, 169 out of 640, or 26.4%, cited extended sitting as a cause of their shoulder pain. However, 15 (2.3%) of respondents indicated that standing was the most significant contributor to their shoulder pain. Walking was cited by 12 (1.9%), followed by participating in sports by 36 (5.6%) and housework by 46 (7.2%). Lastly, 122 respondents (37.5%) reported that there was no specific event that triggered their shoulder pain.

Table 4.9: Overall Characteristics of Neck Pain, Low Back Pain, and Shoulder Pain Experienced by the University Students During the COVID-19 Pandemic

	Neck Pain		Low Back Pain		Shoulder Pain	
	N	%	N	%	N	%
Daytime Window						
After waking up in the morning	56	8.7	41	6.4	37	5.8
After several hours of study	319	49.8	234	36.6	243	38
In the late evening, while resting	35	5.5	53	8.3	34	5.3
No specific moment	62	9.7	78	12.2	82	12.8
Do not have any	168	26.3	234	36.6	244	38.1
Pain Posture Onset						
Sitting	256	40	181	28.3	169	26.4
Standing	10	1.6	40	6.3	15	2.3
Walking	5	0.8	16	2.5	12	1.9

Practicing Sport	11	1.7	23	3.6	36	5.6
Housework	53	8.3	60	9.4	46	7.2
No particular circumstance	135	21.1	96	15	122	19.1
Do not have any	170	26.6	224	35	240	37.5

Note: N = number of respondents, % = percentage

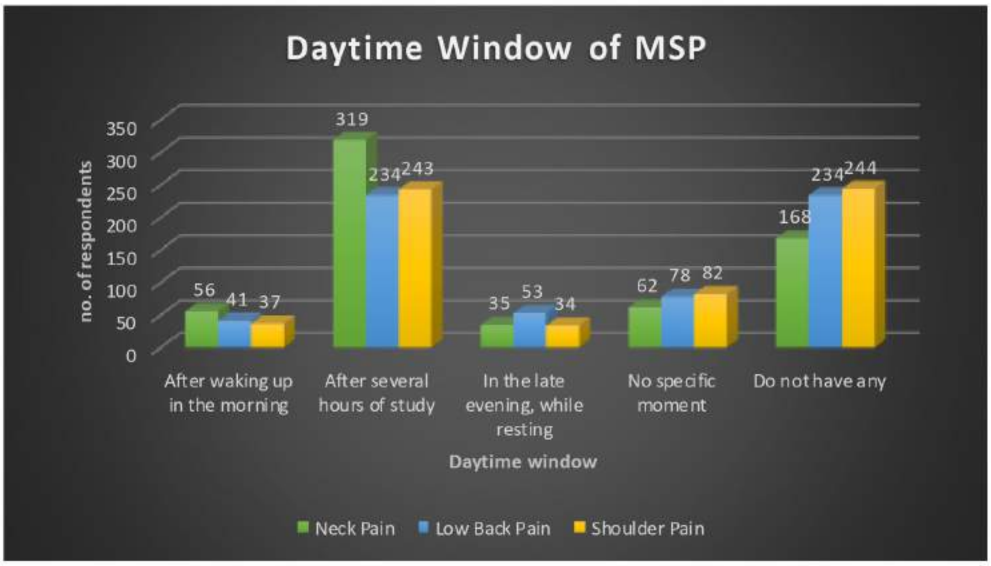

Figure 4.9: The Chart Depicts the Daytime Window During Which the Students Experienced the Most Pain.

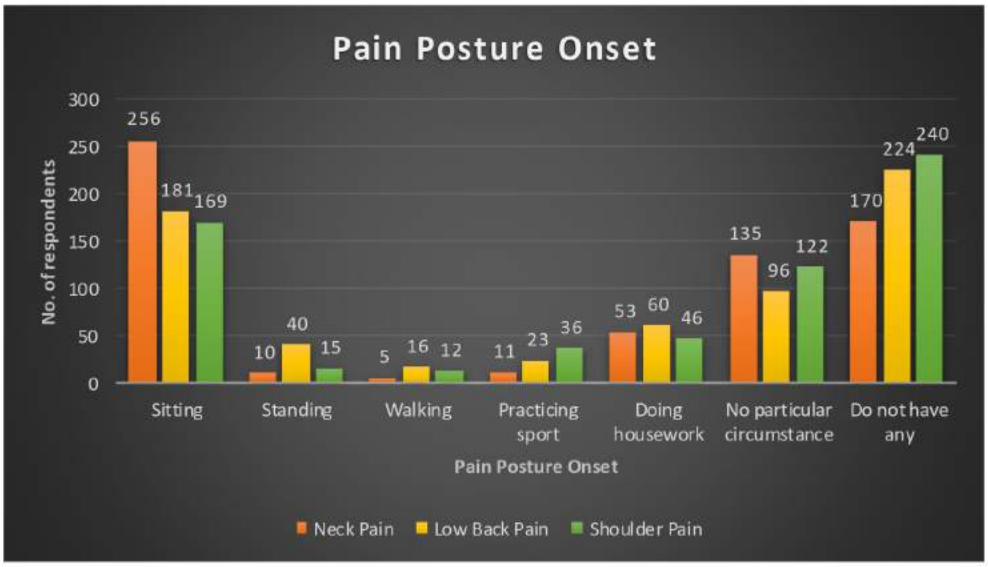

Figure 4.10: The Diagram Depicts the Posture that Causes the Most Pain in Students.

4.5 Ergonomic Risk Factors

In addition to other characteristics, the survey questionnaire was also used to collect information about ergonomic risk factors. According to the collected data, 150 out of 640 (23.4%) respondents understood the term "ergonomics," and 167 out of 640 (26.1%) sat in a chair with low back support. 164 persons (25.6%) sat in height-adjustable chairs, while 175 individuals (27.3%) sat in chairs with armrests. 62 respondents (9.7%) utilised a height-adjustable desk, while 346 respondents (54.1%) had ample leg room under their desk. 312 participants (48.1%) positioned the screen of their electronic devices horizontally with their eyes, whereas 297 respondents (46.4%) positioned the screen at least 30cm away from them. 163 participants (25.5%) placed their keyboard, mouse, and study surface at elbow height with their elbows flexed at a 90-degree angle. 31 respondents (4.8%) spent less than 2 hours each day on their electronic devices, whereas 103 (16.1%) took postural breaks every 30 minutes while using their electronic devices. Lastly, 132 respondents (20.6%) indicated that they did not adopt awkward postures or stances while using electronic gadgets. This summary is provided in Table 4.10 and Figure 4.11 below.

A collection of ergonomic risk factors that were highly prevalent among university students during the COVID-19 pandemic as a result of online learning that contributed to the development of musculoskeletal pain, namely neck, low back, and shoulder pain, were identified through a comprehensive literature review. The 12 ergonomic risk factors include knowledge of ergonomics, the presence of low back support in a chair, the ability to alter the height of a chair, the ability to adjust the height of a desk, the availability of leg room under a desk, the horizontal alignment of an electronic device when using it, the distance between a user and the screen of an electronic device, the location of a keyboard, mouse, and study surface, the length of screen time, regular postural breaks, and awkward postures. Respondents were required to select, among the 12 ergonomic risk factors listed in the questionnaire, all those with which they had a connection during the pandemic while participating in online education.

Institutions switched to online study due to these limitations and movement controls. Although the concept was first well-received, it became an issue for many students as they were required to attend online sessions for lengthy periods of time while seated in one location and staring at the screen of their electronic devices. This practise caused a variety of health issues among the students, with the most frequently mentioned one being the predominance of musculoskeletal pain, particularly neck, low back, and shoulder pain. Again, the MSP that the students experienced during the pandemic are directly related to the ergonomic measures that they upheld while taking online classes throughout the pandemic. The above-mentioned factors connected to computer use in particular and ergonomic risk factors more generally played a crucial role in the development of the MSP (Hanvold, Veiersted and Waersted, 2010; Johnston et al., 2008). A severe impairment of both physical and psychological health can result from persistent pain, which can have wide-ranging and deep impacts on wellbeing (Manchikanti et al., 2009). Therefore, knowledge of the ergonomic risk factors for persistent MSP is crucial.

In light of these difficulties, it is crucial that students recognise these ergonomic risk factors that contribute to their MSP and take the required initiatives to minimize, limit, or eliminate them. Therefore, by gathering this data via the questionnaire, it provides information on the proportion of students who have taken the necessary precautions to safeguard themselves from experiencing any kind of musculoskeletal pain during the pandemic, taking into account the long hours of online learning that they must engage in. In addition, this information provides insight into the collective perspective of the students regarding the importance of ergonomics or achieving ergonomics in their homes or hostels in order to avoid any musculoskeletal pain or pain that could result from the long hours of online classes that began as a result of the pandemic and government restrictions.

It may be extrapolated from the collected data that the majority of students are lacking in this aspect. In order to lessen the prevalence of pain among the students, ergonomic knowledge or awareness is crucial in this case. One must be knowledgeable of what "ergonomics" are in order to properly identify and eliminate the hazards caused by ergonomic issues. However, in this instance, only 23.4% of respondents claimed having understanding of ergonomics or being aware of its meaning. This is concerning because the remaining 76.6% of respondents are putting themselves at a higher risk of developing MSP as a result of ergonomic risk factors because they are not aware of or knowledgeable about ergonomics. This is corroborated by research by Alexander (1997), which found that students were more likely to have MSP if they were unaware of fundamental computer ergonomics.

Second, having a chair that can be adjusted in height to fit a person's preference or needs, as well as a chair with a low back support and arm rests, all contribute significantly to lowering the prevalence of neck, low back, and shoulder pain, respectively. In this survey, only around 25% of respondents reported having access to chairs with low back support, adjustable height, and armrests. This indicates that the remaining 75% of respondents took their online classes while seated in a chair without these features, or it can be inferred that these students did not consider these three features to be a crucial element in their perception of how important they were in reducing their pain. As previously stated, sitting on a chair with adjustable height, low back support, and armrests dramatically lowers the risk of developing MSP. This is confirmed by earlier studies that have linked low back or lumbar support (Dimate-Garcia and Rodríguez-Romero, 2021; Osama, Ali and Malik, 2018; Deivendran Kalirathinam et al., 2017; Fatin Nasuha Abdul Rahim and Shamsul Bahri Mohd Tamrin, 2016; Taspinar et al., 2013; Tullar et al., 2007), height-adjustability (Fatin Nasuha Abdul Rahim and Shamsul Bahri Mohd Tamrin, 2016), and armrests (Dimate-Garcia and Rodríguez-Romero, 2021; Deivendran Kalirathinam et al., 2017) as an important criteria to prevent the onset of MSP among students.

Third, having a suitable table with adjustable height is essential, just like with a chair. Desks that can be adjusted in height help students who are attending online classes perform better, pay attention longer, and are more motivated. As previously discussed, prolonged sitting can impair posture and increase the risk of musculoskeletal pain, including shoulder, neck, and low back pain. Students will be able to alter their working position, boost mobility, and improve circulation by adding height-adjustable desks to a study environment (The Executive Centre, 2018). However, it was discovered in this survey that just 9.7% of the students believe using a height-adjustable desk will help them lower their MSP. The inability of a table without a height-adjustability feature limits a student from being able to change the height of their desk if they discover that it is either too high or low for them to work or study comfortably. This is really detrimental because it's crucial to move around and change positions frequently during online sessions to keep a healthy spine. The use of height-adjustable desks can significantly reduce upper back, shoulder, and neck pain among students. Additionally, it may benefit their health. It can result in less stress and exhaustion than studying while sitting down all day, which indirectly influences the development of MSP. This has been supported by research by Sudholz et al. (2016) and Fatin Nasuha Abdul Rahim and Shamsul Bahri Mohd Tamrin (2016), and others who have emphasised the significance of student desks' ability to be adjusted for height as one of the key factors influencing the prevalence of MSP.

The fourth factor is the importance of a table with ample leg room. When working with applications that need lengthy sitting, comfort and flexibility are crucial factors. Legroom restrictions reduce a healthy person's mobility and create pain (Cascioli, Heusch and McCarthy, 2011). A person cannot have proper posture if they cannot place their feet flat on the floor or on a footrest. If proper posture is not achieved, MSP begins to manifest, causing excruciating pain and decreasing motivation to study or complete a task. Leg cramps, pain in the knee and hip that could eventually radiate to create pain in the neck, the low back, and the shoulders are all prevented when there is enough space for one's legs under the desk. In this survey, almost 54.1% of the participants claimed to have adequate leg room when studying. This is a decent starting point, despite the fact that this figure is still in the middle of the range. By continuously educating students on the benefit of having enough space under their desks while working, this value can be gradually increased.

Fifth, the placement of the screens on electronic devices when in use is crucial. It was discovered in this study that 48.8% and 46.4% of the respondents used their electronic devices while holding them horizontally to their eyes and at least 30 cm away from them, respectively. This suggests that around half of the respondents are aware of the significance of device location and its effect on their health. The other half, however, are still unaware of this or have decided not to prioritise these incredibly crucial parameters that will serve to protect them from MSP. It is crucial to check that the screen is horizontally aligned with the users' eyes and that it is at least 30 cm away from them. When the gadgets are not placed correctly, users are forced to hold their heads in an uncomfortable position while staring at the screen for an extended amount of time. For instance, studies have demonstrated that using a computer with a high screen height causes the neck to erect more (Villanueva et al., 1997); since this posture simultaneously increases the activity of the neck extensor and sternocleidomastoid muscles, prolonged computer use in this position may be harmful (Seghers, Jochem and Spaepen, 2003). The impact of a low computer screen cannot be determined. Studies have shown that using a computer at a low screen height puts more strain on the upper body's musculoskeletal system by increasing neck flexion, neck extensor activity, and compressive loading of neck ligaments, joint capsules, and other cervical spine structures (Szeto and Lee, 2002; Burgess-Limerick et al., 1999; Turville et al., 1998; Straker, Jones and Miller, 1997). However, Fostervold, Aars, and Lie (2006) demonstrated that working with low monitor screen height improved oculomotor condition with considerable decreases in upper body musculoskeletal complaints. All of these have been further supported by studies done by De Vitta et al. (2020) and Kanchanomai et al. (2011), which showed that the onset of neck, low back, and shoulder pain was linked to holding a tablet less than 20 cm away from the eye and using a computer screen that was not level with the eyes.

The location of the keyboard, mouse, and study surface is another consideration. This is to prevent excessive pressure on the hand, wrist, and shoulder when utilising the item. Long-term usage of these devices at an incorrect height can result in MSP. Only roughly 25.5% of the students in this survey make sure that the locations of their keyboard, mouse, and study surface are appropriate for their purposes. The remaining 74.5 percent of responders had little attention for this necessary ergonomic setting to prevent the beginning of MSP. People will twist their bodies to utilise a keyboard and mouse that are off to the side, placing strain on their chest and shoulders. They will become sore if they continue doing this all day. They can type with their shoulders in a natural position and prevent unneeded pain by placing the keyboard and mouse as centrally as possible to their body and in front of them. Furthermore, the shoulders can fall comfortably by their sides when the mouse and keyboard are at the same height as the elbows and forearms. It is crucial to avoid setting the keyboard and mouse at different heights because doing so would require the user to continuously lift their arm. These kind of small, repetitive motions increase the risk of musculoskeletal damage. The importance of placing the keyboard, mouse, and study surface at the proper position and height has been demonstrated by Dimate-Garcia and Rodríguez-Romero (2021), Fatin Nasuha Abdul Rahim and Shamsul Bahri Mohd Tamrin (2016), Kanchanomai et al. (2011), Lorusso, Bruno and L'Abbate (2009), and Tullar et al. (2007).

Spending more than two hours a day on electronic devices is another problem. Greater hours spent using electronic devices equates to more time spent in front of a screen. Screen time frequently prevents people from being active or enjoying the outdoors. Low amounts of physical activity can have an adverse effect on their health over time (Kaneshiro, 2019). Only 4.8% of the students in this study claimed to use their electronic devices for less than two hours, with the remaining 95.2% of respondents saying that they use them for more than two hours. Given the advent of online learning, this is to be expected, but the exceptionally high percentage is still very concerning for students' health. Musculoskeletal pain has been conclusively linked to the amount of time spent using digital screens, according to numerous studies (Hakala et al., 2012; Silva et al., 2016; Queiroz et al., 2018; Suris et al., 2014; De Vitta et al., 2011; Sekiguchi et al., 2017). However, the responder in this study does not appear to have prioritised lowering their technology usage. This demonstrates the lack of understanding that students have on this issue.

Next, the lack of frequent postural breaks contributes to the occurrence of MSP among students. Students should take frequent breaks, especially in the current setting when they are obliged to spend long hours in front of the computer. In this study, just 16.1% of the students reported taking postural rests, while 83.9% said they did not take them often or did not think they were significant. Long periods of time spent in the same position and exercising the same muscles are bad for the neck and back. Ergonomists concur that taking frequent, brief rest breaks is a good idea. The need for frequent rests is outlined in the Health and Safety (Display Screen Equipment) Regulations (1992). Muscles are engaged to support good posture while seated. These muscles might grow weary over time, which increases the risk of injuries. Long periods of standing or sitting can cause muscles to deteriorate (i.e. greater than an hour). Compression and improper postures can harm soft tissue, obstruct the blood supply, and impinge on the nerves. So, getting enough sleep is crucial to maintaining a healthy musculoskeletal system. By taking frequent breaks, one can reduce the likelihood of suffering an ergonomic injury (Health & Safety, University of Stanford, 2022). Several research, such those conducted by Choudhary et al. (2020) and Bennett, Woodcock and Tien (2006), have demonstrated the significance of periodic breaks from extended sitting for students during the pandemic.

Last but not least, utilising electronic gadgets in uncomfortable positions or postures is a major source of worry among students. When doing work-related activities, awkward posture is defined as a significant deviation from the neutral position of the body. Only 20.6% of the students who participated in this study said they avoided inappropriate postures when studying. However, the remaining 79.4% have admitted to hunching over when they are studying. With the introduction of online education, this behaviour tends to become more prevalent. The majority of students not taking the required precautions to avoid adopting unpleasant postures while studying is also extremely alarming. It is not good that 79.4% of students do not understand how important it is to sit up straight when studying in order to reduce the occurrence of MSP. When a person is hunched over, their muscles work less effectively and they have to use more force to finish the task. Awkward posture frequently strains the spine and results in pain and fatigued muscles (Environmental Health & Safety of Yale University, 2018). The risk of MSP is further increased by awkward posture, extended sitting, and computer use (NIOSH, 1997). This is supported by numerous prior research that highlight the negative consequences of poor posture while using electronic devices for studying as well as the significance of having good posture to reduce the prevalence of MSP among students (Deivendran Kalirathinam et al., 2017; Batham and Yasobant, 2016; Padmanathan et al., 2016; Fatin Nasuha Abdul Rahim and Shamsul Bahri Mohd Tamrin, 2016; Punnett, 2014).

Table 4.10: Distribution of Ergonomic Risk Factors

Ergonomic Risk Factors	Yes		No	
	N	%	N	%
I am familiar with the term "ergonomics".	150	23.4	490	76.6
I sit in a chair that provides lower back support.	167	26.1	473	73.9
I sit in a chair that has a height adjustment.	164	25.6	476	74.4
I sit in a chair with armrests.	175	27.3	465	72.7
I use a desk that is height adjustable.	62	9.7	578	90.3
I have enough leg room under my desk to rest my legs comfortably.	346	54.1	294	45.9
I position the screen of my electronic devices (computer, laptop, smartphone, TV, etc.) horizontally with my eyes	312	48.8	328	51.2
I position the screen of my electronic devices (computer, laptop, smartphone, TV, etc.) at least 30cm away from me.	297	46.4	343	53.6
My keyboard, mouse, and study surface are all at elbow height, with my elbows positioned at a 90° angle.	163	25.5	477	74.5
I spend less than 2 hours/day on my electronic devices (computer, laptop, smartphone, TV, etc.)	31	4.8	609	95.2
I take postural breaks every 30 minutes when using my electronic devices (computer, laptop, smartphone, TV, etc.)	103	16.1	537	83.9
I do not adopt awkward postures or positions when using my electronic devices (computer, laptop, smartphone, TV, etc.)	132	20.6	508	79.4

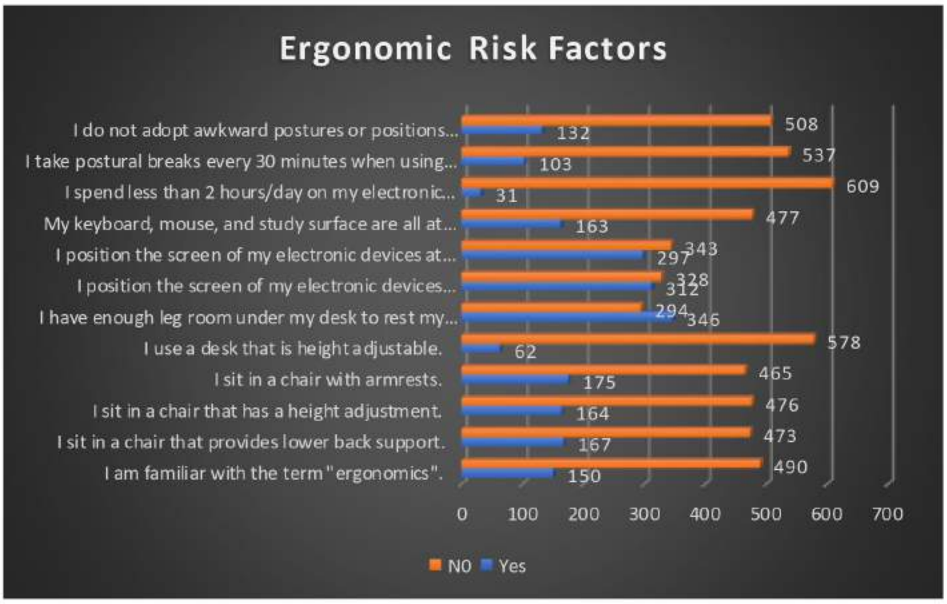

Figure 4.11: Distribution of Ergonomic Risk Factors

4.6 Physical Activity Level

4.6.1 Association Between Physical Activity Level and The Prevalence of Neck Pain Among University Students During the COVID-19 Pandemic

A Spearman's rank-order correlation was computed to investigate the relationship between the level of physical activity performed by the university students per week and the prevalence of neck pain among them during the pandemic. The relationship was found to be negatively correlated and weak in strength, however the results were not statistically significant ($r(638) = -.052$, $p = .191$). This result indicates that there is no significant relationship between the physical activity level of students and the prevalence of neck pain they experienced during the pandemic. This is because the significance value, which is 0.191, is higher than the acceptable limit of 0.05. The findings are detailed in Table 4.11 below, which will aid in understanding the relationship between university students' degree of physical activity and the prevalence of neck pain among them during the COVID-19 pandemic.

Several earlier research have demonstrated a correlation between the level of physical activity and the prevalence of neck pain among university students during the pandemic. Roggio et al. (2021) showed that there is a link between physical activity levels and neck pain among students, with the majority of participants with pain belonging to the no physical activity and light physical activity categories, indicating that those who practise physical activity for fewer than 150 minutes per week (no physical and light physical activity) are more likely to suffer pain, whereas those who practise physical activity for more than 150 minutes per week (moderate and high physical activity) are less likely to experience pain. Similarly, Shan et al. (2013) found that students who actively engaged in physical activities had a reduced prevalence of neck pain than those who did not engage in physical exercise.

In contrast, this study revealed no significant association between the level of physical activity and the onset of neck pain among university students during the pandemic, supporting the findings of earlier studies, such as Sitthipornvorakul et al. (2010), who concluded that there is good evidence that physical activity and neck pain are not associated. Similarly, additional studies found no link between neck pain and physical activity level as well (De Vitta et al., 2014; Wedderkopp et al., 2009; Boström et al., 2008; Auvinen et al., 2007; Diepenmaat, 2006; Mikkelsson, 2006; Østerås et al., 2006; van den Heuvel et al., 2005; and Kujala, Taimela and Viljanen, 1999).

There are two contradictory sets of prior research regarding the relationship between physical activity level and neck pain. Nonetheless, this substantial variation in results can be ascribed to a variety of factors.

The heterogeneity in the type or domain of physical activity conducted by the students may be one of the probable causes for the divergent findings among research. Standardization of the type or domain of physical activity performed by the students during the pandemic was not considered prior to or during data collection in this study, as it was not possible to meticulously control the type of exercises or activities performed by the students for this research due to restrictions imposed by the Malaysian government during the pandemic. Consequently, the respondents were required to answer the questionnaire solely based on the physical activities that they performed on their own during the pandemic, which may have differed from one another, meaning that each of them may have experienced different bodily effects after the physical activity. For instance, the majority of them may have mainly focused on habitual or leisure-time physical activity, which may not accurately reflect daily physical activity (Kędra et al., 2021). This suggests that a student might engage in regular physical activity for 150 minutes or more per week, as advised by WHO, but it would not be as beneficial in reducing neck pain as frequent activities of moderate or high intensity. Even though 21.7% of the students in this study reported engaging in moderate and vigorous activity, they may not have experienced a reduction in neck pain because they may have been performing habitual exercises, which have little or no effect on neck pain, rather than regular high intensity exercises. As a result, the results of this study's link between physical activity level and prevalence of neck pain were affected. This was confirmed by Kalatakis-dos-Santos et al. (2019), who reported that regular physical exercise is unrelated to pain intensity. According to Vitta et al. (2021) and Briggs et al. (2009), there is no correlation between daily habitual physical activities and neck pain. In addition, Peterson and Pihlström (2021) and Scarabottolo et al. (2017) have demonstrated that various physical activity domains are connected with neck pain differentially. Therefore, future research must clarify the classification of the type or domain of physical activities.

Another reason for inconsistency in study results could be the dimensions of physical activity. It is likely that different aspects of recreational and sport-related activities are associated with neck pain differently. Some sports may be advantageous or detrimental to the development of or protection against neck pain in adolescents and young adults (Briggs et al., 2009). For example, regular sports activity was associated with frequent neck pain (Kaartinen et al., 2019). According to Heneweer, Vanhees, and Picavet (2009), the significance of physical activity lay in its quality, not its quantity. Certain sports may be damaging to the neck if they place a great deal of strain on the neck's muscles and ligaments, as is the case with most sports (Agarwal, Thakkar and Than, 2021; DerSarkissian, 2021; Isaac and Dec, 2020). Future research should investigate the risk of neck pain related with extensive sports practise during adolescence. Similarly, vigorous physical activity also contributes. According to WHO (2010), the minimum amount of exercise needed to lead a healthier lifestyle is 150 minutes per week of moderate intensity or 75 minutes per week of vigorous intensity. However, going overboard with this amount of time can occasionally have more of a negative impact than a beneficial one. Although it has many positive health effects, exercise also raises the possibility of acquiring musculoskeletal pain (MSP) (Kamada et al., 2016). In their study, Guddal et al. (2017) discovered that a moderate level of physical activity was associated with decreased neck pain, whereas a high level of activity increased the likelihood of lower extremity pain. Strength and extreme sports were associated with all types of pain in young adults (Guddal et al., 2017). According to a study conducted by Kamada et al. (2016) among Japanese adolescents, high levels of physical activity exhibited a clear linear association with MSP prevalence and risk. The greater the participants' participation in sports, the greater their likelihood of experiencing and developing pain. Each additional hour per week of sports participation was related with a 3% greater likelihood of having or developing MSP. Additionally, Kelly, Dockrell, and Galvin (2009) reported that physical activity exacerbated neck pain. According to Table 4.4, 6.4% of all individuals in this study engaged in 300 minutes or more of physical activity each week during the pandemic. Based on the aforementioned data, even though the WHO recommends this period, it may have also resulted in a small number of students engaging in intensive activity suffering neck injuries and neck pain. This, along with the high prevalence of neck pain among physically inactive students, led to a rise in the total number of students with neck pain, which rendered the link between physical activity level and neck pain non - significant in this study.

Technique errors while completing exercises may also contribute. Technique is the manner in which an exercise is performed in order to target particular muscle groups. Incorrect technique can also be detrimental to the human body. If inappropriate form is utilised when executing a series of strength-training exercises, such as lifting weights, intense landscaping such as plowing and digging, stair climbing, walking up the hill, bicycling, dancing, push-ups, sit-ups, and squats, certain muscles may be overworked, which can result in an overuse injury (Mayo Clinic, 2019). The outcomes will not be as nice as they may be without the appropriate method. Improper form can have detrimental effects on the body and ultimately result in additional pain and injury. Ingraham (2003) further suggests that stretching, which enhances mobility and movement range beyond what is necessary for physical activity or sport-specific movements, may not be beneficial and may possibly induce injury because even slight stretching can cause cytoskeletal injury (Shrier, 2000; Shrier, 1999). Due to movement restrictions imposed by the government, the activities completed by the participants during the pandemic were not standardised prior to data collection in this study. Instead, participants were asked to respond to the survey questions based on their own exercises and physical activities throughout the pandemic. This indicates that everyone performed different types of workouts based on their individual tastes, which may have had varying effects on them. In addition, it is impossible to determine whether the participants utilised the proper exercise routines. Some individuals may have employed improper techniques when exercising, causing them to have increased pain in the neck region. Therefore, even though the students engaged in moderate or vigorous activity during the pandemic, they did not experience any pain relief or positive effects on their necks due to the improper or incorrect techniques they employed while exercising, which increased their neck pain rather than significantly reducing it. This now explains the increase in the number of students experiencing neck pain during the pandemic, as shown in Table, despite the fact that 21.7% of all respondents reported continuing to engage in moderate or vigorous exercise during the pandemic.

In addition, the method employed to measure physical activity could be a contributing factor. In this study, student responses were gathered through a self-administered online questionnaire. Students were asked to recollect the level of physical activity they had engaged in before to and during the pandemic and to select the number of hours per week they spent engaging in physical activities depending on the physical activity level category given in the questionnaire. This may not have been the most reliable method of gathering information about physical activity levels because there is a higher possibility of selection bias on the part of the students. In addition, when surveys are employed, recall bias may be introduced into the estimation. According to Peterson and Pihlström (2021) and Verbunt, Huijnen, and Köke (2009), objective measurements are better to self-report measurements when determining the level of physical activity in participants with musculoskeletal pain. Accelerometer or another objective equipment must have been used to measure physical activity level (Aartun et al., 2016). However, use of an objective equipment, such as an accelerometer, to measure the students' level of physical activity was not feasible in this study due to limitations set by the Malaysian government and the university as well, as a result of the rise of COVID-19 instances during this research study's time frame. This objective approach is advised because objective methods have been demonstrated to produce different results than subjective methods. Inconsistent measurements and classifications of physical activity in terms of frequency, intensity, and duration may have led to misclassification of physical activity levels (Kędra et al., 2021). Future studies must elucidate the measurement techniques and the intensity of the physical activities.

Another concern involves the definition of neck pain. In this study, a definition of neck pain was included in the questionnaire that was given to the participants; nevertheless, the participant may not have understood the definition because it was not sufficiently detailed. Inserting a diagram clearly illustrating the location of neck pain and the bones involved would have been helpful, which, in the case of young students who may not have a clear understanding or complete knowledge of the human anatomy, is essential for better understanding the question and providing a proper answer, as carried out by Bento et al. (2020), Dianat, Alipour and Asghari Jafarabadi (2017), Scarabottolo et al. (2017), Aartun et al. (2016), and Shan et al. (2013). Various prevalence estimates for neck pain may also originate from different definitions of the condition (Kędra et al., 2021). Future study should therefore include a precise definition of neck pain as well as a schematic demonstrating the exact location of the affected muscles and bones.

In addition, the inclusion and exclusion criteria for groups with and without neck pain were not considered. As it may play a significant role in producing neck pain, participants were not tested for any underlying cases of damage to neck muscle or around the neck muscle before to or during data collection. Excluding participants with neck muscular or surrounding neck muscle damage, which may induce neck pain, might have given a more accurate conclusion regarding the association between physical activity and neck pain (Kędra et al., 2021). Therefore, it is recommended that these subjects be excluded from future investigations.

The time frame within which the data was gathered may also be a problem. This study examined a fairly broad time span for the development of neck pain (Kędra et al., 2021), during which the students were asked to report their level of physical activity from two distinct time periods: before the COVID-19 pandemic (before to March 2020) and during the COVID-19 pandemic (March 2020 to present) (from March 2020 to July 2022). However, this study and the dissemination of the questionnaire to collect information from respondents were not undertaken until two years after the outbreak began. The students were asked to recollect their level of physical activity prior to and during the pandemic and to select their level of physical activity each week based on the physical activity level categories given in the questionnaire. Since the students were required to recall specifics of their physical activity from a considerable amount of time ago, the acquired data may not be as accurate as desired. This introduces the possibility of recall bias in the information provided by the student on the questionnaire, as students may overestimate or underestimate their level of physical activity (Kędra et al., 2021). In turn, this may have reduced the strength of the apparent link between physical activity level and the occurrence of neck pain.

The gender of the participants is an additional element that may have played a role. According to certain studies, feminine gender is connected with a higher prevalence and severity of pain (Bento et al., 2020; Hasan et al., 2018; Nicot, 2008; Ohayon, 2004; Bair et al., 2003). A survey conducted in 17 nations from the Americas, Europe, the Middle East, Africa, and Asia found that despite substantial variance in socioeconomic, demographic, and cultural variables across the participating countries and in the country-specific prevalence rates of chronic pain problems, certain findings were cross-nationally similar, including the discovery that females exhibited a greater overall prevalence of chronic pain than males, a finding that was true across all 17 countries (Demyttenaere et al., 2006; Demyttenaere et al., 2007; Ohayon and Schatzberg, 2003; Unruh, 1996). According to Auvinen et al. (2007), nearly half of the girls in their study reported mild neck pain, compared to one-third of the males, and 5% of the girls reported severe neck pain, compared to 2% of the boys. In girls, but not in boys, high levels of physical activity were related with an increased prevalence of severe neck or occipital pain and severe shoulder pain. In addition, Hendi et al. (2019) revealed that musculoskeletal pain was more prevalent in females, a finding supported by other studies (Morais et al., 2019; Rodríguez-Romero et al., 2016; Ng, Hayes and Polster, 2016). Female-specific hormonal and/or psychosocial factors may account for a greater sensitivity to pain and its reporting in females, resulting in a higher prevalence of neck pain (Breivik et al., 2006). According to Table 4.1, 61.1% of the respondents in this survey were female students, compared to 38.9% of the boys. This justifies the increase in the number of students experiencing neck pain during the pandemic, despite the low proportion of students engaging in moderate or vigorous activity. As demonstrated by prior research, the greater the proportion of female students, the greater the likelihood that students may experience musculoskeletal pain after moderate or vigorous activities. This, in addition to the contribution previously made by the physically inactive students' musculoskeletal pain cases, greatly increased the total number of students suffering from musculoskeletal pain during the pandemic, so rendering the link between physical activity level and musculoskeletal pain non - significant in this study.

In addition to correlation analysis, a simple linear regression was calculated to test if the level of physical activity performed by the university students per week significantly predicted the onset of neck pain among them during the pandemic. Preliminary analyses were performed to ensure there was no violation of the assumption of normality and linearity. The fitted regression model was: Neck pain = 3.513 – 0.080*(level of physical activity). However, the overall regression was found to be statistically non-significant ($R^2 = 0.003$, $F (1, 638) = 1.866$, $p = 0.172$). Therefore, this result can be interpreted as the level of physical activity performed by the students did not significantly predict the onset of neck pain among them during the pandemic ($\beta = -0.080$, $p = 0.172$). Table 4.12 summarises the results of this relationship for easier comprehension. The scatter plot in Figure 4.12 illustrates the association between these two variables.

In summary, it was determined that the correlation between the students' physical activity level and the neck pain they had during the pandemic was weak and negatively associated, but the results were not statistically significant. Likewise, the entire regression was determined to be statistically non-significant. This could be attributable to additional confounding variables, such as variation in the type or domain of physical activity, dimensions of physical activity, techniques error, method of measuring physical activity, definition of neck pain, participant exclusion criteria, time frame of study, and gender of participants, which require further exploration in this context. These confounding variables will likely explain the finding; therefore, additional research is required, and future research could incorporate variables that were not determined in this study.

Table 4.11: Results of Spearman's Rank-Order Correlation Analysis Between Independent Variables (Physical Activity Level & Total Siting Time) and Dependent Variables (Neck Pain, Low Back Pain, Shoulder Pain)

	Physical Activity Level	Total Sitting Time	Neck Pain	Low Back Pain	Shoulder Pain
Physical Activity Level	—	-.115**	**-.052**	**-.005**	**-.046**
Total Sitting Time	-.115**	—	**.169****	**.149****	**.186****
Neck Pain	**-.052**	**.169****	—	.417**	.481**
Low Back Pain	**-.005**	**.149****	.417**	—	.342**
Shoulder Pain	**-.046**	**.186****	.481**	.342**	—

Note: **. Correlation is significant at the 0.01 level (2-tailed).

Table 4.22: Simple Linear Regression Analysis Results of Prevalence of Neck Pain Related to The Level of Physical Activity

Predicted (Dependent Variable)	Predictor (Independent Variable)	Unstandardized Coefficients		Standardized Coefficients			
		B	Standard Error	Beta	t	Sig.	Regression Results
Neck Pain	Physical Activity Level	-.080	.058	-.054	-1.366	.172	R = .054 R^2 = .003 Adj. R^2 = .001 F = 1.866 Regression (df) = 1 Residual (df) = 638 $p > .05$

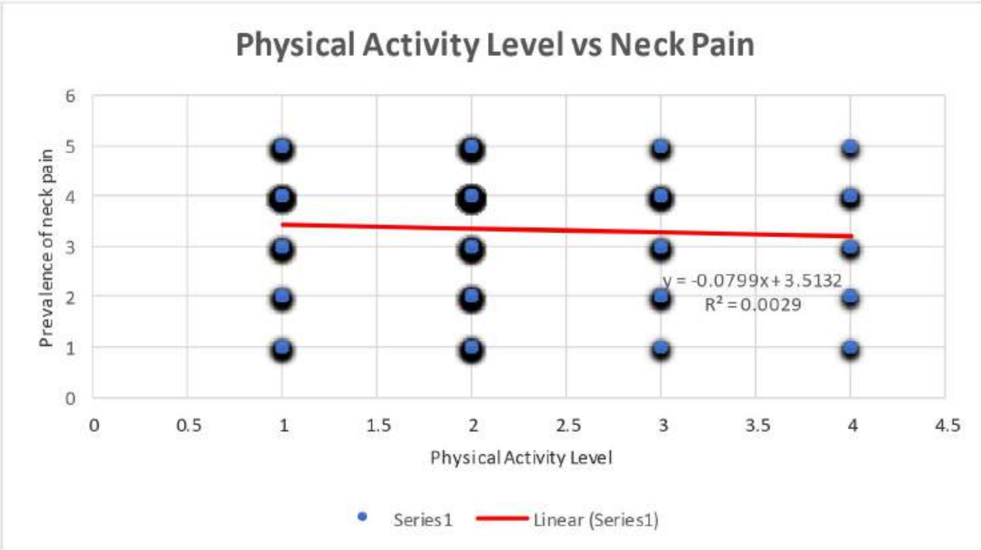

Figure 4.12: Scatter Plot Diagram Depicting the Non-Significant Relationship Between Physical Activity Level (PA) and Prevalence of Neck Pain (NP).

4.6.2 Association Between Physical Activity Level and The Prevalence of Low Back Pain Among University Students During the COVID-19 Pandemic

A Spearman's rank-order correlation was computed to investigate the relationship between the level of physical activity performed by the university students per week and the prevalence of low back pain among them during the pandemic. The relationship was found to be negatively correlated and weak in strength, however the results were not statistically significant (r(638) = -.005, p = .891). This result indicates that there is no significant relation between the students' level of physical activity and the prevalence of low back pain they experienced during the pandemic. This is because the significance value, which is 0.891, is greater than the accepted level of 0.05. The correlation between the level of physical activity performed by university students and the prevalence of low back pain among them during the COVID-19 pandemic is elucidated in Table 4.11 above.

Several previous studies have demonstrated a significant association between the level of physical activity and the prevalence of low back pain among university students during the pandemic. Roggio et al. (2021) determined that there is a correlation between physical activity levels and low back pain. The majority of subjects with low back pain belonged to the no physical activity and light physical activity categories, whereas those in the moderate and high physical activity groups only experienced very low or mild levels of low back pain, indicating that those with less than 150 minutes of physical activity per week are more likely to experience low back pain. In a meta-analysis of cohort studies, Alzahrani et al. (2019) found that moderate physical activity was significantly associated with a reduced risk of developing LBP.

In contrast, this study found no significant association between the level of physical activity and the onset of low back pain among university students during the pandemic, confirming the findings of other studies, such as Sitthipornvorakul et al. (2010), who concluded that there is strong evidence that physical activity and low back pain are not associated. In a meta-analysis of cohort studies, Alzahrani et al. (2019) found that high-level physical activity was not associated with LBP, and in a meta-analysis of cross-sectional studies, neither medium-level nor high-level physical activity was associated with LBP. Similarly, other studies have discovered no link between physical activity and low back pain (Bento et al., 2020; Dianat, Alipour and Asghari Jafarabadi, 2017; Aartun et al., 2016).

Two sets of previous research have produced contradictory findings regarding the relationship between physical activity and low back pain. The stark contrast between the results can be explained, though.

The heterogeneity in the type or domain of physical activity performed by the students may be one of the possible explanations for inconsistent findings across studies. Standardization of the type or domain of physical activity performed by the students during the pandemic was not considered prior to or during data collection in this study, as it was not possible to meticulously control the type of exercises or activities performed by the students for this research due to restrictions imposed by the Malaysian government during the pandemic. Consequently, the respondents were required to answer the questionnaire solely based on the physical activities that they performed on their own during the pandemic, which may have differed from one another, meaning that each of them may have experienced different bodily effects after the physical activity. The majority of them might have concentrated on only leisure time or habitual physical activity, which might not accurately reflect daily physical activity (Kędra et al., 2021). This suggests that a student could engage in regular physical activity for 150 minutes or more per week, as recommended by the WHO, but it would not be as effective in reducing LBP as regular moderate or vigorous exercise. In this study, despite the fact that 21.7% of the students reported engaging in moderate and vigorous activity, they may not have experienced a reduction in LBP because they may have been performing habitual exercises, which have little or no effect on LBP. As a result, the results of this study concerning the relationship between physical activity level and the prevalence of LBP were affected. This was confirmed by Kalatakis-dos-Santos et al. (2019), who reported that habitual physical activity is unrelated to pain intensity. Bento et al. (2020) and Aartun et al. (2016) found no association between daily habitual physical activity and low back pain. In addition, Scarabottolo et al. (2017) reported that various physical activity domains are associated with LBP in varying ways. Future research must further clarify the classification of the type or domain of physical activities.

The dimensions of physical activities may also play a role in the discrepancies between studies' findings. Different dimensions of recreational and sport-related activities may have different relationships with LBP. It appears that certain sports can be advantageous or detrimental to the development or prevention of LBP in youths and adolescents (Kędra et al., 2021). According to Heneweer, Vanhees, and Picavet (2009), the significance of physical activity lay in its quality, not its quantity. Sports are characterised by a variety of back-loading forces; consequently, certain sports may be detrimental to the spine. Future research should examine the risk of LBP associated with intensive sports practise during adolescence. Similarly, vigorous physical activity also contributes. As stated previously, WHO (2010) recommends at least 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity exercise per week for a healthier lifestyle; however, going overboard on this duration can sometimes have more of a negative effect than a positive one. Physical activity has multiple health benefits, but it may also increase the risk of musculoskeletal pain (MSP) (Kamada et al., 2016). In their study, Guddal et al. (2017) found that moderate physical activity was associated with less low back pain, whereas high physical activity increased the likelihood of lower extremity pain.

Participation in technical sports was linked to an increased likelihood of low back pain, whereas participation in team sports was linked to an increased likelihood of lower extremity pain. Strength and extreme sports were associated with all types of pain in young adults (Guddal et al., 2017). According to a study conducted by Kamada et al. (2016) among Japanese adolescents, high levels of physical activity had a clear linear association with MSP prevalence and risk. The greater the participants' participation in sports, the greater their likelihood of experiencing and developing pain. Each additional hour per week of sports activity was associated with a 3% increase in the likelihood of having or developing MSP, with the low back region being the most commonly affected. During the pandemic, 6.4% of the total participants in this study engaged in 300 minutes or more of vigorous activity per week, as shown in Table 4.4. Despite the fact that this duration is recommended by the WHO, based on the aforementioned findings, it may have caused a portion of students engaging in vigorous activity to sustain injuries in or near the low back region, resulting in severe low back pain. This, along with the large number of students with low back pain who were physically inactive, increased the total number of students with low back pain, thereby rendering the relationship between physical activity level and low back pain non - significant in this study.

Technique errors while performing exercises may also contribute. Technique is the manner in which an exercise is performed in order to target particular muscle groups. Incorrect technique can also be detrimental to the human body. If inappropriate form is utilised when executing a series of strength-training exercises, such as lifting weights, intense landscaping such as plowing and digging, stair climbing, walking up the hill, bicycling, dancing, push-ups, sit-ups, and squats, certain muscles may be overworked, which can result in an overuse injury (Mayo Clinic, 2019). The outcomes will not be as good as they could be without a proper technique. Improper form can have detrimental effects on the body and ultimately result in more pain and injury. Ingraham (2003) further suggests that stretching, which enhances mobility and movement range beyond what is necessary for physical activity or sport-specific movements, may not be beneficial and may possibly induce injury because even slight stretching can cause cytoskeletal injury (Shrier, 2000; Shrier, 1999). According to a study by Vahdat et al. (2017), adolescents and young adults frequently sustain lower back injuries during weightlifting due to improper execution of exercises and the use of excessive weights, resulting in low back pain. Similarly, Fares et al. (2020) reported that weightlifting employs heavy weights to engage the body's muscles and, as a result, increases the risk of LBP in adolescents and young adults. The use of excessive weights and improper techniques places the back in a precarious position that may result in injury. Faigenbaum and Myer (2009) also report that improper exercise technique and inappropriate training loads may partially account for some of the reported injuries sustained by young athletes during resistance training. Due to government restrictions on movement, the exercises performed by the participants in this study during the pandemic were not standardised prior to data collection. Instead, participants were asked to respond to the survey questionnaire based on the exercises and physical activities they had engaged in during the pandemic. This indicates that everyone performed different types of exercises based on their individual preferences, which may have had varying effects on them. In addition, it is impossible to determine whether the participants utilised the proper exercise techniques. Some individuals may have employed improper exercise techniques, causing them to experience increased pain in the lower back region. Subsequently, even though the students engaged in moderate or vigorous activity during the pandemic, they did not experience any pain relief or positive impact on their low backs due to the improper or incorrect techniques they employed while exercising, which increased their low back pain rather than significantly reducing it. This explains the increase in the number of students experiencing low back pain during the pandemic, as shown in Table, despite the fact that 21.7% of all respondents reported continuing to engage in moderate or vigorous exercise throughout the pandemic.

In addition, the method employed to measure physical activity could be a contributing factor. Results from students were gathered for this study using a self-administered online questionnaire. Students were asked to recollect the level of physical activity they had engaged in before to and during the pandemic and to select the amount of hours per week they spent engaging in physical activities depending on the physical activity level category provided in the questionnaire. As there is a greater possibility of selection bias on the part of the students, this may not have been the most accurate method for obtaining data on physical activity level. Using surveys may also result in recall bias in the estimating process. An objective measurement is better to a self-report measurement when determining the level of physical activity in participants with musculoskeletal pain (Peterson and Pihlström, 2021; Verbunt, Huijnen and Köke, 2009). Accelerometer or another objective equipment must have been used to measure physical activity level (Aartun et al., 2016). However, use of an objective equipment, such as an accelerometer, to measure the students' level of physical activity was not feasible in this study due to limitations set by the Malaysian government and the university as well, as a result of the rise of COVID-19 instances during the research study's time frame. This strategy is proposed due to the fact that objective methods have been discovered to produce different results than subjective methods. Physical activity levels may have been misclassified due to inconsistent assessments and categorization of physical exercise including duration, frequency, and intensity (Kędra et al., 2021). Future studies must clarify the method used to measure the level of physical activity intensity.

Another point of contention is the definition of low back pain. In this study, the questionnaire supplied to participants did contain an explanation of what low back pain is; nonetheless, the participant may not have found the explanation to be sufficiently detailed. Inserting a diagram clearly illustrating the location of LBP and the bones involved would have been helpful, which, in the case of young students who may not have a clear understanding or complete knowledge of the human anatomy, is essential in order to better comprehend the question and provide an appropriate response, just as carried out by Bento et al. (2020), Dianat, Alipour and Asghari Jafarabadi (2017), Scarabottolo et al. (2017), Aartun et al. (2016), and Shan et al. (2013). Various prevalence estimates for LBP may also emerge from different definitions of the condition (Kędra et al., 2021). Future study should therefore include a precise definition of LBP as well as a schematic demonstrating the precise position of the implicated muscles and bones.

In addition, the study did not address the criteria of inclusion and exclusion for a group with LBP and a group without LBP. As spinal disease or injury may play a substantial role in the development of low back pain, individuals were not screened for it prior to or during data collection. Excluding participants with spinal diseases or injuries, which may cause LBP, might have yielded more accurate findings regarding the connection between physical activity and low back pain (Kędra et al., 2021). Therefore, it is suggested that future research explicitly exclude these individuals.

The time frame during which the data was gathered may also be a concern. This study included a relatively broad span of LBP occurrence (Kędra et al., 2021), and the students were asked to report their level of physical activity from two distinct time periods: before the pandemic (before March 2020) and during the pandemic (March 2020 to present). However, this research and the dissemination of the questionnaire to collect information from respondents did not begin until two years after the outbreak began. The students were asked to recollect their level of physical activity prior to and during the pandemic and to select their level of physical activity each week based on the physical activity level categories given in the questionnaire. Since the students were required to recall specifics of their physical activity from a considerable amount of time ago, the acquired data may not be as accurate as desired. This introduces the possibility of recall bias in the data provided by the student on the questionnaire, as the student may overestimate or underestimate the level of physical activity (Kędra et al., 2021). In turn, this may have reduced the strength of the apparent link between physical activity level and the prevalence of LBP.

The gender of the participants is an additional element that may have played a role. According to certain studies, feminine gender is connected with a higher prevalence and severity of pain (Bento et al., 2020; Hasan et al., 2018; Nicot, 2008; Ohayon, 2004; Bair et al., 2003). A survey conducted in 17 countries from the continents of America, Europe, the Middle East, Africa, and Asia uncovered that despite substantial variation in socio - economic status, demography, and cultural aspects across the involved nations and in the country-specific prevalence rates of persistent diseases or disorders, certain findings were cross-nationally consistent, including the discovery that females demonstrated a higher overall prevalence of chronic pain than males, a finding that was consistent across all 17 countries (Demyttenaere et al., 2006; Demyttenaere et al., 2007; Ohayon and Schatzberg, 2003; Unruh, 1996). In addition, Hendi et al. (2019) revealed that musculoskeletal pain was more prevalent in females, a finding supported by other studies (Morais et al., 2019; Rodríguez-Romero et al., 2016; Ng, Hayes and Polster, 2016). Kikuchi et al. (2019) discovered that LBP was considerably greater in girls than in boys, despite the fact that boys participated in more extracurricular sports activities. Another study found that participation in sports was substantially associated with LBP exclusively in females, despite the fact that males engaged in more intense activities. They also found that prevalences of LBP in females aged 10 and 11 were significantly greater than in boys (Korovessis, Koureas and Papazisis, 2004). Female-specific hormonal and/or psychosocial factors may account for a greater sensitivity to pain and its reporting in females, resulting in a higher prevalence of low back pain (Breivik et al., 2006).

A simple linear regression was calculated to test if the level of physical activity performed by the university students per week significantly predicted the onset of low back pain among them during the pandemic. Preliminary analyses were performed to ensure there was no violation of the assumption of normality and linearity. The fitted regression model was: Low back pain = 3.154 – 0.015*(level of physical activity). However, the overall regression was found to be statistically non-significant ($R^2 = 0.000$, $F(1, 638) = 0.063$, $p = 0.802$). Therefore, this result can be interpreted as the level of physical activity did not significantly predict the onset of low back pain among students during the pandemic ($\beta = -0.015$, $p = 0.802$). Table 4.13 summarises the results of this relationship for easier comprehension. The scatter plot in Figure 4.13 illustrates the association between these two variables.

In summary, it was determined that the correlation between the students' physical activity level and the low back pain they experienced during the pandemic was weak and negatively associated, however the results were not statistically significant. Likewise, the overall regression was determined to be statistically non-significant. This may be attributable to additional confounding variables, such as variation in the type or domain of physical activity, dimensions of physical activity, techniques error, method of measuring physical activity, definition of low back pain, participant exclusion criteria, time frame of study, and gender of participants, which must be investigated further in this context. These confounding variables will likely explain the finding; therefore, additional research is required, and future research could incorporate variables that were not determined in this study.

Table 4.13: Simple Linear Regression Analysis Results Of Prevalence Of Low Back Pain Related To The Level Of Physical Activity

Predicted (Dependent Variable)	Predictor (Independent Variable)	Unstandardized Coefficients		Standardized Coefficients			
		B	Standard Error	Beta	t	Sig.	Regression Results
Low Back Pain	Physical Activity Level	-.015	.058	-.010	-.251	.802	$R = .010$ $R^2 = .000$ Adj. $R^2 = -.001$ $F = .063$ Regression (df) = 1 Residual (df) = 638 $P > .05$

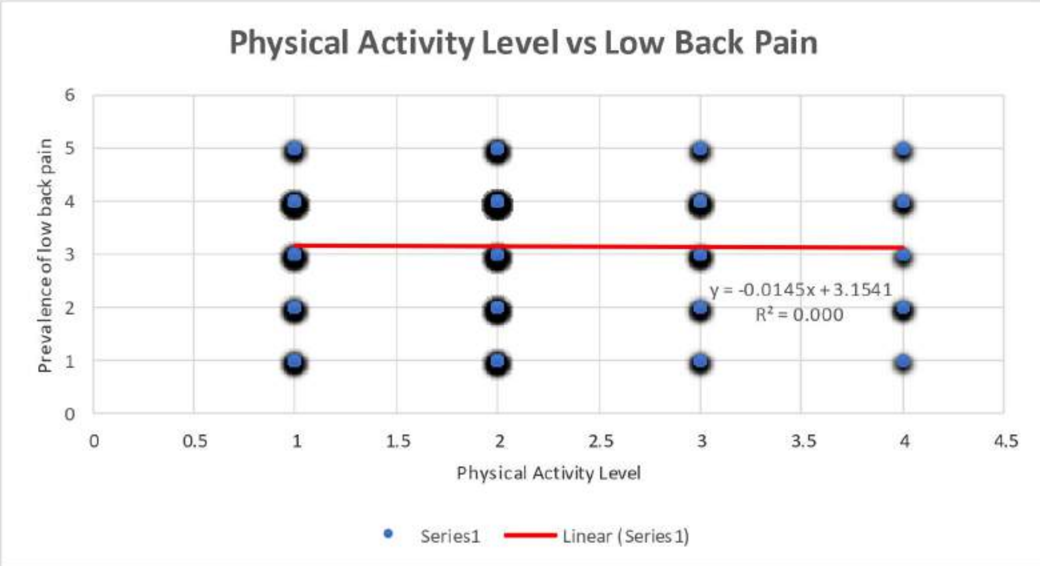

Figure 4.13: Scatter Plot Diagram Depicting the Non-Significant Relationship Between Physical Activity Level (PA) and Prevalence Of Low Back Pain (LBP).

4.6.3 Association Between Physical Activity Level and The Prevalence of Shoulder Pain Among University Students During the COVID-19 Pandemic

A Spearman's rank-order correlation was computed to investigate the relationship between the level of physical activity performed by the university students per week and the prevalence of shoulder pain among them during the pandemic. The relationship was found to be negatively correlated and weak in strength, however the results were not statistically significant (r(638) = -.046, p = .249). This finding demonstrates that there is no significant relation between the physical activity level of the students and the shoulder pain they experienced throughout the pandemic. This is because the significance value is 0.249, which exceeds the acceptable level of 0.05. The association between the level of physical activity undertaken by university students and the prevalence of shoulder pain among them during the Covivirus-19 pandemic is outlined in Table 4.11 above.

Several prior research have demonstrated a correlation between the physical activity level and the prevalence of shoulder pain among university students during the pandemic. Students who regularly involved in athletic activities had a reduced prevalence of shoulder pain compared to those who did not, according to Shan et al. (2013). According to Peterson and Pihlström (2021), there is a correlation between aerobic activity and shoulder pain, with exercises that increase respiration and heart rate being related with a decreased prevalence of shoulder pain. According to another study, shoulder pain is highly connected with physical activity (Ogunlana, Govender and Oyewole, 2021; Guddal et al., 2017; Hanvold, Veiersted and Waersted, 2010; and Auvinen et al., 2007).

In contrast, this study found no significant association between the level of physical activity and the onset of shoulder pain among university students during the pandemic, confirming the findings of Altalhi et al. (2022), who reported that there was no significant association between shoulder pain and physical activity. Peterson and Pihlström (2021) found no relationship between general physical activity and shoulder pain. Other researchers' findings support this viewpoint as well (Salameh et al., 2022; Rossi et al., 2016; Diepenmaat, 2006).

A relationship between the degree of physical activity and the occurrence of shoulder pain among university students has not been conclusively established due to a limited number of studies and inconsistent results across numerous studies. The findings of this investigation are consistent with those of the study by Altalhi et al (2022). Nonetheless, this great disparity in findings is explicable.

The variation in the type or domain of physical exercise conducted by the students may be one of the probable factors for conflicting findings among researches. Standardization of the type of physical activity performed by students during the pandemic was not considered prior to or during data collection in this study, as it was not possible to meticulously control the type of exercises or activities performed by students for the purposes of this study due to restrictions imposed by the Malaysian government during the pandemic. Consequently, the respondents were required to answer the questionnaire solely based on the physical activities that they performed on their own during the pandemic, which may have differed from one another, meaning that each of them may have experienced different bodily effects after the physical activity. For instance, the majority of them may have mainly focused on habitual or leisure-time physical activity, which may not accurately reflect daily physical activity (Kędra et al., 2021). This suggests that a student might engage in regular physical activity for 150 minutes or more per week, as advised by WHO, but it would not be as beneficial in reducing shoulder pain as frequent exercises of moderate or high intensity. In this study, even though 21.7% of the students reported engaging in moderate and intense activity, they may not have noticed a reduction in shoulder pain because they may have been performing habitual activities, which have little or no effect on shoulder pain. As a result, the link between amount of physical activity and prevalence of shoulder pain found in this study was disrupted. This was further supported by Pirnes et al. (2022), Peterson and Pihlström (2021), Øverås et al. (2020), Kalatakis-dos-Santos et al. (2019), and Auvinen et al. (2007), who demonstrated the relationship between domain of physical activities and shoulder pain. In addition, Scarabottolo et al. (2017) revealed that different physical activity domains are connected with shoulder pain in varying ways. Consequently, classification of the type or domain of physical activities must be refined in future research.

The dimensions of physical activities may also have a role in the discrepancies between studies' conclusions. It is probable that different aspects of recreational and sport-related activities have varied associations with shoulder pain. Some sports may be advantageous or detrimental to the development of or protection against shoulder pain in adolescents and young adults (Pirnes et al., 2022; Auvinen et al., 2007). Shoulder injuries caused by sports are widespread among adolescents and young adults (Johansson et al., 2021; Gibson et al., 2021). According to Heneweer, Vanhees, and Picavet (2009), the significance of physical activity lay in its quality, not its quantity. Sports are characterised by a variety of back-loading pressures; hence, certain sports may be damaging to the spine. Shoulder joint pain is a common subsequent symptom of spinal injury (Mulroy et al., 2015). Future research should investigate the risk of shoulder pain related with intense sports practise during adolescence. Similarly, intense physical exercise may also have a role. In order to live a healthier lifestyle, it is advised by WHO (2010) to engage in at least 150 minutes of moderate-intensity activity or 75 minutes of strenuous-intensity exercise per week; however, going overboard on this duration might often have more of a detrimental effect than a beneficial one. The chance of getting musculoskeletal pain

(MSP) is increased by physical activity, which has numerous health benefits (Kamada et al., 2016). In their study, Guddal et al. (2017) discovered that moderate physical activity was related with decreased shoulder pain, whereas high physical activity increased the likelihood of pain in the lower limbs. Strength and excessive sporting were associated with all types of pain in young adults (Guddal et al., 2017). According to a study conducted by Kamada et al. (2016) among Japanese adolescents, high levels of physical activity exhibited a clear linear association with MSP prevalence and risk. The greater the participants' participation in sports, the greater their likelihood of experiencing and developing pain. Each 1 hour per week of more sports activity time was related with a 3% higher likelihood of having or developing MSP. Along with the low back, the shoulders were among the most often affected locations. Additionally, Kelly, Dockrell, and Galvin (2009) reported that physical exercise exacerbated shoulder pain. During the pandemic, 6.4% of the total participants in this study engaged in 300 minutes or more of intense activity per week, as shown in Table 4.4. Despite the fact that this period is suggested by the WHO, based on the aforementioned data, it may have caused a portion of students engaging in intense activity to sustain injuries in or around the shoulder region, resulting in severe shoulder pain. This, along with the large number of shoulder pain cases among physically inactive students, led to a rise in the total number of students with shoulder pain, hence rendering the association between physical activity level and shoulder pain non - significant in this study.

Technique errors while completing exercises may also contribute. Technique is the manner in which an exercise is performed in order to target particular muscle groups. Incorrect technique can also be detrimental to the human body. If inappropriate form is utilised when executing a series of strength-training exercises, such as lifting weights, intense landscaping such as plowing and digging, stair climbing, walking up the hill, bicycling, dancing, push-ups, sit-ups, and squats, certain muscles may be overworked, which can result in an overuse injury (Mayo Clinic, 2019). The outcomes will not be as great as they may be without the appropriate technique. Improper form can have detrimental effects on the body and ultimately result in additional pain and injury. Ingraham (2003) further suggests that stretching, which enhances mobility and movement range beyond what is necessary for physical activity or sport-specific movements, may not be beneficial and may possibly induce injury because even slight stretching can cause cytoskeletal injury (Shrier, 2000; Shrier, 1999). The use of excessive weights and poor techniques places the back in a precarious posture that may result in damage. Faigenbaum and Myer (2009) further suggest that improper exercise technique and unsuitable training loads may partially account for some of the observed injuries incurred by young athletes during resistance training. According to Patel and Breisach (2017), shoulder soreness in young athletes is typically caused by improper technique and overuse. Due to government restrictions on movement, the workouts undertaken by the participants in this study during the epidemic were not standardised prior to data collection. Instead, participants were asked to respond to the survey questions based on their own exercises and physical activities throughout the epidemic. This indicates that everyone performed different types of workouts based on their individual tastes, which may have had varying effects on them. In addition, it is impossible to determine whether the participants utilised the proper exercise routines. Some individuals may have employed improper techniques when exercising, causing them to experience shoulder pain rather than relief. Consequently, even though the students engaged in moderate or vigorous activity during the pandemic, they did not experience shoulder pain relief due to the improper or incorrect techniques they employed while performing their exercises, which increased shoulder pain rather than significantly reducing it. This clearly explains the increase in the number of students experiencing shoulder pain during the pandemic, as seen in Table, despite the fact that 21.7% of all respondents reported continuing to engage in moderate or vigorous activity during the pandemic.

In addition, the method employed to measure physical activity could be a contributing factor. In this study, student responses were gathered through a self-administered online questionnaire. Students were asked to recollect the level of physical activity they had engaged in before to and during the pandemic and to select the amount of hours per week they spent engaging in physical activities depending on the physical activity level category supplied in the questionnaire. As there is a greater possibility of selection bias on the part of the students, this may not have been the most accurate method for obtaining data on physical activity level. Using surveys may also result in recall bias in the estimating process. For participants with musculoskeletal pain, objective measurement is better to self-reporting (Peterson and

Pihlström, 2021; Verbunt, Huijnen and Köke, 2009). Accelerometer or another objective equipment must have been used to measure physical activity level (Aartun et al., 2016). However, due to the rise of COVID-19 instances during the period of this research study, the use of objective instruments such as accelerometers to assess the physical activity level of the students was not possible in this study due to specific restrictions placed by the Malaysian government and the university as well. This strategy is proposed due to the fact that objective methods have been discovered to produce different results than subjective methods. Physical activity levels may have been misclassified due to inconsistent assessments and categorization of duration, intensity, and frequency (Kędra et al., 2021). Future study is required to clarify the method used to measure the intensity of the physical activities.

Another concern involves the definition of shoulder pain. In this study, the participant questionnaire did contain an explanation of what shoulder pain is; nevertheless, the explanation may not have been comprehensive enough for the participants to comprehend. Inserting a diagram clearly illustrating the location of shoulder pain and the bones involved would have been helpful, which, in the case of young students who may not have a clear understanding or complete knowledge of the human anatomy, is essential for better understanding the question and providing a proper answer, just as conducted by Bento et al. (2020), Dianat, Alipour and Asghari Jafarabadi (2017), Scarabottolo et al. (2017), Aartun et al. (2016), and Shan et al. (2013). Various prevalence estimates for shoulder pain may also originate from different definitions of the condition (Kędra et al., 2021). Therefore, future study should include a precise definition of shoulder pain as well as a schematic illustrating the exact location of the implicated shoulder muscles and bones.

In addition, the inclusion and exclusion criteria for groups with and without shoulder pain were not considered. Prior to or during data collection, participants were not checked for shoulder or spinal injuries such as paraplegia, which may have had a significant role in producing shoulder pain (Mulroy et al., 2015). Excluding participants with shoulder and spinal injuries, which may induce shoulder pain, from the study might have given more accurate results about the relationship between physical activity and shoulder pain (Kędra et al., 2021). Therefore, it is recommended that these participants be excluded from future investigations.

The time frame during which the data was gathered may also be a concern. This study covered a wide range of shoulder pain occurrences (Kędra et al., 2021), and students were asked to provide information about their level of physical activity before the pandemic (before March 2020) and during the epidemic (from March 2020 onwards). However, this research and the dissemination of the questionnaire to collect information from respondents were not begin until two years after the outbreak began. The students were asked to recall their level of physical activity prior to and during the pandemic and to select their level of physical activity each week based on the physical activity level categories given in the questionnaire. Since the students were required to recall specifics of their physical activity from a considerable amount of time ago, the acquired data may not be as accurate as desired. This introduces the possibility of recall bias in the data provided by the student on the questionnaire, as the student may overestimate or underestimate the level of physical activity (Kędra et al., 2021). In turn, this may have reduced the strength of the reported link between physical activity level and shoulder pain prevalence in this study.

A simple linear regression was calculated to test if the level of physical activity performed by the university students per week significantly predicted the onset of shoulder pain among them during the pandemic. Preliminary analyses were performed to ensure there was no violation of the assumption of normality and linearity. The fitted regression model was: Shoulder pain = 3.329 – 0.088*(level of physical activity). However, the overall regression was found to be statistically non-significant ($R^2 = 0.003$, $F (1, 638) = 2.025$, $p = 0.155$). Therefore, this result can be interpreted as the level of physical activity did not significantly predict the onset of shoulder pain among students during the pandemic ($\beta = -0.088$, $p = 0.155$). Table 4.14 summarises the results of this relationship for easier comprehension. The scatter plot in Figure 4.14 illustrates the association between these two variables.

In summary, it was established that the association between the physical activity level of the students and the shoulder pain they had during the pandemic was weak and negative, although the results were not statistically significant. Similarly, it was concluded that the entire regression was statistically non-significant. As stated previously, this may be related to additional confounding variables, such as variation in the type or domain of physical activity, dimensions of physical activity, techniques error, method of measuring physical activity, definition of shoulder pain, participant exclusion criteria, and time frame of study. These confounding variables will likely explain the finding; thus, additional research is necessary, and future studies could incorporate variables that were not determined in this study.

Table 4.14: Simple Linear Regression Analysis Results Of Prevalence Of Shoulder Pain Related To The Level Of Physical Activity

Predicted (Dependent Variable)	Predictor (Independent Variable)	Unstandardized Coefficients		Standardized Coefficients			
		B	Standard Error	Beta	t	Sig.	Regression Results
Shoulder Pain	Physical Activity Level	-.088	.062	-.056	-1.423	.155	$R = .056$ $R^2 = .003$ Adj. $R^2 = .002$ $F = 2.025$ Regression (df) = 1 Residual (df) = 638 $p > .05$

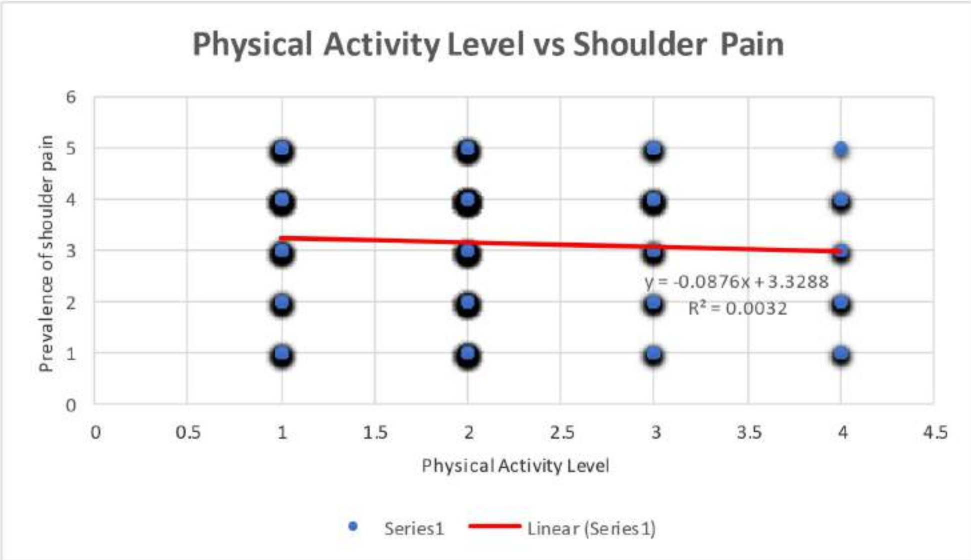

Figure 4.14: Scatter Plot Diagram Depicting the Non-Significant Relationship Between Physical Activity Level (PA) and Prevalence of Shoulder Pain (SP).

4.7 Total Sitting Time

4.7.1 Association Between Total Sitting Time and The Prevalence of Neck Pain Among University Students During the COVID-19 Pandemic

A Spearman's rank-order correlation was computed to investigate the relationship between the number of hours a university student spent sitting per day and the prevalence of neck pain experienced by them during the COVID-19 pandemic. The findings indicated a positive correlation between total sitting time and the prevalence of neck pain among university students during the pandemic, with the relationship being highly statistically significant at the 0.01 level, however the correlation was weak in strength ($r(638) = .169$, $p < 0.001$). This data suggests that the longer a student sat, the more likely they were to feel neck pain, although the effect was minimal. The association between the number of hours a student sat each day and the prevalence of neck pain among them during the COVID-19 pandemic is indicated in Table 4.11 above.

Many prior research have also demonstrated a high correlation between student sitting time and neck pain (Roggio et al., 2021; Ogunlana, Govender and Oyewole, 2021; Weleslassie et al., 2020; Yang et al., 2016; Caromano et al., 2015; Kanchanomai et al., 2011).

According to this study, the COVID-19 pandemic may directly be responsible for the positive correlation between sitting time and the prevalence of neck pain among university students.

The Malaysian government implemented measures including social isolation and a national lockdown for all educational institutions during the COVID-19 pandemic by switching to other methods of learning. E-learning techniques were therefore heavily implicated. It was difficult to transition to online schooling. Due to the epidemic, students were compelled to remain in their homes or hostels and were forced to access their online classes and other educational resources through electronic devices like computers, tablets, and phones (Karingada and Sony, 2021). This required the students to spend a lot of time in front of the screens of their electronic devices. The students were required to study for several hours while seated. Numerous student complaints about the prevalence of neck pain were linked to this change in teaching strategies. According to Yaseen and Salah (2021), there is a substantial relationship between the length and intensity of physical pain and the amount of time spent using a desktop, laptop, or tablet for e-learning. These findings indicate that the duration and intensity of pain increases with the duration of time spent on e-learning.

Moreover, as a result of the convenience of being at home or in a dormitory, students assumed awkward positions when using their electronic devices during online lectures. The majority of students sit with their supine position sloping forward while using desktop/laptop or tablet computers (Yaseen and Salah, 2021), which may also be related to other ergonomic risk factors like as awareness of ergonomics, availability of adequate chair, space, and neck support while sitting in a chair, all of which have a significant role in the prevalence of neck pain among students throughout the pandemic.

The timeframe of the pain varied across individuals as well, however the most prevalent timeframe of pain for this study's participants was after many hours of study. As noted previously, watching online lectures and completing projects on electronic devices while sitting for extended periods of time leads students to adopt an unnatural posture. Additionally, it makes the student's neck hunch forward as they spend a lot of time staring at computer screens. Students who engage in this activity risk developing neck pain. Some pupils have also mentioned that they get neck pain late at night or while they are sleeping. This is a crucial discovery because neck pain in the evening or at night can interfere with sleep, and some preliminary research suggests that fatigue, trouble falling asleep, waking up in the middle of the night, and other sleep issues can increase the risk of neck pain (El-Metwally et al., 2004). As a result, this factor may make neck pain from e-learning worse.

Additionally, It was discovered that participants' ability to get out of bed, stay asleep through the night, turn over in bed, stand for 20-30 minutes without becoming tired, bend over, walk several miles, and more was also significantly impacted by the amount of time they spent using a desktop, laptop, or tablet for e-learning (Yaseen and Salah, 2021). The risk of neck pain might be raised by interfering with these regular activities and prohibiting the pupils from performing even a basic exercise like walking or bending. The pain connected with e-learning raising the danger of these everyday activities is a red flag for this young demographic of the population since it could harm their overall health and potentially impair their ability to learn (Yaseen and Salah, 2021).

All of these studies could explain the strong link between sitting time and the prevalence of neck pain among students during the COVID-19 pandemic, given that the normal dynamic student lifestyle has transformed to a more sedentary lifestyle, with students receiving the majority of their education online while seated at home.

Despite a statistically significant result, a weak correlation was identified between sitting duration and the prevalence of neck pain among students in this study. Several considerations could explain why this conclusion differs from the findings of other researchers.

One of the explanations for the limited correlation between sitting time and prevalence of neck pain may be the incapacity of the students to appropriately assess the degree of their own neck pain. The overview of the respondents' daily sitting time before and throughout the epidemic is shown in Table 4.5. A staggering 82.5% of the respondents spent more than 8 hours a day sitting during the epidemic, which puts them at high and very high risk for developing musculoskeletal pain. This implies that 82.5% of the respondents had an extremely high likelihood of experiencing musculoskeletal pain. However, when the data on the prevalence of neck pain among students, as presented in Table 4.6 and Figure 4.6, was analysed, only 55.6% of the total respondents categorically stated that they experienced neck pain. 25.3% of respondents claimed categorically that they did not experience pain. The remaining 19.1% of respondents were ambivalent, as they answered "neither agree nor disagree" to the question. This suggests that 19.1% of the respondents were undecided and unable to categorise the degree of their pain; as a result, they chose to be a fence sitter by neither agreeing with the statement nor disagreeing with it. In turn, this 19.1% indecisiveness contributed to the analysis by resulting in a weak association between sitting duration and neck pain.

The method of assessing the amount of time students spend seated could also be a contributing factor. Results from students were gathered for this study using a self-administered online questionnaire. In addition to choosing how much time they spent sitting each day based on the categories offered in the questionnaire, students were asked to recall how much time they spent sitting before and during the pandemic. Given the higher likelihood of student selection bias, this method of gathering data on sitting time may not have been the most reliable. When surveys are employed, it may also result in recall bias in the estimation. The pupils may overestimate or underestimate the duration of the sitting period. A more desirable assessment method than self-reporting is an objective measure when determining the amount of sitting time in participants with neck pain (Hallman et al., 2016a; 2016b). To measure sitting time, an objective tool like an accelerometer must have been utilised (Hallman et al., 2016a; 2016b). This approach is recommended since one of the issues is that results reported by objective methods have been found to differ from those acquired by subjective ones. The studies used different methods for measuring and classifying sitting time in terms of length and risk level, which could have resulted in incorrect classification of sitting time (Kedra et al., 2021). Future research needs to clarify the sitting duration measurement method.

The time frame within which the data was gathered may also be a problem. This study examined a fairly broad time span for the occurrence of neck pain (Kędra et al., 2021), and the students were asked to report their sitting time throughout two distinct time periods: before the pandemic (before March 2020) and during the pandemic (after March 2020). However, this research and the dissemination of the questionnaire to collect information from respondents were not begin until two years after the outbreak began. Students were instructed to recollect the amount of time they sat before and during the pandemic and to select the amount of time they sat per day depending on the sitting time category given in the survey. Since the students had to recall specifics of their sitting time from a long time ago, this may not be the best situation in terms of the accuracy of the data collected. Due to the possibility that the students may overestimate or underestimate their sitting time, recall bias in the information they provided in the questionnaire is formed (Kędra et al., 2021). This may have had an impact on the study's findings regarding the relationship between sitting time and the prevalence of neck pain by weakening the association.

A simple linear regression was constructed in addition to a correlation analysis to see if the number of hours per day that university students spent sitting influenced their likelihood of developing neck pain during the pandemic. It was determined through preliminary analyses that the assumptions of normality and linearity had not been violated. Neck pain = 2.559 + 0.252*(sitting time) was the regression model that was fit. There was statistically significant overall regression ($R^2 = 0.025$, $F(1, 638) = 16.056$, $p < 0.001$). As a result, this finding can be understood to mean that sitting time during the pandemic significantly predicted the onset of neck pain in students ($R^2 = .025$, $p < 0.001$). For ease of understanding, Table 4.15 summarises the findings of this association. The scatter plot in Figure 4.15 illustrates the association between these two variables.

In this study, students who selected 'agree' and 'strongly agree,' corresponding to values 4 and 5, on the pain scale supplied in the questionnaire, were judged to have neck pain. This indicates that a pain index of at least four indicates that the students were experiencing neck pain. The regression model for neck pain derived by the regression analysis, which states Neck pain = 2.559 + 0.252*(sitting time), was used to determine the minimal amount of time the students had to spend seated for them to develop or start feeling neck pain. Given that a pain value of 4 indicates that students experience pain frequently, it was added to the equation, which resulted in a value of 5.7 hours of sitting time. This illustrates how students' frequent neck ache is caused by a minimum of 5.7 hours of sitting per day, which is considered to be of medium risk. This data was verified by Behera et al. (2020), who reported that individuals who sat and studied for more than 4 hours had 3.2 times the risk of developing neck pain compared to those who sat and studied for 4 hours or less. Another study by Daher and Halperin (2021a; 2021b) also found a similar outcome. But because this analysis's R-square value was 0.025, it shows that sitting time explains just 2.5% of the variation in the occurrence of neck pain across students. Despite the fact that the total regression was highly statistically significant, the regression model had trouble predicting the likelihood that students will experience neck pain and how much time they would spend sitting. This is due to the fact that the data collected from the students via the questionnaire regarding the prevalence of neck pain showed a higher degree of variability. Due to this heterogeneity, the data were dispersed around the regression line (Frost, 2019), making it difficult to forecast the likelihood that students may experience neck pain based just on their sitting time. Some of the above-mentioned reasons may be to blame for the varying statistics on the prevalence of neck pain among students that was gathered.

In conclusion, there was a positive, highly statistically significant, but weak association between total sitting time and the prevalence of neck pain among university students during the pandemic. Similarly, the overall regression was statistically significant, but the prediction of the prevalence of neck pain resulting from sitting time based on the regression model was extremely weak. This discrepancy in results may be caused by the considerable variability in the information gathered from the students about the onset of neck pain or other confounding factors that have been addressed above and that require more research in this context. These confounding variables likely explain the finding; therefore, additional research is required, and future research could incorporate variables that were not determined in the present study.

Table 4.15: Simple Linear Regression Analysis Results Of Prevalence Of Neck Pain Related To The Total Sitting Time

Predicted (Dependent Variable)	Predictor (Independent Variable)	Unstandardized Coefficients		Standardized Coefficients			
		B	Standard Error	Beta	t	Sig.	Regression Results
Neck Pain	Total Sitting Time	.252	.063	.157	4.007	.000	R = .157 R^2 = .025 Adj. R^2 = .023 F = 16.056 Regression (df) = 1 Residual (df) = 638 $p < 0.001$

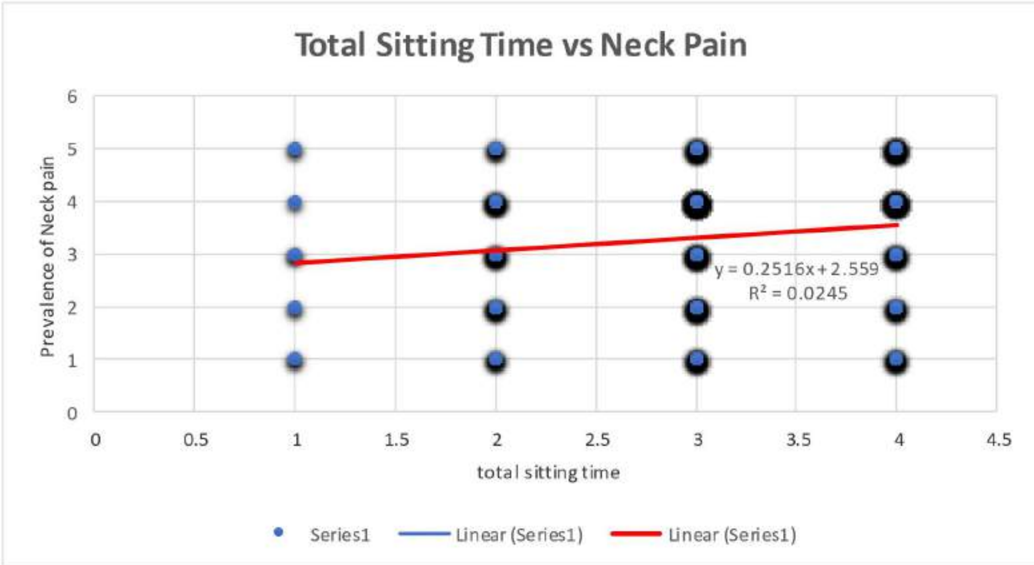

Figure 4.15: Scatter Plot Diagram Depicting The Relationship Between Total Sitting Time (TST) and The Prevalence Of Neck Pain (NP). This Relationship Is Positively Correlated and Statistically Significant But Weak In Strength.

4.7.2 Association Between Total Sitting Time and The Prevalence of Low Back Pain Among University Students During the COVID-19 Pandemic

A Spearman's rank-order correlation was computed to investigate the relationship between the number of hours a university student spent sitting per day and the prevalence of low back pain experienced by them during the COVID-19 pandemic. The findings indicated a positive correlation between total sitting time and the prevalence of low back pain among university students during the pandemic, with the relationship being highly statistically significant at the 0.01 level, however the correlation was weak in strength ($r(638) = .149$, $p < 0.001$). Therefore, this result can be interpreted as the longer a student sat, the more likely they were to experience low back pain; however, the effect was very minimal. The results are explicated in Table 4.11 above which will help to understand the correlation between the number of hours a student spent sitting per day and the prevalence of low back pain among them during the COVID-19 pandemic.

There is a high correlation between sitting duration and low back pain among students, as demonstrated by a large number of prior research (Roggio et al., 2021; Ogunlana, Govender and Oyewole, 2021; Weleslassie et al., 2020; Yang et al., 2016; Caromano et al., 2015; Kanchanomai et al., 2011). According to Mowatt et al. (2017), low back pain is one of the most common health problems among those who use electronic devices for many hours in a sitting position, and 89.9 percent of university students suffer from this condition (Reddy et al., 2013). According to several other research, students have a habit of sitting for too long and maintaining an unpleasant posture for an extended period of time, which has developed with a high static muscular load (Casas S, Patiño S and Camargo L, 2016; Lim, Sharanjit Kaur and Tan, 2013). Long-term sitting became one of the causes of musculoskeletal pain, particularly among students with low back pain (Issa et al., 2016; S, F and V, 2016; Nor Azlin, Ajit Singh and Lim, 2014).

In this context, the explanation for the significant correlation between sitting time and low back pain prevalence among college students is directly tied to the pandemic. Students had to use electronic devices like computers, tablets, and phones to access their online classes and other educational materials because they were compelled to stay in their homes or hostels as a result of the pandemic. This meant that the students had to spend extended periods of time in front of their technological devices. The students were required to study for several hours while seated. The comfort of their homes or hostels also caused the students to adopt unnatural positions when utilising their electronic devices during online lessons. The prevalence of low back pain among the students was also significantly influenced by other factors, including understanding of ergonomics, the availability of a suitable chair, space, and back support while seated in a chair.

Despite a substantial outcome in this investigation, a minor correlation between sitting duration and the prevalence of low back pain among students was discovered. Several factors could account for this variation in the results from other researchers.

The inability of the students to appropriately identify the degree of their low back pain could be one of the explanations for the weak correlation between sitting time and prevalence of low back pain. The overview of the respondents' daily sitting time before and during the pandemic is shown in Table 4.5. A staggering 82.5% of the respondents spent more than 8 hours a day sitting during the pandemic, which puts them at high and very high risk for developing low back pain. This implies that 82.5% of the respondents had an extremely high likelihood of experiencing musculoskeletal pain. However, only 47.2% of the total respondents firmly claimed that they had low back pain when the data on the prevalence of low back pain among students, summarised in Table 4.7, was assessed. 31.8% of respondents definitively indicated that they did not suffer any pain. However, the remaining 21.1% of respondents expressed ambivalence by selecting "neither agree nor disagree" as their response to the question. This suggests that 21.1% of the respondents were undecided and unable to categorise the degree of their pain; as a result, they chose to be a fence sitter by neither agreeing with the statement nor disagreeing with it. This 21.1% of uncertainty contributed to the research by establishing a weak connection between sitting duration and low back pain.

The method of assessing the amount of time students spend seated is another possible explanation. In this study, student responses were obtained via a self-administered online survey. Students were asked to recollect the amount of time they sat before and during the pandemic and to select the amount of time they sat every day according on the sitting time category given in the survey. This may not have been the most reliable method of collecting data on sitting time, as there is a greater chance of selection bias on the part of the students. In addition, when surveys are employed, recall bias may be introduced into the estimation. The students may overestimate or underestimate the duration of the sitting period. An objective assessment is preferred to self-report measurement for determining the sitting time of participants with low back pain (Hallman et al., 2016a; 2016b). A measurable, objective equipment, such as an accelerometer, must have been utilised to determine the duration of sitting (Hallman et al., 2016a; 2016b). This strategy is proposed due to the fact that objective methods have been discovered to produce different results than subjective methods. Inconsistent measurements and classifications of sitting time in terms of length and risk level among studies may have led to misclassification of sitting time (Kędra et al., 2021). Future studies should provide more clarity on the sitting time assessment method.

The time frame during which the data was gathered may also be a concern. This study examined a fairly broad span of the occurrence of low back pain (Kędra et al., 2021), and the students were asked to report their sitting time throughout two distinct time periods: before the pandemic (before March 2020) and during the pandemic (after March 2020). However, this research and the dissemination of the questionnaire to collect information from respondents were not begin until two years after the outbreak began. Students were asked to recollect the amount of time they sat before and during the epidemic and to select the amount of time per day they sat depending on the sitting time category given in the questionnaire. Since the students were required to recall information of their sitting time from a considerable amount of time ago, the acquired data may not be as accurate. This introduces the possibility of recall bias in the information provided by the student on the questionnaire, as students may overestimate or underestimate the sitting time (Kędra et al., 2021). In turn, this may have reduced the strength of the apparent link between sitting duration and the prevalence of low back pain.

In addition to correlation, a simple linear regression was calculated to test if the hours spent sitting by the university students per day significantly predicted the onset of low back pain among them during the pandemic. Preliminary analyses were performed to ensure there was no violation of the assumption of normality and linearity. The fitted regression model was: Low back pain = 2.366 + 0.240*(sitting time). The overall regression was statistically significant ($R^2 = 0.023$, $F(1, 638) = 15.007$, $p < 0.001$). Therefore, this result can be interpreted as the sitting time significantly predicted the onset of low back pain among students during the pandemic ($\beta = 0.240$, $p < 0.001$). Table 4.16 summarise the results of this relationship for easier comprehension. The scatter plot in Figure 4.16 illustrates the association between these two variables.

In this study, students who selected "agree" and "strongly agree" on the pain scale supplied in the questionnaire, with respective values of 4 and 5, were determined to have low back pain. This implies that a minimal pain rating of 4 indicates that the students were experiencing low back pain. This figure was used to determine the minimal amount of time students had to sit in order to develop or begin feeling low back pain, based on the regression model for low back pain derived from the regression analysis, which states Low back pain = 2.366 + 0.240*(sitting time). Since a pain value of 4 indicates that pain is prevalent among students, it was incorporated into this method, yielding a value of 6.8 hours of sitting time. This clarifies how sitting for a minimum of 6.8 hours a day, which is considered to be of medium risk, relates to the prevalence of low back pain among students. Eloi, Quemelo, and Sousa (2022) validated this conclusion by stating that students who spent up to seven hours per day seated while studying had a higher prevalence of low back pain. Similar findings were observed by Belakang et al. (2014), where 31% of students who sat in front of a computer for 6 hours or more each day reported a higher prevalence of low back pain. However, given that the R-square value derived from this study is 0.023, sitting time explains just 2.3% of the variance in the prevalence of low back pain among students. Although the overall regression was highly statistically significant, the model's ability to predict the occurrence of low back pain in students in connection to their sitting time was minimal. This is due to a greater degree of variation in the data received from the students' questionnaires indicating the prevalence of low back pain. This variance caused the data to be dispersed around the regression line (Frost, 2019), resulting in a weak prediction of the prevalence of low back pain in students based on their sitting duration. As previously indicated, the observed variation in the prevalence of low back pain among students could be related to a number of reasons.

In summary, the relationship between total sitting time and the prevalence of low back pain among university students during the pandemic was positive, statistically significant, but weak. Likewise, the overall regression was statistically significant, but the prediction of the prevalence of low back pain attributable to sitting time based on the regression model was fairly weak. This discrepancy may be attributable to the significant variability of the data acquired from the students about the onset of low back pain, or to other confounding factors indicated above, which require additional examination in this context. These confounding variables will likely explain the finding; therefore, additional research is required, and future research could incorporate variables that were not determined in this study.

Table 4.16: Simple Linear Regression Analysis Results Of Prevalence Of Low Back Pain Related To The Total Sitting Time

Predicted (Dependent Variable)	Predictor (Independent Variable)	Unstandardized Coefficients		Standardized Coefficients			
		B	Standard Error	Beta	t	Sig.	Regression Results
Low Back Pain	Total Sitting Time	.240	.062	.152	3.874	.000	R = .152 R^2 = .023 Adj. R^2 = .021 F = 15.007 Regression (df) = 1 Residual (df) = 638 $p < 0.001$

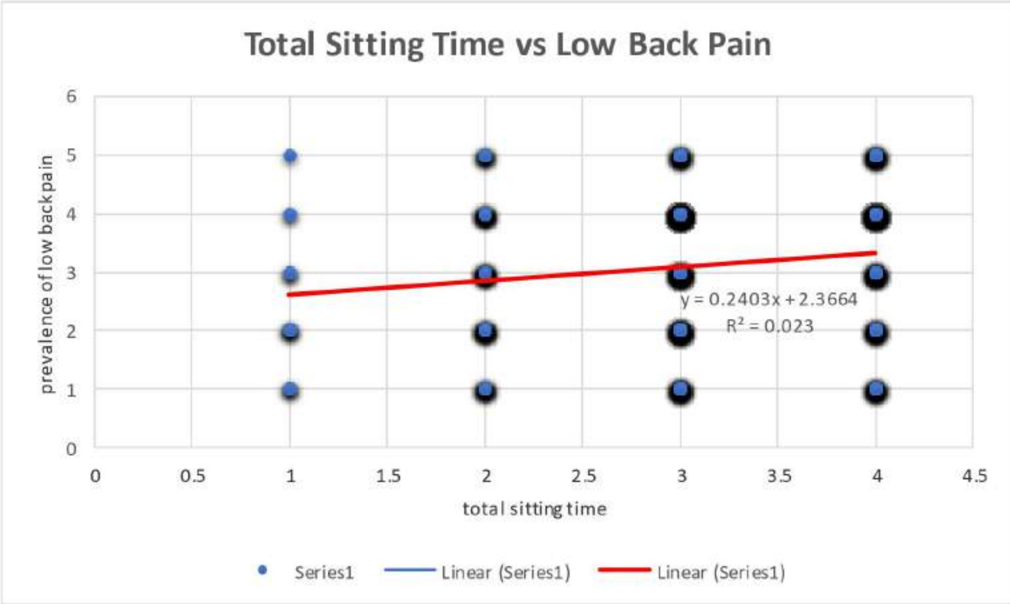

Figure 4.16: Scatter Plot Diagram Depicting the Relationship Between Total Sitting Time (TST) And The Prevalence Of Low Back Pain (LBP). This Relationship Is Positively Correlated and Statistically Significant But Weak In Strength.

4.7.3 Association Between Total Sitting Time and The Prevalence of Shoulder Pain Among University Students During the COVID-19 Pandemic

A Spearman's rank-order correlation was computed to investigate the relationship between the number of hours a university student spent sitting per day and the prevalence of shoulder pain experienced by them during the COVID-19 pandemic. The findings indicated a positive correlation between total sitting time and the prevalence of shoulder pain among university students during the pandemic, with the relationship being highly statistically significant at the 0.01 level, however the correlation was weak in strength ($r(638) = .186$, $p < 0.001$). This data suggests that the longer a student sat, the more likely they were to have shoulder pain; nevertheless, the effect was extremely small. The findings are explained in Table 4.11 above, which will aid in understanding the relationship between a student's daily sitting time and their susceptibility for shoulder pain during the COVID-19 pandemic.

Many prior research have also demonstrated a high correlation between students' sitting time and shoulder pain (Anggiat, Wan Hazmy Che Hon and Siti Nur Baait, 2018; Hallman et al., 2016b; Hallman et al., 2015; Straker et al., 2009).

According to Mowatt et al. (2017), shoulder pain is one of the most prevalent health issues among individuals who use electronic devices for numerous hours in a seated position, and 89.9% of undergraduate university students have a prevalence of this health issue (Reddy et al., 2013). Several other research have reached the conclusion that students who sit for too long acquire a prolonged, unpleasant posture with a high static muscle load (Casas S, Patiño S and Camargo L, 2016; Lim, Sharanjit Kaur and Tan, 2013). The majority of students report at least one sort of musculoskeletal pain, predominantly shoulder pain, due to prolonged sitting (Salameh et al., 2022).

In this context, the rationale for the strong correlation between sitting time and shoulder pain prevalence among university students is directly tied to the pandemic. Due to the pandemic, students were compelled to remain at home or in hostels and were required to use electronic devices such as laptops, tablets, and smartphones to access their online classes and other educational materials (Karingada and Sony, 2021). This meant that the students had to spend extended periods of time in front of their technological devices. The students were required to study while seated for several hours. Moreover, as a result of the convenience of being at home or in a dormitory, students assumed awkward postures when using electronic devices during online lectures. Additionally, other ergonomic risk variables like awareness of ergonomics, accessibility to a suitable chair, available space, and neck support when seated in a chair all played a significant role in the prevalence of shoulder pain among the students throughout the pandemic.

Despite a statistically significant finding, a weak connection was identified in this study between sitting duration and the prevalence of shoulder pain among students. Several factors could explain the disparity between this conclusion and that of other researchers.

The inability of the students to appropriately identify the degree of their shoulder pain could be one of the explanations for the weak correlation between sitting time and prevalence of shoulder pain. Table 4.5 provides a summary of the respondents' daily sitting time before and throughout the pandemic. A staggering 82.5% of the respondents spent more than 8 hours a day sitting during the pandemic, which puts them at high and very high risk for developing musculoskeletal pain. This implies that 82.5% of the respondents had an extremely high likelihood of experiencing musculoskeletal pain. However, when the data on the prevalence of shoulder pain among students, presented in Table 4.8, was analysed, only 48.3% of the total respondents reported having shoulder pain. 31.9% of respondents definitively indicated that they did not suffer any pain. The remaining 19.8% of respondents, however, displayed ambivalence by responding "neither agree nor disagree." This suggests that 19.8% of the respondents were undecided and unable to describe the intensity of their pain; as a result, they chose the less difficult choice of being a fence sitter by neither agreeing with nor disagreeing with the statement. This 19.8% indecision added to the analysis by establishing a weak association between sitting duration and shoulder pain.

The method of assessing the amount of time students spend seated could also be a contributing factor. A self-administered online questionnaire was used in this study to gather student responses. Students were asked to recall the amount of time they sat before and during the pandemic and to select the amount of time they sat every day depending on the sitting time category given in the survey. This may not have been the most reliable method of collecting data on sitting time, as there is a greater chance of selection bias on the part of the students. In addition, when surveys are employed, recall bias may be introduced into the estimation. The students may overestimate or underestimate the duration of the sitting period. An objective measure is preferred to self-report measurement when assessing the sitting time of participants with shoulder pain (Hallman et al., 2016a; 2016b). A measurable, objective equipment, such as an accelerometer, must have been utilised to determine the duration of sitting (Hallman et al., 2016a; 2016b). This strategy is proposed due to the fact that objective methods have been discovered to produce different results than subjective methods. Inconsistent measurements and classifications of sitting time in terms of length and risk level among studies may have led to misclassification of sitting time (Kędra et al., 2021). Future studies must further elucidate the method for measuring sitting time.

The time frame during which the data was gathered may also be a concern. This study examined a fairly broad span of shoulder pain occurrence (Kędra et al., 2021), in which students were asked to report their sitting time from two distinct time periods, such as before the pandemic (before to March 2020) and during the pandemic (from March 2020 onwards). However, this research and the dissemination of the questionnaire to collect information from respondents were not begin until two years after the outbreak began. Students were asked to recollect the amount of time they sat before and during the pandemic and to select the amount of time per day they sat based on the sitting time category given in the questionnaire. Since the students were required to recall information of their sitting time from a considerable amount of time ago, the acquired data may not be as accurate. This introduces the possibility of recall bias in the data provided by the student on the questionnaire, since the student may overestimate or underestimate the sitting time (Kędra et al., 2021). This, in turn, may have had an effect on the relationship between sitting duration and the prevalence of shoulder pain found in this study by weakening the association.

In addition to correlation analysis, a simple linear regression was used to test if the hours spent sitting by the university students per day significantly predicted the onset of shoulder pain among them during the pandemic. Preliminary analyses were performed to ensure there was no violation of the assumption of normality and linearity. The fitted regression model was: Shoulder pain = 2.240 + 0.289*(sitting time). The overall regression was statistically significant ($R^2 = 0.029$, $F(1, 638) = 19.218$, $p < 0.001$). Therefore, this result can be interpreted as the sitting time significantly predicted the onset of shoulder pain among students during the pandemic ($\beta = 0.289$, $p < 0.001$). Table 4.17 summarises the results of this relationship for easier comprehension. The scatter plot in Figure 4.17 illustrates the association between these two variables.

In this study, students who selected "agree" and "strongly agree" on the pain scale supplied in the questionnaire, with respective values of 4 and 5, were determined to have shoulder pain. This implies that a minimum pain score of 4 indicates that the students had shoulder pain. This value was calculated using the regression model for shoulder pain acquired by the regression analysis, which states Shoulder pain = 2.240 + 0.289*(sitting time), to determine the minimal amount of time the students had to spend sitting before they developed or started experiencing shoulder pain. Since a pain score of 4 indicates the prevalence of pain among students, it was incorporated into this formula, yielding a result of 6.1 hours of sitting time. This reveals that a minimum of 6.1 hours of sitting time, which falls under the category of moderate risk, leads to the occurrence of shoulder pain among students. This is validated by the studies of Anggiat, Wan Hazmy Che Hon and Siti Nur Baait (2018), Hallman et al. (2016b), and Hallman et al. (2015). However, given that the R-square value derived from this study is 0.029, sitting time explains just 2.9% of the variance in the prevalence of shoulder pain among students. Although the overall regression was highly statistically significant, the model's ability to predict the occurrence of shoulder pain in students in connection to their sitting duration was minimal. This is due to the fact that there was greater variation in the shoulder pain prevalence statistics gathered from the student questionnaires. This variance caused the data to be dispersed around the regression line (Frost, 2019), resulting in a weak prediction of the prevalence of shoulder pain in students based on their sitting duration. The varying results regarding the prevalence of shoulder pain among students can be linked to a number of the previously mentioned factors.

In summary, the connection between total sitting time and the frequency of shoulder pain among university students during the pandemic was positive, statistically significant, but weak. Similarly, the overall regression was statistically significant, but the prediction of the prevalence of shoulder pain as a result of sitting time based on the regression model was extremely weak. This discrepancy may be attributable to the significant variability of the data acquired from the students about the onset of shoulder pain, or to other confounding factors described above, which require additional examination in this context. These confounding variables will likely explain the finding; therefore, additional research is required, and future research could incorporate variables that were not determined in this study.

Table 4.17: Simple Linear Regression Analysis Results Of Prevalence Of Shoulder Pain Related To The Total Sitting Time

Predicted (Dependent Variable)	Predictor (Independent Variable)	Unstandardized Coefficients		Standardized Coefficients			
		B	Standard Error	Beta	t	Sig.	Regression Results
Shoulder Pain	Total Sitting Time	.289	.066	.171	4.384	.000	R = .171 R^2 = .029 Adj. R^2 = .028 F = 19.218 Regression (df) = 1 Residual (df) = 638 $p < 0.001$

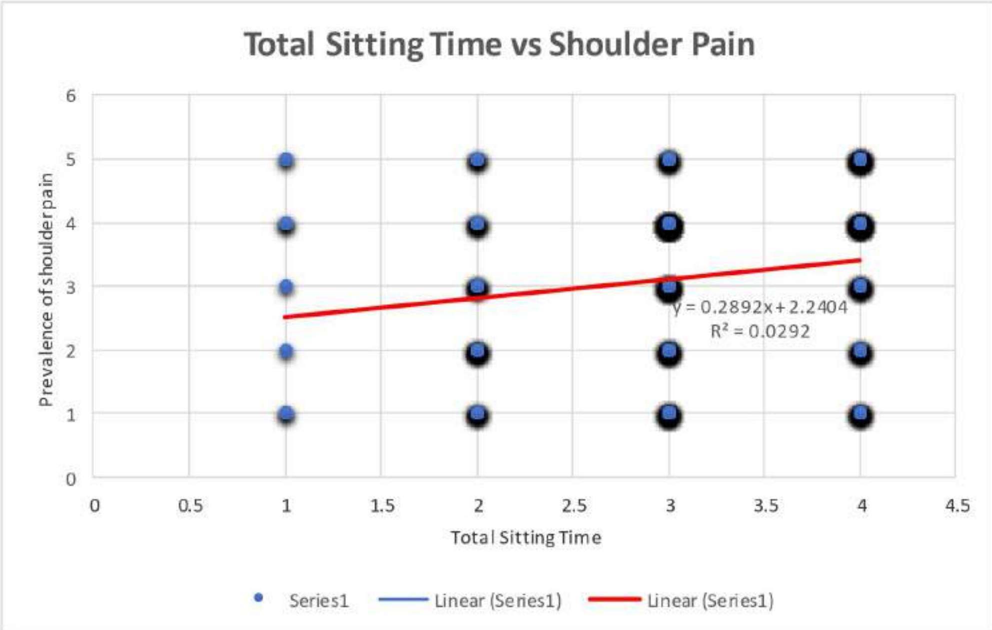

Figure 4.17: Scatter Plot Diagram Depicting the Relationship Between Total Sitting Time (TST) And the Prevalence Of Shoulder Pain (SP). This Relationship Is Positively Correlated and Statistically Significant but Weak In Strength.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Research Conclusion

COVID-19 had a huge impact on the lives of everyone. University students were one of the populations who were severely hit by this pandemic. Due to the pandemic, the change to online learning presented various challenges for the students, one of which was the emergence of MSP. Consequently, the purpose of this study was to gain a better understanding of the symptoms and effects of MSP, as well as the relationship between MSP and online learning among Malaysian university students during the COVID-19 pandemic. Through a comprehensive review of the literature, analysis of the data, and interpretation of the respondents' responses, it is safe to conclude that the research aim and objectives of this study were accomplished with precision.

In general, the conclusions reached from the outcomes and findings of this study are summarized as follows:

i. The research aim and objectives of this study were precisely attained.
ii. NP, LBP, and SP are the most prevalent MSPs among university students during the pandemic.
iii. Students' PA intensity levels decreased slightly during the pandemic compared to before the pandemic. More students (78.3%) engaged in light or no physical activity than moderate or vigorous physical activity (21.7%).

iv. Students' total ST increased moderately during the pandemic compared to before the pandemic. A greater proportion of participants (82.5%) sat for eight hours or more than those who sat for less than eight hours (17.5%).
v. There is no correlation between students' PA intensity levels and the prevalence of NP, LBP, and SP during the pandemic ($p > .05$).
vi. Students' physical activity levels did not significantly predict the prevalence of NP, LBP, and SP during the pandemic.
vii. There is a weak positive correlation between students' total ST and the prevalence of NP, LBP, and SP during the pandemic ($p < 0.001$).
viii. Students' total ST significantly predicted the prevalence of NP, LBP, and SP during the pandemic; however, the relationship was weak.
ix. The majority of students greatly undervalue the significance of ergonomics, as the majority of them did not practice ergonomics during the pandemic.
x. No concrete evidence could be established in terms of the relationship between PA & ST and NP, LBP, & SP. Hence, further research is needed.

In conclusion, the results of this study are not robust enough to draw firm conclusions on the relationship between the prevalence of neck, low back, and shoulder pain, the level of physical activity, and the amount of time university students spent sitting overall during the COVID-19 pandemic. More research is needed before any firm conclusions can be drawn. However, according to the findings of this study, there was a significant decrease in the students' level of physical activity and a substantial increase in their overall sitting time during the pandemic compared to before the pandemic. This change in practise is unquestionably attributable to the advent of the COVID-19 pandemic and the subsequent introduction of online education, which encourages students to adopt a more sedentary lifestyle. In addition, the data acquired from this study regarding the percentage of students who do not practise even the most fundamental ergonomic elements is quite alarming and may be a factor in the development of pain. Therefore, based on the findings of this study, it can be said that the university administration and other pertinent authorities should be aware of this health concern and devise remedial actions to combat MSP among university students. Targeted prevention strategies should be developed and put into practise to reduce the risk of MSP in students who are at risk due to a lack of physical activity and prolonged sitting. Likewise, more awareness programmes and campaigns must be done, or initiatives must be taken, to ensure that students are endowed with the understanding of the significance of ergonomics and the potential benefits of practising effective ergonomics.

5.2 Strengths and Limitations of the Study

5.2.1 Strength of the Study

The strengths of this study included narrowing the focus of the research to the three most common types of musculoskeletal pain, namely neck, low back, and shoulder pain, as well as getting a large population and sample size, a high response rate, and a good consistency because of a narrow age range.

Another strength of this study is that the analysis adjusted for potential confounding factors such as gender, age range, and weight in the students analysed (Dianat et al., 2014). These variables may be connected to neck pain, low back pain, and shoulder pain.

5.2.2 Limitation of the Study

This study has various limitations that must be addressed when interpreting the results. The limitations of the study are as follows:

- **i.** First, the questionnaire was delivered via online channels, which may indicate a lack of interest in properly addressing all questions.
- **ii.** Second, the questionnaire was self-reported, suggesting an underestimation or an overestimation of self-conditions by the students based on the questions.
- **iii.** Third, a selection and/or recall bias concerning PA levels and the total sitting time before and during the pandemic may be present due to the time elapsed.

iv. Fourth, exclusion criteria for underlying conditions or injuries were not taken into account, which may have influenced the onset of musculoskeletal pain during the pandemic.

v. Fifth, heterogeneity in the type or domain of physical activity conducted by the students may have influenced the onset of pain, as different types or domains of physical exercise might have varying impacts on various body areas.

vi. Sixth, this study has a cross-sectional design, so inference must be evaluated carefully.

5.3 Recommendations

5.3.1 For Future Studies

Based on the limitations and other elements of this study, a number of recommendations have been made for future research as well as for university authorities and other relevant personnel. They are as follows:

i. Future studies should categorise or standardise the type or domain of physical activity that students participated in throughout the pandemic. Distinct types or domains of physical activity have different consequences on different body regions, which may have influenced the evolution of the MSP (Kędra et al., 2021). The classification or standardisation of physical activity was not considered in this study because the restrictions imposed by the Malaysian government during the pandemic made it impossible to monitor the type or domain of physical activities that the students engaged in.

ii. Future research should clarify the dimensions of physical activities engaged in by university students. Varied dimensions of physical activity may have different associations with MSP, suggesting that they may promote or inhibit the development of MSP in university students, or serve as a preventative factor against it (Briggs et al., 2009).

iii. The level of physical activity among university students should be monitored using an objective approach, such as an accelerometer, as opposed to a subjective method, such as an online questionnaire that is self-administered. It may contribute to selection bias when selecting an answer and recall bias in estimation when utilising questionnaires. An objective assessment is more accurate than a self-report measurement for estimating a person's level of physical activity (Peterson and Pihlström, 2021). It was not possible to utilise accelerometers to assess the level of physical activity among the students due to the restrictions placed by the Malaysian government and university authorities in response to the rise of COVID-19 cases during the duration of this research project.

iv. Future study should incorporate a detailed definition of the MSP and a diagram depicting the precise locations of the afflicted muscles and bones. It would be advantageous to add a diagram that clearly defines the region of MSP and the bones involved so that young students who may not have a thorough understanding of human anatomy may comprehend the question and make a suitable response (Bento et al., 2020).

v. Exclusion criteria for students with an underlying musculoskeletal injury or condition must be developed. The participants should be checked for any underlying musculoskeletal injuries or problems. Excluding these individuals, who may influence the development of MSP, from the investigation could result in a more accurate conclusion (Kędra et al., 2021).

vi. This study has a cross-sectional approach, thus inferences must be carefully considered because prevalence may change over time in subsequent cross-sectional populations (Kesmodel, 2018). In addition, causation could not be proven using a cross-sectional design, so future studies should include longitudinal data to capture time-oriented variation in MSP symptoms.

5.3.2 For University Administration and Other Relevant Authorities

Measures that must be taken by the university administration and other relevant authorities are as given below:

- **i.** Complying with health standards, promoting good health, and enhancing the quality of life of students necessitates the implementation of measures that encourage an increase in physical activity and a decrease in sitting time.
- **ii.** The inclusion of ergonomic factors in the design of online classes can reduce MSP among students. Institutions should help students learn about the significance of using ergonomic principles when attending online courses in addition to considering the number of hours a student should devote to learning activities.
- **iii.** Accordingly, academic institutions should construct intervention strategies focused on primary, secondary, and tertiary prevention as 50 to 55 percentage of participants in this study had symptoms of an MSP.
- **iv.** Establishing discipline-specific ergonomic risk ratings for online courses will allow institutions to launch their primary preventative measures. Students who are female or have disabilities, such as those who need to wear glasses for medical reasons, must be very careful to avoid any potential hazards. Ergonomic solutions can be implemented at the individual and class levels.
- **v.** As alternate intervention strategies, an institution may undertake routine MSP screenings on its students. When conducting online learning, the frequency of monitoring should be decided based on professional guidance and taking into account course/discipline-specific characteristics.
- **vi.** The tertiary preventative measures would concentrate on motivating students to resume online learning utilising a set of best practises. Considerations for the best practises include type, study discipline, gender, social and cultural contexts, as well as physical and psychological issues.
- **vii.** Students should be exposed to MSP as little as feasible through the way that institutions design the online learning hours for each online course.
- **viii.** Institutions should use a variety of teaching methods to cut down on screen time.

ix. The university should also gauge how frustrated the student is with online education. This is significant because symptoms of MSP will manifest at increased levels of frustration. Institutions should therefore create standard operating protocols for tracking the level of student discontent with each course as well as the necessary intervention strategies to keep it to a minimum.

x. As the major point of contact with students, lecturers should be trained to recognise MSP signs so that they can aid in early identification.

xi. Educators should also encourage stretching exercises and leisure physical activity while online learning. Students will be reminded to maintain proper postures while learning online using these intervention strategies.

xii. Furthermore, universities should also routinely provide MSP management programmes, such as yoga, basic exercises, meditation, resistance training, community-based psychosocial interventions, and so on, for students.

REFERENCES

Aartun, E., Boyle, E., Hartvigsen, J., Ferreira, P.H., Maher, C.G., Ferreira, M.L. and Hestbaek, L. (2016). The Most Physically Active Danish Adolescents Are at Increased Risk for Developing Spinal pain: a two-year Prospective Cohort Study. *BMJ Open Sport & Exercise Medicine*, [online] 2(1), p.e000097. doi:10.1136/bmjsem-2015-000097.

Adedoyin, O. and Soykan, E., 2020. COVID-19 pandemic and online learning: the challenges and opportunities. *Interactive Learning Environments*, [online] pp.1-13. Available at: <https://www.tandfonline.com/doi/full/10.1080/10494820.2020.1813180> [Accessed 13 February 2022].

Adegbehingbe, O., Fatusi, A., Adegbenro, C., Adeitan, O., Abass, G. and Akintunde, A. (2009). Musculoskeletal pain: Epidemiology and Treatment Seeking Behavior of Secondary School Students in a Nigerian Community. *Indian Journal of Community Medicine*, [online] 34(2), p.140. doi:10.4103/0970-0218.51231.

Agarwal, N., Thakkar, R. and Than, K. (2021). *Sports-related Neck Injury – Statistics, Symptoms and Treatments*. [online] www.aans.org. Available at: https://www.aans.org/Patients/Neurosurgical-Conditions-and-Treatments/Sports-related-Neck-Injury [Accessed 18 Aug. 2022].

Ainsworth, B.E., Haskell, W.L., Herrmann, S.D., Meckes, N., Bassett, D.R., Tudor-Locke, C., Greer, J.L., Vezina, J., Whitt-Glover, M.C. And Leon, A.S. (2011). 2011 Compendium of Physical Activities. *Medicine & Science in Sports & Exercise*, [online] 43(8), pp.1575–1581. doi:10.1249/mss.0b013e31821ece12.

Alexander, M.W. (1997). An Assessment of Student Computer Ergonomic Knowledge. *Information Technology, Learning, and Performance Journal*, [online] 15(2), pp.27–33. Available at: https://www.learntechlib.org/p/85277/. [Accessed 21 Mar. 2022].

Algarni, A.D., Al-Saran, Y., Al-Moawi, A., Bin Dous, A., Al-Ahaideb, A. and Kachanathu, S.J. (2017). The Prevalence of and Factors Associated with Neck, Shoulder, and Low-Back Pain among Medical Students at University Hospitals in Central Saudi Arabia. *Pain Research and Treatment*, [online] 2017, pp.1–7. Available at: https://doi.org/10.1155/2017/1235706 [Accessed 23 Feb. 2022].

Al-Hadidi, F., Bsisu, I., AlRyalat, S.A., Al-Zu'bi, B., Bsisu, R., Hamdan, M., Kanaan, T., Yasin, M. and Samarah, O. (2019). Association between Mobile Phone Use and Neck Pain in University students: a cross-sectional Study Using Numeric Rating Scale for Evaluation of Neck Pain. *PLOS ONE*, [online] 14(5), p.e0217231. doi:10.1371/journal.pone.0217231.

Al-Kumaim, N., Alhazmi, A., Mohammed, F., Gazem, N., Shabbir, M. and Fazea, Y., 2021. Exploring the Impact of the COVID-19 Pandemic on University Students' Learning Life: An Integrated Conceptual Motivational Model for Sustainable and Healthy Online Learning. *Sustainability*, 13(5), p.2546.

Allegri, M., Montella, S., Salici, F., Valente, A., Marchesini, M., Compagnone, C., Baciarello, M., Manferdini, M.E. and Fanelli, G. (2016). Mechanisms of low back pain: a guide for diagnosis and therapy. *F1000Research*, [online] 5, p.1530. Available at: https://f1000research.com/articles/5-1530/v2 [Accessed 18 Mar. 2022].

Almalki, M.M., Algarni, S.S. and Almansouri, B.H. (2017). Use of Smartphones, Ipads, Laptops and Desktops as a Risk Factor for Non-Specific Neck Pain among Undergraduate University Students. *The Egyptian Journal of Hospital Medicine*, [online] 69(5), pp.2438–2441. Available at: https://journals.ekb.eg/article_11963.html [Accessed 20 Mar. 2022].

Alshagga, M.A., Nimer, A.R., Yan, L.P., Ibrahim, I.A.A., Al-Ghamdi, S.S. and Radman Al-Dubai, S.A. (2013). Prevalence and factors associated with neck, shoulder and low back pain among medical students in a Malaysian Medical College. *BMC Research Notes*, [online] 6(1), p.244. Available at: https://doi.org/10.1186/1756-0500-6-244 [Accessed 5 Mar. 2022].

Altalhi, I., Elsiddig, A., Althobaiti, M., Alwethainani, M. and Alzahrani, A. (2022). Prevalence of Neck and Shoulder Pain among Saudi universities' Students Who Are Using Smartphones and Computers. *Journal of Family Medicine and Primary Care*, [online] 11(1), p.194. doi:10.4103/jfmpc.jfmpc_1138_21.

Althomali, O.W., Amin, J., Alghamdi, W. and Shaik, D.H. (2021). Prevalence and Factors Associated with Musculoskeletal pain among Secondary Schoolteachers in Hail, Saudi Arabia: A Cross-Sectional Survey. *International Journal of Environmental Research and Public Health*, [online] 18(12), p.6632. doi:10.3390/ijerph18126632.

Alzahrani, H., Mackey, M., Stamatakis, E., Zadro, J.R. and Shirley, D. (2019). The Association between Physical Activity and Low Back pain: a Systematic Review and meta-analysis of Observational Studies. *Scientific Reports*, [online] 9(1). doi:10.1038/s41598-019-44664-8.

Ambrosio, L., Vadalà, G., Russo, F., Papalia, R. and Denaro, V. (2020). The Role of the Orthopaedic Surgeon in the COVID-19 era: Cautions and Perspectives.

Journal of Experimental Orthopaedics, [online] 7(1). doi:10.1186/s40634-020-00255-5.

Amjad, F., Farooq, M.N., Batool, R. and Irshad, A. (2020). Frequency of wrist pain and its associated risk factors in students using mobile phones. *Pakistan Journal of Medical Sciences*, [online] 36(4), pp.746–749. Available at: https://doi.org/10.12669/pjms.36.4.1797 [Accessed 23 Feb. 2022].

Angelone A, M., Mattei, A., Sbarbati, M.M. and Di Orio, F. (2011). Prevalence and correlates for self-reported sleep problems among nursing students. *J Prev Med Hyg*, [online] 52(4), pp.201–8. Available at: https://www.researchgate.net/publication/221971806 [Accessed 23 Feb. 2022].

Anggiat, L., Wan Hazmy Che Hon and Siti Nur Baait (2018). The Prevalence of Low Back Pain among University Students. *Online Journals Universitas Kristen Indonesia*, [online] 4(3), pp.475–485. Available at: https://core.ac.uk/download/pdf/236429585.pdf [Accessed 2 Sep. 2022].

Arora, T. and Grey, I. (2020). Health Behaviour Changes during COVID-19 and the Potential consequences: a mini-review. *Journal of Health Psychology*, [online] 25(9), p.135910532093705. doi:10.1177/1359105320937053.

Arshad, M.A., Shamsudin, M.Z. and Mustafa, M.J.A. (2020). Laptop Use and Upper Extremities Musculoskeletal pain among Higher Learning Students. *MAEH Journal of Environmental Health*, [online] 2(2), pp.1–4. Available at: https://jurnal.maeh4u.org.my/index.php/home/article/view/1 [Accessed 14 Aug. 2022].

Atiković, A., Pavletič, M.S., Kalinski, S.D., Bilalić, J. and Kurt, A. (2017). Prevalence and risk factors of low back pain among undergraduate students in Bosnia and Herzegovina. *Gazzetta Medica Italiana Archivio per le Scienze Mediche*, [online] 176(5). Available at: https://doi.org/10.23736/S0393-3660.16.03371-4 [Accessed 20 Mar. 2022].

Auvinen, J., Tammelin, T., Taimela, S., Zitting, P. and Karppinen, J. (2007). Neck and Shoulder Pain in Relation to Physical Activity and Sedentary Activities in Adolescence. *Spine*, [online] 32(9), pp.1038–1044. doi:10.1097/01.brs.0000261349.94823.c1.

Ayanniyi, O., Mbada, C., Mbada, C.E. and Iroko, O.P. (2010). Neck Pain Occurrence and Characteristics in Nigerian University Undergraduates [Nijeryalı Üniversite Lisans Öğrencilerinde Boyun Ağrısı Gelişimi ve Özellikleri]. *TAF Preventive Medicine Bulletin*, [online] 9(3), pp.167–174. Available at: https://www.bibliomed.org/mnsfulltext/1/khb_009_03-167.pdf?1647779586 [Accessed 20 Mar. 2022].

Ayhualem, S., Alamer, A., Dabi, S.D., Bogale, K.G., Abebe, A.B. and Chala, M.B. (2021). Burden of neck pain and associated factors among smart phone user students in University of Gondar, Ethiopia. *PLOS ONE*, [online] 16(9), p.e0256794. Available at: https://doi.org/10.1371/journal.pone.0256794 [Accessed 20 Mar. 2022].

Azahar, N., 2020. Distant learning a new normal in education. *New Straight Times*, [online] Available at: <https://www.nst.com.my/opinion/letters/2020/04/584165/distant-learning-new-normal-education> [Accessed 13 February 2022].

Azuar, A., 2021. Gadget sales up during lockdown. *The Malaysian Reserve*, [online] Available at: <https://themalaysianreserve.com/2021/09/02/gadget-sales-up-during-lockdown/> [Accessed 12 February 2022].

Bair, M.J., Robinson, R.L., Katon, W. and Kroenke, K. (2003). Depression and Pain Comorbidity. *Archives of Internal Medicine*, [online] 163(20), p.2433. doi:10.1001/archinte.163.20.2433.

Barrett, E. (2016). *Examining the role of thoracic kyphosis in shoulder pain*. [Doctoral Thesis] *Handle.net*, University of Limerick, p.ii. Available at: http://hdl.handle.net/10344/5557 [Accessed 21 Mar. 2022].

Barrett, P.T. and Kline, P. (1981). The Observation to Variable Ratio in Factor Analysis. *Personality Study & Group Behaviour*, 1(1), pp.23–33.

Batham, C. and Yasobant, S. (2016). A risk assessment study on work-related musculoskeletal pain among dentists in Bhopal, India. *Indian Journal of Dental Research*, [online] 27(3), p.236. Available at: https://doi.org/10.4103/0970-9290.186243 [Accessed 21 Mar. 2022].

Bauman, A.E. (2004). Updating the evidence that physical activity is good for health: an epidemiological review 2000–2003. *Journal of Science and Medicine in Sport*, [online] 7(1), pp.6–19. Available at: https://doi.org/10.1016/s1440-2440(04)80273-1 [Accessed 4 Mar. 2022].

Behera, P., Majumdar, A., Revadi, G., Santoshi, J., Nagar, V. and Mishra, N. (2020). Neck pain among undergraduate medical students in a premier institute of central India: A cross-sectional study of prevalence and associated factors. *Journal of Family Medicine and Primary Care*, 9(7), p.3574. doi:10.4103/jfmpc.jfmpc_206_20.

Belakang, S., Risikonya, F., Prasiswazah, K., Kesihatan, S., Nordin, M., Kaur, D., Singh, A. and Kanglun, L. (2014). Low Back Pain and Associated Risk Factors among Health Science Undergraduates. *Sains Malaysiana*, [online] 43(3), pp.423–428. Available at:

http://journalarticle.ukm.my/6928/1/12_Nor_Azlin_Mohd_Nordin.pdf [Accessed 31 Aug. 2022].

Benítez-Porres, J., Delgado, M. and Ruiz, J.R. (2013). Comparison of Physical Activity Estimates Using International Physical Activity Questionnaire (IPAQ) and Accelerometry in Fibromyalgia patients: the Al-Andalus Study. *Journal of Sports Sciences*, [online] 31(16), pp.1741–1752. doi:10.1080/02640414.2013.803594.

Bennett, C., Woodcock, A. and Tien, D. (2006). Ergonomics for Students and Staff. *Safe and Healthy School Environments*, [online] pp.58–77. doi:10.1093/acprof:oso/9780195179477.003.0006.

Bento, T.P.F., Cornelio, G.P., Perrucini, P. de O., Simeão, S.F.A.P., de Conti, M.H.S. and de Vitta, A. (2020). Low Back Pain in Adolescents and Association with Sociodemographic factors, Electronic devices, Physical Activity and Mental Health. *Jornal De Pediatria*, [online] 96(6), pp.717–724. doi:10.1016/j.jped.2019.07.008.

Bergqvist, U., Wolgast, E., Nilsson, B. and Voss, M. (1995a). The influence of VDT work on musculoskeletal pain. *Ergonomics*, [online] 38(4), pp.754–762. Available at: https://doi.org/10.1080/00140139508925147 [Accessed 21 Mar. 2022].

Bergqvist, U., Wolgast, E., Nilsson, B. and Voss, M. (1995b). Musculoskeletal pain among visual display terminal workers: individual, ergonomic, and work organizational factors. *Ergonomics*, [online] 38(4), pp.763–776. Available at: https://doi.org/10.1080/00140139508925148 [Accessed 21 Mar. 2022].

Bernard, B., Sauter, S., Fine, L., Petersen, M. and Hales, T. (1994). Job task and psychosocial risk factors for work-related musculoskeletal pain among newspaper employees. *Scandinavian Journal of Work, Environment & Health*, [online] 20(6), pp.417–426. Available at: https://doi.org/10.5271/sjweh.1379 [Accessed 21 Mar. 2022].

Biddle, S.J., Gorely, T. and Stensel, D.J. (2004). Health-enhancing physical activity and sedentary behaviour in children and adolescents. *Journal of Sports Sciences*, 22(8), pp.679–701.

Bina, E.S., Arash, B., Roghaye, A. and Marziyeh, P. (2013). Prevalence And Risk Factors Of Neck And Shoulder Pain In Medical Students Of Tabriz University Of Medical Sciences. *Medical Journal of Tabriz University of Medical Sciences*, [online] 35, pp.12–17. Available at: https://mj.tbzmed.ac.ir/Article/8574 [Accessed 21 Mar. 2022].

Binder, A.I. (2008). Neck pain. *BMJ Clinical Evidence*, [online] 2008. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2907992/ [Accessed 18 Mar. 2022].

Booth, F.W., Roberts, C.K., Thyfault, J.P., Ruegsegger, G.N. and Toedebusch, R.G. (2017). Role of Inactivity in Chronic Diseases: Evolutionary Insight and Pathophysiological Mechanisms. *Physiological Reviews*, [online] 97(4), pp.1351–1402. Available at: https://doi.org/10.1152/physrev.00019.2016 [Accessed 5 Mar. 2022].

Boström, M., Dellve, L., Thomée, S. and Hagberg, M. (2008). Risk Factors for Generally Reduced Productivity—a Prospective Cohort Study of Young Adults with Neck or upper-extremity Musculoskeletal Symptoms. *Scandinavian Journal of Work, Environment & Health*, [online] 34(2), pp.120–132. doi:10.5271/sjweh.1218.

Brattberg, G. (1994). The prevalence of back pain and headache among Swedish school children. *Quality of Life Research*, [online] 3(S1), pp.S27–S31. Available at: https://doi.org/10.1007/BF00433372 [Accessed 20 Mar. 2022].

Breivik, H., Collett, B., Ventafridda, V., Cohen, R. and Gallacher, D. (2006). Survey of Chronic Pain in Europe: Prevalence, Impact on Daily life, and Treatment. *European Journal of Pain*, [online] 10(4), pp.287–287. doi:10.1016/j.ejpain.2005.06.009.

Briggs, A.M., Straker, L.M., Bear, N.L. and Smith, A.J. (2009). Neck/shoulder Pain in Adolescents Is Not Related to the Level or Nature of self-reported Physical Activity or Type of Sedentary Activity in an Australian Pregnancy Cohort. *BMC Musculoskeletal pain*, [online] 10(1). doi:10.1186/1471-2474-10-87.

Brink, Y., Louw, Q., Grimmer, K. and Jordaan, E. (2015). The relationship between sitting posture and seated-related upper quadrant musculoskeletal pain in computing South African adolescents: A prospective study. *Manual Therapy*, [online] 20(6), pp.820–826. Available at: https://doi.org/10.1016/j.math.2015.03.015 [Accessed 23 Feb. 2022].

Buckle, P.W. and Devereux, J.J. (2002). The nature of work-related neck and upper limb musculoskeletal pain. *Applied Ergonomics*, [online] 33(3), pp.207–217. Available at: https://pubmed.ncbi.nlm.nih.gov/12164505/ [Accessed 4 Mar. 2022].

Buckworth, J. and Nigg, C. (2004). Physical Activity, Exercise, and Sedentary Behavior in College Students. *Journal of American College Health*, [online] 53(1), pp.28–34. Available at: https://doi.org/10.3200/jach.53.1.28-34 [Accessed 30 Mar. 2022].

Bumgardner, W. (2021). *Are You Inactive or Sedentary?* [online] Verywell Fit. Available at: https://www.verywellfit.com/what-is-physical-inactivity-3435077 [Accessed 5 Mar. 2022].

Burgess-Limerick, R., Plooy, A., Fraser, K. and Ankrum, D.R. (1999). The Influence of Computer Monitor Height on Head and Neck Posture. *International Journal of Industrial Ergonomics*, [online] 23(3), pp.171–179. doi:10.1016/s0169-8141(97)00033-4.

Burton, A.K., Clarke, R.D., McClune, T.D. and Tillotson, K.M. (1996). The Natural History of Low Back Pain in Adolescents. *Spine*, [online] 21(20), pp.2323–2328. Available at: https://doi.org/10.1097/00007632-199610150-00004 [Accessed 20 Mar. 2022].

Butterworth, P.A., Landorf, K.B., Smith, S.E. and Menz, H.B. (2012). The association between body mass index and musculoskeletal foot disorders: a systematic review. *Obesity Reviews*, [online] 13(7), pp.630–642. Available at: 10.1111/j.1467-789X.2012.00996.x [Accessed 23 Feb. 2022].

Cagnie, B., Danneels, L., Van Tiggelen, D., De Loose, V. and Cambier, D. (2006). Individual and Work Related Risk Factors for Neck Pain among Office workers: a Cross Sectional Study. *European Spine Journal*, [online] 16(5), pp.679–686. doi:10.1007/s00586-006-0269-7.

Calestine, J., Bopp, M., Bopp, C.M. and Papalia, Z. (2017). College Student Work Habits Are Related to Physical Activity and Fitness. *International Journal of Exercise Science*, [online] 10(7), pp.1009–1017. Available at: https://pubmed.ncbi.nlm.nih.gov/29170702/ [Accessed 20 Aug. 2022].

Callaghan, J.P. and McGill, S.M. (2001). Low back joint loading and kinematics during standing and unsupported sitting. *Ergonomics*, [online] 44(3), pp.280–294. Available at: https://doi.org/10.1080/00140130118276 [Accessed 30 Mar. 2022].

Can, S. and Karaca, A. (2019). Determination of Musculoskeletal System pain, Physical Activity intensity, and Prolonged Sitting of University Students Using Smartphone. *Biomedical Human Kinetics*, [online] 11(1), pp.28–35. doi:10.2478/bhk-2019-0004.

Canizares, M. and Badley, E.M. (2018). Generational differences in patterns of physical activities over time in the Canadian population: an age-period-cohort analysis. *BMC Public Health*, [online] 18(1). Available at: https://doi.org/10.1186/s12889-018-5189-z [Accessed 5 Mar. 2022].

Caromano, F.A., Amorim, C.A.P. de, Rebelo, C. de F., Contesini, A.M., Fávero, F.M., Frutuoso, J.R.C., Kawai, M.M. and Voos, M.C. (2015). Prolonged Sitting and Physical Discomfort in University Students. *Acta Fisiátrica*, [online] 22(4). doi:10.5935/0104-7795.20150034.

Casas S, A.S., Patiño S, M.S. and Camargo L, D.M. (2016). Association between the Sitting Posture and Back Pain in College Students. *Revista de la Universidad Industrial de Santnader. Salud*, [online] 48(4), pp.446–454. doi:10.18273/revsal.v48n4-2016003.

Cascioli, V., Heusch, A.I. and McCarthy, P.W. (2011). Does Prolonged Sitting with Limited Legroom Affect the Flexibility of a Healthy Subject and Their Perception of discomfort? *International Journal of Industrial Ergonomics*, [online] 41(5), pp.471–480. doi:10.1016/j.ergon.2011.06.003.

Caspersen, C.J., Powell, K.E. and Christenson, G.M. (1985). Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public health reports (Washington, D.C. : 1974)*, [online] 100(2), pp.126–31. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1424733/ [Accessed 4 Mar. 2022].

CCOHS (2014). *Work-related Musculoskeletal pain (WMSP)*. [online] Ccohs.ca. Available at: https://www.ccohs.ca/oshanswers/diseases/rmirsi.html [Accessed 20 Mar. 2022].

Chambonniere, C., Lambert, C., Fearnbach, N., Tardieu, M., Fillon, A., Genin, P., Larras, B., Melsens, P., Bois, J., Pereira, B., Tremblay, A., Thivel, D. and Duclos, M. (2021). Effect of the COVID-19 Lockdown on Physical Activity and Sedentary Behaviors in French Children and adolescents: New Results from the ONAPS National Survey. *European Journal of Integrative Medicine*, [online] 43, p.101308. doi:10.1016/j.eujim.2021.101308.

Chan, L.L.Y., Wong, A.Y.L., Wang, M.H., Cheung, K. and Samartzis, D. (2020). The prevalence of neck pain and associated risk factors among undergraduate students: A large-scale cross-sectional study. *International Journal of Industrial Ergonomics*, 76, p.102934.

Chang, C. (Joe), Amick, B.C., Menendez, C.C., Katz, J.N., Johnson, P.W., Robertson, M. and Dennerlein, J.T. (2007). Daily computer usage correlated with undergraduate students' musculoskeletal symptoms. *American Journal of Industrial Medicine*, [online] 50(6), pp.481–488. Available at: https://doi.org/10.1002/ajim.20461 [Accessed 21 Mar. 2022].

Chaput, J.P. and Tremblay, A. (2010). Intelligence and obesity: does the intensity of mental workload matter? *Obesity Reviews*, [online] 11(7), pp.548–549. Available at: https://doi.org/10.1111/j.1467-789X.2010.00730.x [Accessed 5 Mar. 2022].

Chaput, J.P., Drapeau, V., Poirier, P., Teasdale, N. and Tremblay, A. (2008). Glycemic Instability and Spontaneous Energy Intake: Association With Knowledge-Based Work. *Psychosomatic Medicine*, [online] 70(7), pp.797–804. Available at: https://doi.org/10.1097/PSY.0b013e31818426fa [Accessed 5 Mar. 2022].

Chaput, J.P., Visby, T., Nyby, S., Klingenberg, L., Gregersen, N.T., Tremblay, A., Astrup, A. and Sjödin, A. (2011). Video game playing increases food intake in adolescents: a randomized crossover study. *The American Journal of Clinical*

Nutrition, [online] 93(6), pp.1196–1203. Available at: https://doi.org/10.3945/ajcn.110.008680 [Accessed 5 Mar. 2022].

Chastin, S.F.M. and Granat, M.H. (2010). Methods for Objective measure, Quantification and Analysis of Sedentary Behaviour and Inactivity. *Gait & Posture*, [online] 31(1), pp.82–86. doi:10.1016/j.gaitpost.2009.09.002.

Chastin, S.F.M., Ferriolli, E., Stephens, N.A., Fearon, K.C.H. and Greig, C. (2011). Relationship between Sedentary behaviour, Physical activity, Muscle Quality and Body Composition in Healthy Older Adults. *Age and Ageing*, [online] 41(1), pp.111–114. doi:10.1093/ageing/afr075.

Chau, J.Y., Grunseit, A., Midthjell, K., Holmen, J., Holmen, T.L., Bauman, A.E. and Van der Ploeg, H.P. (2013). Sedentary behaviour and risk of mortality from all-causes and cardiometabolic diseases in adults: evidence from the HUNT3 population cohort. *British Journal of Sports Medicine*, [online] 49(11), pp.737–742. Available at: https://bjsm.bmj.com/content/49/11/737 [Accessed 30 Mar. 2022].

Choudhary, M.S.B., Choudary, A.B., Jamal, S., Kumar, R. and Jamal, S. (2020). The Impact of Ergonomics on Children Studying Online during COVID-19 Lockdown. *Hyderabad Spine Clinics*, [online] 500094, pp.36–136. doi:10.36348/jaspe.2020.v03i08.001.

Cleveland Clinic (2014). *Musculoskeletal Pain | Cleveland Clinic*. [online] Cleveland Clinic. Available at: https://my.clevelandclinic.org/health/diseases/14526-musculoskeletal-pain [Accessed 1 Sep. 2022].

Cleveland Clinic (2020). *Musculoskeletal System | Cleveland Clinic*. [online] Cleveland Clinic. Available at: https://my.clevelandclinic.org/health/articles/12254-musculoskeletal-system-normal-structure--function [Accessed 4 Mar. 2022].

Comrey, A.L. and Lee, H.B. (2013). *A First Course in Factor Analysis*. 2nd ed. [online] New York: Psychology Press, p.442. Available at: https://doi.org/10.4324/9781315827506 [Accessed 8 Apr. 2022].

Cooper, K.N., Campbell-Kyureghyan, N.H. and Sommerich, C.M. (2008). *Computer usage and ergonomic risk factors among college students*. [online] *http://www.est.or.th/*, In Proceedings of Southeast Asian Ergonomics Conference, pp.1–9. Available at: http://www.est.or.th/SEAES2008/CD/Engine/C48_Naira%20Campbell%20Kyurehgyan_2.pdf [Accessed 21 Mar. 2022].

Côté, P., van der Velde, G., Cassidy, J.D., Carroll, L.J., Hogg-Johnson, S., Holm, L.W., Carragee, E.J., Haldeman, S., Nordin, M., Hurwitz, E.L., Guzman, J. and

Peloso, P.M. (2009). The Burden and Determinants of Neck Pain in Workers. *Journal of Manipulative and Physiological Therapeutics*, [online] 32(2), pp.S70–S86. Available at: https://doi.org/10.1016/j.jmpt.2008.11.012 [Accessed 21 Mar. 2022].

Croft, P.R., Lewis, M., Papageorgiou, A.C., Thomas, E., Jayson, M.I.V., Macfarlane, G.J. and Silman, A.J. (2001). Risk factors for neck pain: a longitudinal study in the general population. *Pain*, [online] 93(3), pp.317–325. Available at: https://doi.org/10.1016/s0304-3959(01)00334-7 [Accessed 20 Mar. 2022].

Crombie, A.P., Ilich, J.Z., Dutton, G.R., Panton, L.B. and Abood, D.A. (2009). The freshman weight gain phenomenon revisited. *Nutrition Reviews*, [online] 67(2), pp.83–94. Available at: https://doi.org/10.1111/j.1753-4887.2008.00143.x [Accessed 30 Mar. 2022].

Cruder, C., Barbero, M., Koufaki, P., Soldini, E. and Gleeson, N. (2020). Prevalence and associated factors of playing-related musculoskeletal pain among music students in Europe. Baseline findings from the Risk of Music Students (RISMUS) longitudinal multicentre study. *PLOS ONE*, [online] 15(12), p.e0242660. Available at: https://doi.org/10.1371/journal.pone.0258608 [Accessed 22 Feb. 2022].

Curtis, S. (2019). *Neck Pain Symptoms*. [online] Spine-health. Available at: https://www.spine-health.com/conditions/neck-pain/neck-pain-symptoms [Accessed 6 Mar. 2022].

Daher, A. and Halperin, O. (2021a). Association between Psychological Stress and Neck Pain among College Students during the Coronavirus Disease of 2019 Pandemic: a Questionnaire-Based Cross-Sectional Study. *Healthcare*, [online] 9(11), p.1526. doi:10.3390/healthcare9111526.

Daher, A. and Halperin, O. (2021b). The Impact of the COVID-19 Pandemic and Lockdown on Prevalence of and Risk Factors for Neck Pain among College Students: a Cross-sectional Study. *Research Square*. [online] doi:10.21203/rs.3.rs-701878/v1.

Dajpratham, P., Ploypetch, T., Kiattavorncharoen Dds, S., Kiatanant, B. and Dds (2010). Prevalence and Associated Factors of Musculoskeletal Pain among the Dental Personnel in a Dental School. *J Med Assoc Thai*, [online] 93(6). Available at: https://www.thaiscience.info/Journals/Article/JMAT/10657982.pdf [Accessed 23 Feb. 2022].

De Pietro, M.A. (2021). *Why Does My Wrist hurt?* [online] Medicalnewstoday.com. Available at: https://www.medicalnewstoday.com/articles/312070 [Accessed 6 Mar. 2022].

De Vitta, A., Candido, J.P., Bento, T., Cornelio, G.P., Perrucini, P.D.O., Fernandes, J.A.A. and Ramos, W. (2020). Neck pain and factors associated in university students: a cross sectional study. *Ciência em Movimento*, [online] 22(43), p.89. Available at: https://doi.org/10.15602/1983-9480/cm.v22n43p89-101 [Accessed 20 Mar. 2022].

De Vitta, A., Martinez, M.G., Piza, N.T., Simeão, S.F. de A.P. and Ferreira, N.P. (2011). Prevalência e fatores associados à dor lombar em escolares. *Cadernos de Saúde Pública*, 27(8), pp.1520–1528.

De Vitta, A., Trize, D. de M., Fiorelli, A., Carnaz, L., De Conti, M.H.S., Simeão, S.F. de A.P., De Vitta, A., Trize, D. de M., Fiorelli, A., Carnaz, L., De Conti, M.H.S. and Simeão, S.F. de A.P. (2014). Neck/shoulders Pain and Its Relation to the Use of tv/computer/videogame and Physical Activity in School Students from Bauru. *Fisioterapia em Movimento*, [online] 27(1), pp.111–118. doi:10.1590/0103-5150.027.001.AO12.

Deardorff, W. (2019). *Types of Back Pain: Acute Pain, Chronic Pain, and Neuropathic Pain*. [online] Spine-health. Available at: https://www.spine-health.com/conditions/chronic-pain/types-back-pain-acute-pain-chronic-pain-and-neuropathic-pain [Accessed 6 Mar. 2022].

Deivendran Kalirathinam, Manoj Abraham Manoharlal, Mei, C., Ling, C.K., Sheng, T.W.Y., Jerome, A. and US Mahadeva Rao (2017). Association between the usage of Smartphone as the risk factor for the prevalence of upper extremity and neck symptoms among University students: A cross-sectional survey based study. *Research Journal of Pharmacy and Technology*, [online] 10(4), p.1184. Available at: http://dx.doi.org/10.5958/0974-360X.2017.00213.X [Accessed 20 Mar. 2022].

Deliens, T., Deforche, B., De Bourdeaudhuij, I. and Clarys, P. (2015). Determinants of physical activity and sedentary behaviour in university students: a qualitative study using focus group discussions. *BMC Public Health*, [online] 15(1). Available at: https://doi.org/10.1186/s12889-015-1553-4 [Accessed 30 Mar. 2022].

Demyttenaere, K., Bonnewyn, A., Bruffaerts, R., Brugha, T., De Graaf, R. and Alonso, J. (2006). Comorbid Painful Physical Symptoms and depression: Prevalence, Work loss, and Help Seeking. *Journal of Affective Disorders*, [online] 92(2-3), pp.185–193. doi:10.1016/j.jad.2006.01.007.

Demyttenaere, K., Bruffaerts, R., Lee, S., Posada-Villa, J., Kovess, V., Angermeyer, M.C., Levinson, D., de Girolamo, G., Nakane, H., Mneimneh, Z., Lara, C., de Graaf, R., Scott, K.M., Gureje, O., Stein, D.J., Haro, J.M., Bromet, E.J., Kessler, R.C., Alonso, J. and Von Korff, M. (2007). Mental Disorders among Persons with Chronic Back or Neck pain: Results from the World Mental Health Surveys. *PAIN*, [online] 129(3), pp.332–342. doi:10.1016/j.pain.2007.01.022.

DerSarkissian, C. (2021). *Neck Injuries in Sports: What You Should Know*. [online] WebMD. Available at: https://www.webmd.com/pain-management/neck-injuries [Accessed 18 Aug. 2022].

Des Moines University (2011). *Musculoskeletal system diseases - Des Moines University*. [online] Des Moines University. Available at: https://www.dmu.edu/medterms/musculoskeletal-system/musculoskeletal-system-diseases/.

DeYoung, W. and Li, K. (2022). Association of Perceived Stress with Changes in Physical Activity and Sitting Time before and during COVID-19 Pandemic among College Students. *Journal of American College Health*, [online] pp.1–8. doi:10.1080/07448481.2022.2082847.

Dhawan, S., 2020. Online Learning: A Panacea in the Time of COVID-19 Crisis. *Journal of Educational Technology Systems*, [online] 49(1), pp.5-22. Available at: <https://journals.sagepub.com/doi/full/10.1177/0047239520934018> [Accessed 13 February 2022].

Dianat, I., Alipour, A. and Asghari Jafarabadi, M. (2017). Prevalence and Risk Factors of Low Back Pain among School Age Children in Iran. *Health Promotion Perspectives*, [online] 7(4), pp.223–229. doi:10.15171/hpp.2017.39.

Dianat, I., Karimi, M.A., Asl Hashemi, A. and Bahrampour, S. (2013). Classroom furniture and anthropometric characteristics of Iranian high school students: Proposed dimensions based on anthropometric data. *Applied Ergonomics*, [online] 44(1), pp.101–108. Available at: https://doi.org/10.1016/j.apergo.2012.05.004 [Accessed 23 Feb. 2022].

Dianat, I., Sorkhi, N., Pourhossein, A., Alipour, A. and Asghari-Jafarabadi, M. (2014). Neck, Shoulder and Low Back Pain in Secondary Schoolchildren in Relation to Schoolbag carriage: Should the Recommended Weight Limits Be gender-specific? *Applied Ergonomics*, [online] 45(3), pp.437–442. doi:10.1016/j.apergo.2013.06.003.

Diepenmaat, A.C.M. (2006). Neck/Shoulder, Low Back, and Arm Pain in Relation to Computer Use, Physical Activity, Stress, and Depression among Dutch Adolescents. *PEDIATRICS*, [online] 117(2), pp.412–416. doi:10.1542/peds.2004-2766.

Dighriri, Y.H., Akkur, M.A., Alharbi, S.A., Madkhali, N.A., Matabi, K.I. and Mahfouz, M.S. (2019). Prevalence and associated factors of neck, shoulder, and low-back pain among medical students at Jazan University, Saudi Arabia: A cross-sectional study. *Journal of Family Medicine and Primary Care*, [online] 8(12), pp.3826–3831. Available at: https://dx.doi.org/10.4103%2Fjfmpc.jfmpc_721_19 [Accessed 21 Mar. 2022].

Dimate-Garcia, A.E. and Rodríguez-Romero, D.C. (2021). Risk factors associated to musculoskeletal pain perception in college students, Bogota, 2016. *International Journal of Industrial Ergonomics*, [online] 81, p.103010. Available at: https://doi.org/10.1016/j.ergon.2020.103010 [Accessed 21 Mar. 2022].

Dul, J. and Weerdmeester, B. (2003). *Ergonomics For Beginners A Quick Reference Guide, Second Edition*. 2nd ed. London and New York: Crc Press, p.1.

Dzakpasu, F.Q.S., Carver, A., Brakenridge, C.J., Cicuttini, F., Urquhart, D.M., Owen, N. and Dunstan, D.W. (2021). Musculoskeletal Pain and Sedentary Behaviour in Occupational and non-occupational settings: a Systematic Review with meta-analysis. *International Journal of Behavioral Nutrition and Physical Activity*, [online] 18(1). doi:10.1186/s12966-021-01191-y.

Ekelund, U., Brown, W.J., Steene-Johannessen, J., Fagerland, M.W., Owen, N., Powell, K.E., Bauman, A.E. and Lee, I-Min. (2018). Do the associations of sedentary behaviour with cardiovascular disease mortality and cancer mortality differ by physical activity level? A systematic review and harmonised meta-analysis of data from 850 060 participants. *British Journal of Sports Medicine*, 53(14), pp.886–894.

Elgar, F.J., Roberts, C., Moore, L. and Tudor-Smith, C. (2005). Sedentary behaviour, physical activity and weight problems in adolescents in Wales. *Public Health*, 119(6), pp.518–524.

El-Metwally, A., Salminen, J.J., Auvinen, A., Kautiainen, H. and Mikkelsson, M. (2004). Prognosis of non-specific Musculoskeletal Pain in preadolescents: a Prospective 4-year follow-up Study Till Adolescence. *Pain*, [online] 110(3), pp.550–559. doi:10.1016/j.pain.2004.03.021.

Eloi, D.R.L., Quemelo, P.R.V. and Sousa, M.N.A. de (2022). Influence of Physical Activity and Time in the Sitting Position on the Condition of Low Back Pain among University Students. *Coluna/Columna*, [online] 21(1). doi:10.1590/s1808-185120222101253794.

Environmental Health & Safety of Yale University (2018). *Ergonomics: Awkward Posture*. [online] *Yale University*. New Haven, Connecticut: Yale University. Available at: https://ehs.yale.edu/sites/default/files/files/ergo-awkward-posture.pdf [Accessed 7 Sep. 2022].

Faigenbaum, A.D. and Myer, G.D. (2009). Resistance Training among Young athletes: safety, Efficacy and Injury Prevention Effects. *British Journal of Sports Medicine*, [online] 44(1), pp.56–63. doi:10.1136/bjsm.2009.068098.

Fals Martínez, J., González Martínez, F., Orozco Páez, J., Correal Castillo, S.P. and Pernett Gómez, C.V. (2012). Musculoskeletal alterations associated factors physical and environmental in dental students. *Rev Bras Epidemiol*, [online] 15(4), pp.884–895. Available at: https://doi.org/10.1590/S1415-790X2012000400018 [Accessed 23 Feb. 2022].

Fan, W. and Yan, Z. (2010). Factors Affecting Response Rates of the Web Survey: a Systematic Review. *Computers in Human Behavior*, [online] 26(2), pp.132–139. Available at: https://dl.acm.org/doi/10.1016/j.chb.2009.10.015 [Accessed 2 Sep. 2022].

Fares, M.Y., Fares, J., Salhab, H.A., Khachfe, H.H., Bdeir, A. and Fares, Y. (2020). Low Back Pain Among Weightlifting Adolescents and Young Adults. *Cureus*, [online] 12(7). doi:10.7759/cureus.9127.

Fatin Nasuha Abdul Rahim and Shamsul Bahri Mohd Tamrin (2016). Association between Ergonomic Risk Factors and Musculoskeletal Discomfort among the Hostel's Residence of University Putra Malaysia. *Malaysian Journal of Human Factors and Ergonomics*, [online] 1(1), pp.77–85. Available at: https://hfej.hfem.org/wp-content/uploads/2019/03/association-between-ergonomic-risk-factors-and-musculoskeletal-among-the-hostel%e2%80%99s-residence-of-university-putra.pdf [Accessed 21 Mar. 2022].

Fennell, C., Barkley, J.E. and Lepp, A. (2019). The relationship between cell phone use, physical activity, and sedentary behavior in adults aged 18–80. *Computers in Human Behavior*, [online] 90, pp.53–59. Available at: https://doi.org/10.1016/j.chb.2018.08.044 [Accessed 5 Mar. 2022].

Ferrara, M., Langiano, E., Falese, L., Diotaiuti, P., Cortis, C. and De Vito, E. (2022). Changes in Physical Activity Levels and Eating Behaviours during the COVID-19 Pandemic: Sociodemographic Analysis in University Students. *International Journal of Environmental Research and Public Health*, [online] 19(9), p.5550. doi:10.3390/ijerph19095550.

Ferrari, R. and Russell, A.S. (2003). Neck pain. *Best Practice & Research Clinical Rheumatology*, [online] 17(1), pp.57–70. Available at: https://doi.org/10.1016/S1521-6942(02)00097-9 [Accessed 18 Mar. 2022].

Fincham, J.E. (2008). Response Rates and Responsiveness for surveys, standards, and the Journal. *American journal of pharmaceutical education*, [online] 72(2), p.43. doi:10.5688/aj720243.

Fletcher, G.F., Balady, G.J., Amsterdam, E.A., Chaitman, B., Eckel, R., Fleg, J., Froelicher, V.F., Leon, A.S., Piña, I.L., Rodney, R., Simons-Morton, D.A., Williams, M.A. and Bazzarre, T. (2001). Exercise Standards for Testing and Training. *Circulation*, [online] 104(14), pp.1694–1740. Available at: https://doi.org/10.1161/hc3901.095960 [Accessed 4 Mar. 2022].

Fostervold, K.I., Aarås, A. and Lie, I. (2006). Work with Visual Display units: Long-term Health Effects of High and Downward line-of-sight in Ordinary Office

Environments. *International Journal of Industrial Ergonomics*, [online] 36(4), pp.331–343. doi:10.1016/j.ergon.2005.05.003.

Frost, J. (2019). *How to Interpret Regression Models That Have Significant Variables but a Low R-squared - Statistics by Jim*. [online] Statistics By Jim. Available at: https://statisticsbyjim.com/regression/low-r-squared-regression/ [Accessed 31 Aug. 2022].

Gallagher, S. and Heberger, J.R. (2012). Examining the Interaction of Force and Repetition on Musculoskeletal pain Risk. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, [online] 55(1), pp.108–124. Available at: https://doi.org/10.1177/0018720812449648 [Accessed 23 Feb. 2022].

Garber, C.E., Blissmer, B., Deschenes, M.R., Franklin, B.A., Lamonte, M.J., Lee, I-Min., Nieman, D.C. and Swain, D.P. (2011). Quantity and Quality of Exercise for Developing and Maintaining Cardiorespiratory, Musculoskeletal, and Neuromotor Fitness in Apparently Healthy Adults. *Medicine & Science in Sports & Exercise*, [online] 43(7), pp.1334–1359. Available at: https://doi.org/10.1249/MSS.0b013e318213fefb [Accessed 4 Mar. 2022].

Gerr, F., Marcus, M. and Monteilh, C. (2004). Epidemiology of musculoskeletal pain among computer users: lesson learned from the role of posture and keyboard use. *Journal of Electromyography and Kinesiology*, [online] 14(1), pp.25–31. Available at: https://doi.org/10.1016/j.jelekin.2003.09.014 [Accessed 21 Mar. 2022].

Gerr, F., Marcus, M., Ensor, C., Kleinbaum, D., Cohen, S., Edwards, A., Gentry, E., Ortiz, D.J. and Monteilh, C. (2002). A prospective study of computer users: I. Study design and prevalence of musculoskeletal symptoms and disorders. *American Journal of Industrial Medicine*, [online] 41(4), pp.221–235. Available at: https://doi.org/10.1002/ajim.10066 [Accessed 21 Mar. 2022].

Gibson, E., Cairo, A., Räisänen, A., Kuntze, C., Emery, C. and Pasanen, K. (2021). The Epidemiology of sport-related Shoulder Injuries among youth: a Systematic Review. *British Journal of Sports Medicine*, [online] 55(Suppl 1), pp.A37–A37. doi:10.1136/bjsports-2021-IOC.84.

Gorsuch, R.L. (1983). *Factor Analysis*. 2nd ed. Hillsdale, NJ: Lawrence Erlbaum Associates.

Grasdalsmoen, M., Engdahl, B., Fjeld, M.K., Steingrímsdóttir, Ó.A., Nielsen, C.S., Eriksen, H.R., Lønning, K.J. and Sivertsen, B. (2020). Physical exercise and chronic pain in university students. *PLOS ONE*, [online] 15(6), p.e0235419. doi:10.1371/journal.pone.0235419.

Greier, K., Drenowatz, C., Bischofer, T., Petrasch, G., Greier, C., Cocca, A. and Ruedl, G. (2021). Physical Activity and Sitting Time Prior to and during COVID-

19 Lockdown in Austrian high-school Students. *AIMS Public Health*, [online] 8(3), pp.531–540. doi:10.3934/publichealth.2021043.

Grimes, P. and Legg, S. (2004). Musculoskeletal pain (MSD) in School Students as a Risk Factor for Adult MSD: A Review of the Multiple Factors Affecting Posture, Comfort and Health in Classroom Environments. *Journal of the Human-Environment System*, [online] 7(1), pp.1–9. Available at: https://doi.org/10.1618/jhes.7.1 [Accessed 23 Feb. 2022].

Guddal, M.H., Stensland, S.Ø., Småstuen, M.C., Johnsen, M.B., Zwart, J.-A. and Storheim, K. (2017). Physical Activity Level and Sport Participation in Relation to Musculoskeletal Pain in a Population-Based Study of Adolescents. *Orthopaedic Journal of Sports Medicine*, [online] 5(1), p.232596711668554. doi:10.1177/2325967116685543.

Hagströmer, M., Oja, P. and Sjöström, M. (2006). The International Physical Activity Questionnaire (IPAQ): a study of concurrent and construct validity. *Public Health Nutrition*, [online] 9(6), pp.755–762. Available at: https://www.cambridge.org/core/journals/public-health-nutrition/article/international-physical-activity-questionnaire-ipaq-a-study-of-concurrent-and-construct-validity/A78914A4CFE41987A40C122FDF8BE229 [Accessed 30 Mar. 2022].

Hakala, P.T., Saarni, L.A., Punamäki, R.-L., Wallenius, M.A., Nygård, C.-H. and Rimpelä, A.H. (2012). Musculoskeletal symptoms and computer use among Finnish adolescents - pain intensity and inconvenience to everyday life: a cross-sectional study. *BMC Musculoskeletal pain*, 13(1).

Hallman, D.M., Gupta, N., Heiden, M., Mathiassen, S.E., Korshøj, M., Jørgensen, M.B. and Holtermann, A. (2016a). Is Prolonged Sitting at Work Associated with the Time Course of Neck–shoulder pain? a Prospective Study in Danish blue-collar Workers. *BMJ Open*, [online] 6(11), p.e012689. doi:10.1136/bmjopen-2016-012689.

Hallman, D.M., Gupta, N., Mathiassen, S.E. and Holtermann, A. (2015). Association between Objectively Measured Sitting Time and Neck–shoulder Pain among blue-collar Workers. *International Archives of Occupational and Environmental Health*, [online] 88(8), pp.1031–1042. doi:10.1007/s00420-015-1031-4.

Hallman, D.M., Mathiassen, S.E., Heiden, M., Gupta, N., Jørgensen, M.B. and Holtermann, A. (2016b). Temporal patterns of sitting at work are associated with neck–shoulder pain in blue-collar workers: a cross-sectional analysis of accelerometer data in the DPHACTO study. *International Archives of Occupational and Environmental Health*, [online] 89(5), pp.823–833. doi:10.1007/s00420-016-1123-9.

Hamilton, M.T., Hamilton, D.G. and Zderic, T.W. (2004). Exercise Physiology versus Inactivity Physiology: an Essential Concept for Understanding Lipoprotein

Lipase Regulation. *Exercise and Sport Sciences Reviews*, [online] pp.161–166. doi:10.1097/00003677-200410000-00007.

Hansen, B.H., Anderssen, S.A., Andersen, L.B., Hildebrand, M., Kolle, E., Steene-Johannessen, J., Kriemler, S., Page, A.S., Puder, J.J., Reilly, J.J., Sardinha, L.B., van Sluijs, E.M.F., Wedderkopp, N. and Ekelund, U. (2022). Cross-Sectional Associations of Reallocating Time between Sedentary and Active Behaviours on Cardiometabolic Risk Factors in Young People: an International Children's Accelerometry Database (ICAD) Analysis. *Sports Medicine*, [online] 48(10), pp.2401–2412. doi:10.1007/s40279-018-0909-1.

Hanvold, T.N., Veiersted, K.B. and Waersted, M. (2010). A Prospective Study of neck, shoulder, and Upper Back Pain among Technical School Students Entering Working Life. *The Journal of Adolescent Health: Official Publication of the Society for Adolescent Medicine*, [online] 46(5), pp.488–494. doi:10.1016/j.jadohealth.2009.11.200.

Hanvold, T.N., Veiersted, K.B. and Waersted, M. (2010). A Prospective Study of neck, shoulder, and Upper Back Pain among Technical School Students Entering Working Life. *The Journal of Adolescent Health: Official Publication of the Society for Adolescent Medicine*, [online] 46(5), pp.488–494. doi:10.1016/j.jadohealth.2009.11.200.

Haroon, H., Mehmood, S., Imtiaz, F., Ali, S.A. and Sarfraz, M. (2018). Musculoskeletal pain and its associated risk factors among medical students of a public sector University in Karachi, Pakistan. *JPMA. The Journal of the Pakistan Medical Association*, [online] 68(4), pp.682–688. Available at: https://pubmed.ncbi.nlm.nih.gov/29808072/ [Accessed 5 Mar. 2022].

Harreby, M., Neergaard, K., Hesselsôe, G. and Kjer, J. (1995). Are Radiologic Changes in the Thoracic and Lumbar Spine of Adolescents Risk Factors for Low Back Pain in Adults? *Spine*, [online] 20(21), pp.2298–2302. Available at: https://doi.org/10.1097/00007632-199511000-00007 [Accessed 20 Mar. 2022].

Harris, C. and Straker, L. (2000). Survey of physical ergonomics issues associated with school childrens' use of laptop computers. *International Journal of Industrial Ergonomics*, [online] 26(3), pp.337–346. Available at: http://dx.doi.org/10.1016/S0169-8141(00)00009-3 [Accessed 21 Mar. 2022].

Harvard T.H. Chan School of Public Health (2019). *Staying Active*. [online] The Nutrition Source. Available at: https://www.hsph.harvard.edu/nutritionsource/staying-active/ [Accessed 4 Mar. 2022].

Hasan, M.M., Yaqoob, U., Ali, S.S. and Siddiqui, A.A. (2018). Frequency of Musculoskeletal Pain and Associated Factors among Undergraduate Students. *Case Reports in Clinical Medicine*, [online] 07(02), pp.131–145. Available at: https://doi.org/10.4236/crcm.2018.72011 [Accessed 20 Mar. 2022].

Hashim, R., Salah, A., Mayahi, F. and Haidary, S. (2021). Prevalence of postural musculoskeletal symptoms among dental students in United Arab Emirates. *BMC Musculoskeletal pain*, [online] 22(1). Available at: https://doi.org/10.1186/s12891-020-03887-x [Accessed 5 Mar. 2022].

Haskell, W.L., Lee, I-Min., Pate, R.R., Powell, K.E., Blair, S.N., Franklin, B.A., Macera, C.A., Heath, G.W., Thompson, P.D. and Bauman, A. (2007). Physical Activity and Public health: Updated Recommendation for Adults from the American College of Sports Medicine and the American Heart Association. *Medicine & Science in Sports & Exercise*, [online] 39(8), pp.1423–1434. doi:10.1249/mss.0b013e3180616b27.

Hassan, H., 2021. Sales of laptops, tablets and other gadgets surge in Malaysia during ongoing MCO. *The Straight Times*, [online] Available at: <https://www.straitstimes.com/asia/se-asia/sales-of-laptops-tablets-and-other-gadgets-surge-in-malaysia> [Accessed 13 February 2022].

Hatcher, L. (1994). *A step-by-step Approach to Using the SAS System for Factor Analysis and Structural Equation Modeling*. Cary, Nc: Sas Institute.

Health & Safety, University of Stanford (2022). *Microbreaks*. [online] Health & Safety, University of Stanford. Available at: https://ehs.stanford.edu/subtopic/microbreaks [Accessed 7 Sep. 2022].

Healy, G.N., Clark, B.K., Winkler, E.A.H., Gardiner, P.A., Brown, W.J. and Matthews, C.E. (2011a). Measurement of Adults' Sedentary Time in Population-Based Studies. *American journal of preventive medicine*, [online] 41(2), pp.216–227. doi:10.1016/j.amepre.2011.05.005.

Healy, G.N., Matthews, C.E., Dunstan, D.W., Winkler, E.A.H. and Owen, N. (2011b). Sedentary Time and cardio-metabolic Biomarkers in US adults: NHANES 2003–06. *European Heart Journal*, [online] 32(5), pp.590–597. doi:10.1093/eurheartj/ehq451.

Hendi, O.M., Abdulaziz, A.A., Althaqafi, A.M., Hindi, A.M., Khan, S.A. and Atalla, A.A. (2019). Prevalence Of Musculoskeletal pain and Its Correlation To Physical Activity Among Health Specialty Students. *International Journal of Preventive Medicine*, [online] 10(1), p.48. doi:10.4103/2008-7802.257213.

Hendi, O.M., Alturkistani, L.H., Bajaber, A.S., Alhamoud, M.A. and Mahmoud Mahfouz, M.E. (2021). Prevalence of Musculoskeletal pain and Its Relation to Stress among Medical Student at Taif University, Saudi Arabia. *International Journal of Preventive Medicine*, [online] 12, p.98. doi:10.4103/ijpvm.IJPVM_335_20.

Heneweer, H., Vanhees, L. and Picavet, S.J.H. (2009). Physical Activity and Low Back pain: a U-shaped relation? *Pain*, [online] 143(1), pp.21–25. doi:10.1016/j.pain.2008.12.033.

Hermassi, S., Hayes, L.D., Salman, A., Sanal-Hayes, N.E.M., Abassi, E., Al-Kuwari, L., Aldous, N., Musa, N., Alyafei, A., Bouhafs, E.G. and Schwesig, R. (2021). Physical Activity, Sedentary Behavior, and Satisfaction with Life of University Students in Qatar: Changes during Confinement Due to the COVID-19 Pandemic. *Frontiers in Psychology*, [online] 12. doi:10.3389/fpsyg.2021.704562.

Hills, A.P., Mokhtar, N. and Byrne, N.M. (2014). Assessment of Physical Activity and Energy Expenditure: An Overview of Objective Measures. *Frontiers in Nutrition*, [online] 1(5). Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4428382/.

Hodges, C.B., Moore, S., Lockee, B.B., Trust, T. and Bond, M.A. (2020). The Difference Between Emergency Remote Teaching and Online Learning. *vtechworks.lib.vt.edu*. [online] Available at: http://hdl.handle.net/10919/104648 [Accessed 23 Feb. 2022].

Hoving, J.L., de Vet, H.C.W., Twisk, J.W.R., Devillé, W.L.J.M., van der Windt, D., Koes, B.W. and Bouter, L.M. (2004). Prognostic factors for neck pain in general practice. *Pain*, [online] 110(3), pp.639–645. Available at: https://doi.org/10.1016/j.pain.2004.05.002 [Accessed 20 Mar. 2022].

Howard, J. (2022). *Americans at more than 10 hours a day on screens*. [online] CNN. Available at: https://edition.cnn.com/2016/06/30/health/americans-screen-time-nielsen/index.html [Accessed 5 Mar. 2022].

Hoy, D., March, L., Woolf, A., Blyth, F., Brooks, P., Smith, E., Vos, T., Barendregt, J., Blore, J., Murray, C., Burstein, R. and Buchbinder, R. (2014). The global burden of neck pain: estimates from the Global Burden of Disease 2010 study. *Annals of the Rheumatic Diseases*, [online] 73(7), pp.1309–1315. Available at: https://doi.org/10.1136/annrheumdis-2013-204431 [Accessed 20 Mar. 2022].

Hu, F.B. (2003). Sedentary lifestyle and risk of obesity and type 2 diabetes. *Lipids*, [online] 38(2), pp.103–108. Available at: https://doi.org/10.1007/s11745-003-1038-4 [Accessed 30 Mar. 2022].

Huey, T. and Sharmila Gopala Krishna Pillai (2021). Prevalence and Associated Risk Factors of Neck Pain among University Students in Kuantan, Pahang during COVID-19 Pandemic. *Asian Journal of Medicine and Health Sciences*, [online] 4, p.229. Available at: https://www.ajmhsrcmp.org/images/journal/Vol4SupplementIssue1_Oct21/07_PREVALENCE%20AND%20ASSOCIATED%20RISK%20FACTORS%20OF%20NECK%20PAIN%20AMONG%20UNIVERSITY%20STUDENTS%20IN%20KUANTAN%2C%20PAHANG%20DURING%20COVID-

19%20PANDEMIC_AJMHS_Full%20Paper_ICPHS2021.pdf [Accessed 20 Mar. 2022].

Hupert, N., Amick, B.C., Fossel, A.H., Coley, C.M., Robertson, M.M. and Katz, J.N. (2004). Upper extremity musculoskeletal symptoms and functional impairment associated with computer use among college students. *Work (Reading, Mass.)*, [online] 23(2), pp.85–93. Available at: https://pubmed.ncbi.nlm.nih.gov/15502288/ [Accessed 21 Mar. 2022].

IBM (2021). *SPSS Statistics - Overview*. [online] Ibm.com. Available at: https://www.ibm.com/products/spss-statistics [Accessed 9 Apr. 2022].

Imdad, F., Ishaque, F., Yasmeen, S., Lal, W., Sheikh, S.A., Nawaz, U., Fazleazim and Khanzada, S. (2016). Prevalence of Low Back Pain among the Undergraduate Students of Isra University Karachi Campus. *International Journal of Physiotherapy*, [online] 3(1). Available at: https://doi.org/10.15621/ijphy/2016/v3i1/88925 [Accessed 20 Mar. 2022].

Ingraham, S.J. (2003). The Role of Flexibility in Injury Prevention and Athletic performance: Have We Stretched the truth? *Minnesota Medicine*, [online] 86(5), pp.58–61. Available at: https://europepmc.org/article/med/15495679 [Accessed 14 Aug. 2022].

Inoue, M., Iso, H., Yamamoto, S., Kurahashi, N., Iwasaki, M., Sasazuki, S. and Tsugane, S. (2008). Daily Total Physical Activity Level and Premature Death in Men and Women: Results From a Large-Scale Population-Based Cohort Study in Japan (JPHC Study). *Annals of Epidemiology*, [online] 18(7), pp.522–530. Available at: https://doi.org/10.1016/j.annepidem.2008.03.008 [Accessed 30 Mar. 2022].

International Ergonomics Association (2020). *What is Ergonomics?* [online] International Ergonomics Association. Available at: https://iea.cc/what-is-ergonomics/ [Accessed 21 Mar. 2022].

IOMC (2022). *Common Musculoskeletal pain | Medical Journals*. [online] www.iomcworld.org. Available at: https://www.iomcworld.org/medical-journals/common-musculoskeletal-disorders-54158.html [Accessed 1 Sep. 2022].

Iqbal, M., Ahmad, A., Khattak, S., Hammad, S.M., Zeb, G.S. and Daud, M. (2017). Frequency of Low Back Pain in Under Graduate Students of Khyber Medical University: JRCRS. 2017; 5(1): 25-28. *Journal Riphah College of Rehabilitation Sciences*, [online] 5(1), pp.25–28. Available at: https://journals.riphah.edu.pk/index.php/jrcrs/article/view/458/267 [Accessed 23 Feb. 2022].

Isaac, Z. and Dec, K.L. (2020). *UpToDate*. [online] www.uptodate.com. Available at: https://www.uptodate.com/contents/neck-pain-beyond-the-basics [Accessed 18 Aug. 2022].

Issa, L.F., Seleem, N.A., Bakheit, A.M., Baky, A.A. and Alotaibi, A.F. (2016). Low back pain among undergraduate students at Taif University-Saudi Arabia. *www.semanticscholar.org*, [online] 5(6), pp.276–284. Available at: https://www.internationalscholarsjournals.com/articles/low-back-pain-among-undergraduate-students-at-taifuniversity--saudi-arabia.pdf [Accessed 20 Mar. 2022].

Jacobs, K. and Baker, N.A. (2002). The association between children's computer use and musculoskeletal discomfort. *Work (Reading, Mass.)*, [online] 18(3), pp.221–226. Available at: https://pubmed.ncbi.nlm.nih.gov/12441562/ [Accessed 21 Mar. 2022].

Jacobs, K., Johnson, P., Dennerlein, J., Peterson, D., Kaufman, J., Gold, J., Williams, S., Richmond, N., Karban, S., Firn, E., Ansong, E., Hudak, S., Tung, K., Hall, V., Pencina, K. and Pencina, M. (2009). University Students' Notebook Computer Use. *Applied Ergonomics*, [online] 40(3), pp.404–409. doi:10.1016/j.apergo.2008.11.009.

Jahangeer, S., (2020). *How lockdown reveals actual state of e-education in India - ET Government*. [online] ETGovernment.com. Available at: <https://government.economictimes.indiatimes.com/news/education/how-lockdown-reveals-actual-state-of-e-education-in-india/75803841> [Accessed 12 February 2022].

Jahre, H., Grotle, M., Smedbråten, K., Dunn, K.M. and Øiestad, B.E. (2020). Risk factors for non-specific neck pain in young adults. A systematic review. *BMC Musculoskeletal pain*, [online] 21(1). Available at: https://doi.org/10.1186/s12891-020-03379-y [Accessed 20 Mar. 2022].

Jakicic, J.M. and Davis, K.K. (2011). Obesity and Physical Activity. *Psychiatric Clinics of North America*, [online] 34(4), pp.829–840. Available at: https://doi.org/10.1016/j.psc.2011.08.009 [Accessed 30 Mar. 2022].

Jans, M.P., Proper, K.I. and Hildebrandt, V.H. (2007). Sedentary Behavior in Dutch Workers. *American Journal of Preventive Medicine*, [online] 33(6), pp.450–454. doi:10.1016/j.amepre.2007.07.033.

Janwantanakul, P., Pensri, P., Jiamjarasrangsi, W. and Sinsongsook, T. (2009). Associations between Prevalence of Self-reported Musculoskeletal Symptoms of the Spine and Biopsychosocial Factors among Office Workers. *Journal of Occupational Health*, [online] 51(2), pp.114–122. doi:10.1539/joh.l8105.

Johansson, F., Cools, A., Gabbett, T., Fernandez-Fernandez, J. and Skillgate, E. (2021). Association between Spikes in External Training Load and Shoulder Injuries in Competitive Adolescent Tennis Players: the SMASH Cohort Study. *Sports Health: a Multidisciplinary Approach*, [online] 14(1), pp.103–110. doi:10.1177/19417381211051643.

Johnston, V., Souvlis, T., Jimmieson, N.L. and Jull, G. (2008). Associations between Individual and Workplace Risk Factors for self-reported Neck Pain and Disability among Female Office Workers. *Applied Ergonomics*, [online] 39(2), pp.171–182. doi:10.1016/j.apergo.2007.05.011.

Jones, G.T. and Macfarlane, G.J. (2005). Epidemiology of low back pain in children and adolescents. *Archives of Disease in Childhood*, [online] 90(3), pp.312–316. Available at: https://doi.org/10.1136/adc.2004.056812 [Accessed 20 Mar. 2022].

Joshi, O., Chapagain, B., Kharel, G., Poudyal, N.C., Murray, B.D. and Mehmood, S.R. (2020). Benefits and challenges of online instruction in agriculture and natural resource education. *Interactive Learning Environments*, [online] pp.1–12. Available at: https://doi.org/10.1080/10494820.2020.1725896 [Accessed 23 Feb. 2022].

Kaartinen, S., Aaltonen, S., Korhonen, T., Latvala, A., Mikkelsson, M., Kujala, U.M. and Kaprio, J. (2019). Is Diversity of leisure-time Sport Activities Associated with Low Back and Neck–shoulder Region pain? a Finnish Twin Cohort Study. *Preventive Medicine Reports*, [online] 15, p.100933. doi:10.1016/j.pmedr.2019.100933.

Kalatakis-dos-Santos, A.E., Fidelis-de-Paula-Gomes, C.A., Bassi-Dibai, D., Gonçalves, M.C., Martins-de-Sousa, P.H., Pires, F. de O., Almeida, M.Q.G. and Dibai-Filho, A.V. (2019). Correlation between Habitual Physical Activity and Central Sensitization, Pain Intensity, Kinesiophobia, Catastrophizing, and the Severity of Myogenous Temporomandibular Disorder. *Journal of Chiropractic Medicine*, [online] 18(4), pp.299–304. doi:10.1016/j.jcm.2019.07.004.

Kamada, M., Abe, T., Kitayuguchi, J., Imamura, F., Lee, I-Min., Kadowaki, M., Sawada, S.S., Miyachi, M., Matsui, Y. and Uchio, Y. (2016). Dose–response relationship between sports activity and musculoskeletal pain in adolescents. *Pain*, [online] 157(6), pp.1339–1345. doi:10.1097/j.pain.0000000000000529.

Kanchanomai, S., Janwantanakul, P., Pensri, P. and Jiamjarasrangsi, W. (2012). Prevalence of and Factors Associated with Musculoskeletal Symptoms in the Spine Attributed to Computer Use in Undergraduate Students. *Work*, [online] 43(4), pp.497–506. doi:10.3233/wor-2012-1387.

Kanchanomai, S., Janwantanakul, P., Pensri, P. and Jiamjarasrangsi, W. (2011). Risk Factors for the Onset and Persistence of Neck Pain in Undergraduate students: 1-year Prospective Cohort Study. *BMC Public Health*, [online] 11(1). doi:10.1186/1471-2458-11-566.

Kaneshiro, N. (2019). *Screen time and children: MedlinePlus Medical Encyclopedia*. [online] Medlineplus.gov. Available at: https://medlineplus.gov/ency/patientinstructions/000355.htm [Accessed 5 Mar. 2022].

Karingada, K.T. and Sony, M. (2021). Demonstration of the Relationship between MSD and Online Learning during the COVID-19 Pandemic. *Journal of Applied Research in Higher Education*, [online] ahead-of-print(ahead-of-print). doi:10.1108/jarhe-08-2020-0269.

Kasim, M.A.B. and M. H, S.R.B. (2012). Assessment of Quality for Internal Audit functions: a Quest for a Valid and Reliable Instrument. *African Journal of Business Management*, [online] 6(9). Available at: https://doi.org/10.5897/AJBM11.2848 [Accessed 8 Apr. 2022].

Kastelic, K., Pedišić, Ž., Lipovac, D., Kastelic, N., Chen, S.-T. and Šarabon, N. (2021). Associations of meeting 24-h movement guidelines with stress and self-rated health among adults: is meeting more guidelines associated with greater benefits? *BMC Public Health*, 21(1).

Katch, V.L., Mcardle, W.D. and Katch, F.I. (2011). Energy expenditure during rest and physical activity. In: *Essentials of exercise physiology*. [online] Philadelphia: Wolters Kluwer/Lippincott Williams & Wilkins Health, pp.237–262. Available at: https://edisciplinas.usp.br/pluginfile.php/4880617/mod_resource/content/1/Essentials%20of%20Exercise%20Physiology%204a%20ed%20Katch%20McArdle%20Katch.pdf [Accessed 4 Mar. 2022].

Katz, J.N., Amick, B.C., Carroll, B.B., Hollis, C., Fossel, A.H. and Coley, C.M. (2000). Prevalence of upper extremity musculoskeletal pain in college students. *The American Journal of Medicine*, [online] 109(7), pp.586–588. Available at: https://doi.org/10.1016/s0002-9343(00)00538-6 [Accessed 21 Mar. 2022].

Keating, X.D., Guan, J., Piñero, J.C. and Bridges, D.M. (2005). A Meta-Analysis of College Students' Physical Activity Behaviors. *Journal of American College Health*, [online] 54(2), pp.116–126. Available at: https://doi.org/10.3200/jach.54.2.116-126 [Accessed 30 Mar. 2022].

Kędra, A., Kolwicz-Gańko, A., Kędra, P., Bochenek, A. and Czaprowski, D., 2017. Back pain in physically inactive students compared to physical education students with a high and average level of physical activity studying in Poland. *BMC Musculoskeletal pain*, 18(1).

Kędra, A., Plandowska, M., Kędra, P. and Czaprowski, D. (2021). Physical Activity and Low Back Pain in Children and adolescents: a Systematic Review. *European Spine Journal*, [online] 30, pp.946–956. doi:10.1007/s00586-020-06575-5.

Kelly, G., Dockrell, S. and Galvin, R. (2009). Computer use in school: Its effect on posture and discomfort in schoolchildren. *Work*, [online] 32(3), pp.321–328. doi:10.3233/wor-2009-0830.

Kesmodel, U.S. (2018). Cross-sectional Studies - What Are They Good for? *Acta obstetricia et gynecologica Scandinavica*, [online] 97(4), pp.388–393. doi:10.1111/aogs.13331.

Kett, A.R. and Sichting, F. (2020). Sedentary behaviour at work increases muscle stiffness of the back: Why roller massage has potential as an active break intervention. *Applied Ergonomics*, [online] 82, p.102947. Available at: https://www.sciencedirect.com/science/article/pii/S000368701930167X [Accessed 19 Nov. 2019].

Kett, A.R., Milani, T.L. and Sichting, F. (2021). Sitting for Too Long, Moving Too Little: Regular Muscle Contractions Can Reduce Muscle Stiffness During Prolonged Periods of Chair-Sitting. *Frontiers in Sports and Active Living*, [online] 3. Available at: https://doi.org/10.3389/fspor.2021.760533 [Accessed 30 Mar. 2022].

Kikuchi, R., Hirano, T., Watanabe, K., Sano, A., Sato, T., Ito, T., Endo, N. and Tanabe, N. (2019). Gender Differences in the Prevalence of Low Back Pain Associated with Sports Activities in Children and adolescents: a six-year Annual Survey of a Birth Cohort in Niigata City, Japan. *BMC Musculoskeletal pain*, [online] 20(1). doi:10.1186/s12891-019-2707-9.

Kim, R., Wiest, C., Clark, K., Cook, C. and Horn, M. (2018). Identifying Risk Factors for first-episode Neck pain: a Systematic Review. *Musculoskeletal Science and Practice*, [online] 33, pp.77–83. doi:10.1016/j.msksp.2017.11.007.

King, A.C., Powell, K.E. and Kraus, W.E. (2019). The US Physical Activity Guidelines Advisory Committee Report—Introduction. *Medicine & Science in Sports & Exercise,* [online] 51(6), pp.1203–1205. doi:10.1249/mss.0000000000001946.

Kloimüller, I., 2021. *Return to Work After MSD-Related Sick Leave in the Context of Psychosocial Risks at Work.* [ebook] Europe: European Agency for Safety and Health at Work (EUOSHA). Available at: <https://osha.europa.eu/sites/default/files/MSP_Psych_Return_to_work.pdf> [Accessed 13 February 2022].

Knezevic, N.N., Candido, K.D., Vlaeyen, J.W.S., Van Zundert, J. and Cohen, S.P. (2021). Low back pain. *The Lancet*, [online] 398(10294). Available at: https://doi.org/10.1016/S0140-6736(21)00733-9 [Accessed 18 Mar. 2022].

Knight, J.A. (2012). Physical inactivity: Associated Diseases and Disorders. *Annals of clinical and laboratory science*, [online] 42(3), pp.320–337. Available at: https://pubmed.ncbi.nlm.nih.gov/22964623/ [Accessed 5 Mar. 2022].

Koes, B.W., van Tulder, M.W. and Thomas, S. (2006). Diagnosis and treatment of low back pain. *BMJ*, [online] 332(7555), pp.1430–1434. Available at: https://www.bmj.com/content/332/7555/1430 [Accessed 18 Mar. 2022].

Kooijman, M., Swinkels, I., Dijk, C. van, Bakker, D. de and Veenhof, C. (2013). Patients with shoulder syndromes in general and physiotherapy practice: an observational study. *BMC Musculoskeletal pain*, [online] 14(1). Available at: https://doi.org/10.1186/1471-2474-14-128 [Accessed 21 Mar. 2022].

Korovessis, P., Koureas, G. and Papazisis, Z. (2004). Correlation between Backpack Weight and Way of Carrying, Sagittal and Frontal Spinal Curvatures, Athletic Activity, and Dorsal and Low Back Pain in Schoolchildren and Adolescents. *Clinical Spine Surgery*, [online] 17(1), pp.33–40. Available at: https://journals.lww.com/jspinaldisorders/Abstract/2004/02000/Correlation_Between_Backpack_Weight_and_Way_of.8.aspx [Accessed 21 Aug. 2022].

Korovessis, P., Repantis, T. and Baikousis, A. (2010). Factors Affecting Low Back Pain in Adolescents. *Journal of Spinal Disorders & Techniques*, [online] 23(8), pp.513–520. Available at: https://doi.org/10.1097/BSD.0b013e3181bf99c6 [Accessed 20 Mar. 2022].

Koskelo, R., Vuorikari, K. and Hänninen, O. (2007). Sitting and standing postures are corrected by adjustable furniture with lowered muscle tension in high-school students. *Ergonomics*, [online] 50(10), pp.1643–1656. Available at: https://doi.org/10.1080/00140130701587236 [Accessed 23 Feb. 2022].

Kujala, U.M., Taimela, S. and Viljanen, T. (1999). Leisure Physical Activity and Various Pain Symptoms among Adolescents. *British Journal of Sports Medicine*, [online] 33(5), pp.325–328. doi:10.1136/bjsm.33.5.325.

Kumar, R., 2020. Lockdown Is Disrupting a Generation's Education. What Can Be Done?. *The Wire*, [online] Available at: <https://thewire.in/education/coronavirus-lockdown-education-students> [Accessed 13 February 2022].

Kyu, H.H., Bachman, V.F., Alexander, L.T., Mumford, J.E., Afshin, A., Estep, K., Veerman, J.L., Delwiche, K., Iannarone, M.L., Moyer, M.L., Cercy, K., Vos, T., Murray, C.J.L. and Forouzanfar, M.H. (2016). Physical activity and risk of breast cancer, colon cancer, diabetes, ischemic heart disease, and ischemic stroke events: systematic review and dose-response meta-analysis for the Global Burden of Disease Study 2013. *BMJ*, [online] p.i3857. Available at: https://doi.org/10.1136/bmj.i3857 [Accessed 5 Mar. 2022].

Landmark, T., Romundstad, P., Borchgrevink, P.C., Kaasa, S. and Dale, O. (2011). Associations between recreational exercise and chronic pain in the general population: Evidence from the HUNT 3 study. *Pain*, [online] 152(10), pp.2241–2247. doi:10.1016/j.pain.2011.04.029.

Landmark, T., Romundstad, P.R., Borchgrevink, P.C., Kaasa, S. and Dale, O. (2013). Longitudinal Associations between Exercise and Pain in the General Population - The HUNT Pain Study. *PLoS ONE*, [online] 8(6), p.e65279. doi:10.1371/journal.pone.0065279.

Laskowski, E. (2018). *Sitting risks: How harmful is too much sitting?* [online] Mayo Clinic. Available at: https://www.mayoclinic.org/healthy-lifestyle/adult-health/expert-answers/sitting/faq-20058005 [Accessed 30 Mar. 2022].

Ledakis, G.E. and Hewett, T.T. (1999). *Factor Analytic Models of the Mattis Dementia Rating Scale in Dementia of the Alzheimer's Type and Vascular Dementia Patients*. [Thesis/Dissertation] *Open WorldCat*. Available at: https://www.worldcat.org/title/factor-analytic-models-of-the-mattis-dementia-rating-scale-in-dementia-of-the-alzheimers-type-and-vascular-dementia-patients/oclc/45664221 [Accessed 8 Apr. 2022].

Lee, S.H., Son, C., Yeo, S. and Ha, I.H. (2019). Cross-sectional analysis of self-reported sedentary behaviors and chronic knee pain among South Korean adults over 50 years of age in KNHANES 2013-2015. *BMC Public Health*, [online] 19(1). Available at: https://doi.org/10.1186/s12889-019-7653-9 [Accessed 5 Mar. 2022].

Lee, T., 2020. *Malaysian student sits exams in a tree to ensure good wifi*. [online] BBC News. Available at: <https://www.bbc.com/news/blogs-news-from-elsewhere-53079907> [Accessed 13 February 2022].

Lim, C.V., Sharanjit Kaur and Tan, C.L. (2013). *The Prevalence of Low Back Pain and Disability among University Students: a Cross-Sectional Study*. [Thesis] Available at: http://eprints.utar.edu.my/1710/1/Research_Project__The_Prevalence_of_LBP_%26_Disability_among_University_Students_.pdf [Accessed 17 Aug. 2022].

Lim, S., Vos, T., Flaxman, A., Danaei, G., Shibuya, K., Adair-Rohani, H., AlMazroa, M., Amann, M., Anderson, H., Andrews, K., Aryee, et al. 2012. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *The Lancet*, 380(9859), pp.2224-2260.

Long, M.H., Johnston, V. and Bogossian, F. (2012). Work-related upper quadrant musculoskeletal pain in midwives, nurses and physicians: A systematic review of risk factors and functional consequences. *Applied Ergonomics*, [online] 43(3), pp.455–467. Available at: https://doi.org/10.1016/j.apergo.2011.07.002 [Accessed 20 Mar. 2022].

López-Valenciano, A., Suárez-Iglesias, D., Sanchez-Lastra, M.A. and Ayán, C. (2021). Impact of COVID-19 Pandemic on University Students' Physical Activity Levels: an Early Systematic Review. *Frontiers in Psychology*, [online] 11. doi:10.3389/fpsyg.2020.624567.

Lorusso, A., Bruno, S. and L'Abbate, N. (2009). [Musculoskeletal pain among university student computer users]. *La Medicina Del Lavoro*, [online] 100(1), pp.29–34. Available at: https://pubmed.ncbi.nlm.nih.gov/19263870/#:~:text=Neck%20pain%20was%20the%20most [Accessed 5 Mar. 2022].

Lozano, R., Naghavi, M., Foreman, K., Lim, S., Shibuya, K., Aboyans, V., Abraham, J., Adair, T., Aggarwal, R., Ahn, S.Y., AlMazroa, M.A., Alvarado, M., Anderson, H.R., Anderson, L.M., Andrews, K.G., Atkinson, C., Baddour, L.M., Barker-Collo, S., Bartels, D.H. and Bell, M.L. (2012). Global and Regional Mortality from 235 Causes of Death for 20 Age Groups in 1990 and 2010: a Systematic Analysis for the Global Burden of Disease Study 2010. *The Lancet*, [online] 380(9859), pp.2095–2128. doi:10.1016/s0140-6736(12)61728-0.

Lunde, L.-K., Koch, M., Knardahl, S. and Veiersted, K.B. (2017). Associations of objectively measured sitting and standing with low-back pain intensity: a 6-month follow-up of construction and healthcare workers. *Scandinavian Journal of Work, Environment & Health*, [online] 43(3), pp.269–278. Available at: https://www.sjweh.fi/show_abstract.php?abstract_id=3628 [Accessed 30 Mar. 2022].

Mahaba, H.M., Saed, A.E. and Alelyani, M.M. (2017). Probable subjective health hazards of mobile phone. *The Egyptian Journal of Community Medicine*, [online] 35(1), pp.27–38. Available at: https://ejcm.journals.ekb.eg/article_2809_5a323c290dc2502166a9b46af45bd93a.pdf [Accessed 23 Feb. 2022].

Mahajan, S., 2020. Technological, social, pedagogical issues must be resolved for online teaching. *The Indian Express*, [online] Available at: <https://indianexpress.com/article/opinion/columns/india-coronavirus-lockdown-online-education-learning-6383692/> [Accessed 13 February 2022].

Manchikanti, L., Singh, V., Datta, S., Cohen, S.P., Hirsch, J.A. and American Society of Interventional Pain Physicians (2009). Comprehensive Review of epidemiology, scope, and Impact of Spinal Pain. *Pain Physician*, [online] 12(4), pp.E35-70. doi:https://pubmed.ncbi.nlm.nih.gov/19668291/.

Marshall, S.J., Biddle, S.J.H., Gorely, T., Cameron, N. and Murdey, I. (2004). Relationships between media use, body fatness and physical activity in children and youth: a meta-analysis. *International Journal of Obesity*, [online] 28(10), pp.1238–1246. Available at: http://vuir.vu.edu.au/29915/1/Screen%20media%20and%20body%20fat%20meta%20analysis%20(IJO%202004)%20(VU%20IR%2025-1-16).pdf.

Matthews, C.E., George, S.M., Moore, S.C., Bowles, H.R., Blair, A., Park, Y., Troiano, R.P., Hollenbeck, A. and Schatzkin, A. (2012). Amount of time spent in sedentary behaviors and cause-specific mortality in US adults. *The American Journal of Clinical Nutrition*, [online] 95(2), pp.437–445. Available at: https://doi.org/10.3945/ajcn.111.019620 [Accessed 30 Mar. 2022].

Mayo Clinic (2019). *4 Rules for Avoiding Overuse Injuries*. [online] Mayo Clinic. Available at: https://www.mayoclinic.org/healthy-lifestyle/fitness/in-depth/overuse-injury/art-20045875 [Accessed 13 Aug. 2022].

McLean, S.M., May, S., Klaber-Moffett, J., Sharp, D.M. and Gardiner, E. (2010). Risk factors for the onset of non-specific neck pain: a systematic review. *Journal of Epidemiology & Community Health*, [online] 64(7), pp.565–572. Available at: https://pubmed.ncbi.nlm.nih.gov/20466711/ [Accessed 23 Feb. 2022].

Means, B., Toyama, Y., Murphy, R., Bakia, M. and Jones, K. (2011). Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies - ALT Open Access Repository. *Alt.ac.uk*. [online] Available at: https://repository.alt.ac.uk/629/ [Accessed 23 Feb. 2022].

Medline Plus (2021). *Health Risks of an Inactive Lifestyle*. [online] Medlineplus.gov. Available at: https://medlineplus.gov/healthrisksofaninactivelifestyle.html [Accessed 30 Mar. 2022].

Melkevik, O., Torsheim, T., Iannotti, R.J. and Wold, B. (2010). Is spending time in screen-based sedentary behaviors associated with less physical activity: a cross national investigation. *International Journal of Behavioral Nutrition and Physical Activity*, [online] 7(1), p.46. Available at: https://dx.doi.org/10.1186%2F1479-5868-7-46 [Accessed 30 Mar. 2022].

Meyler, Z. (2019). *Cervical Radiculopathy Symptoms*. [online] Spine-health. Available at: https://www.spine-health.com/conditions/neck-pain/cervical-radiculopathy-symptoms [Accessed 1 Sep. 2022].

Mikkelsson, L.O. (2006). Adolescent flexibility, Endurance strength, and Physical Activity as Predictors of Adult Tension neck, Low Back pain, and Knee injury: a 25 Year Follow up Study. *British Journal of Sports Medicine*, [online] 40(2), pp.107–113. doi:10.1136/bjsm.2004.017350.

Miller, Y.D. (2010). Psychological Determinants and Outcomes of Sedentary and Physical Activity Behaviours. *International Journal of Behavioral Medicine*, [online] 17(4), pp.243–245. Available at: https://doi.org/10.1007/s12529-010-9115-8 [Accessed 30 Mar. 2022].

Ministry of Health of Malaysia (2010). *Malaysian Dietary Guidelines*. [online] Kuala Lumpur: National Coordinating Committee On Food And Nutrition, Ministry Of Health Malaysia, pp.38–62. Available at:

https://www.moh.gov.my/moh/images/gallery/Garispanduan/diet/KM3.pdf [Accessed 4 Mar. 2022].

Misailidou, V., Malliou, P., Beneka, A., Karagiannidis, A. and Godolias, G. (2010). Assessment of patients with neck pain: a review of definitions, selection criteria, and measurement tools. *Journal of Chiropractic Medicine*, [online] 9(2), pp.49–59. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2943658/#bib28 [Accessed 18 Mar. 2022].

Mitchell, C., Adebajo, A., Hay, E. and Carr, A. (2005). Shoulder pain: diagnosis and management in primary care. *BMJ*, [online] 331(7525), pp.1124–1128. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1283277/ [Accessed 18 Mar. 2022].

Moley, P.J. (2020a). *Low Back Pain*. [online] MSD Manual Consumer Version. Available at: https://www.msdmanuals.com/home/bone,-joint,-and-muscle-disorders/low-back-and-neck-pain/low-back-pain [Accessed 6 Mar. 2022].

Moley, P.J. (2020b). *Neck Pain*. [online] MSD Manual Consumer Version. Available at: https://www.msdmanuals.com/home/bone,-joint,-and-muscle-disorders/low-back-and-neck-pain/neck-pain [Accessed 6 Mar. 2022].

Moodley, M., Ismail, F. and Kriel, A. (2020). Work-related musculoskeletal pain amongst undergraduate nursing students at the University of Johannesburg. *Health SA Gesondheid*, [online] 25(0). Available at: . https://doi. org/10.4102/hsag.v25i0.1460 [Accessed 22 Feb. 2022].

Morais, B.X., Dalmolin, G. de L., Andolhe, R., Dullius, A.I. dos S. and Rocha, L.P. (2019). Musculoskeletal pain in undergraduate health students: prevalence and associated factors. *Revista da Escola de Enfermagem da USP*, [online] 53, p.e03444. doi:10.1590/s1980-220x2018014403444.

Moreno-Betancur, M., Koplin, J.J., Ponsonby, A.-L., Lynch, J. and Carlin, J.B. (2018). Measuring the impact of differences in risk factor distributions on cross-population differences in disease occurrence: a causal approach. *International Journal of Epidemiology*, [online] 47(1), pp.217–225. Available at: https://doi.org/10.1093/ije/dyx194 [Accessed 20 Mar. 2022].

Morris, J.N., Heady, J.A., Raffle, P.A.B., Roberts, C.G. and Parks, J.W. (1953). CORONARY HEART-DISEASE AND PHYSICAL ACTIVITY OF WORK. *The Lancet*, [online] 262(6795), pp.1053–1057. Available at: https://pubmed.ncbi.nlm.nih.gov/13110049/ [Accessed 4 Mar. 2022].

Mowatt, L., Gordon, C., Santosh, A.B.R. and Jones, T. (2017). Computer vision syndrome and ergonomic practices among undergraduate university students. *International Journal of Clinical Practice*, [online] 72(1), p.e13035. Available at: https://doi.org/10.1111/ijcp.13035 [Accessed 5 Mar. 2022].

Mulroy, S.J., Hatchett, P., Eberly, V.J., Lighthall Haubert, L., Conners, S. and Requejo, P.S. (2015). Shoulder Strength and Physical Activity Predictors of Shoulder Pain in People with Paraplegia from Spinal Injury: Prospective Cohort Study. *Physical Therapy*, [online] 95(7), pp.1027–1038. doi:10.2522/ptj.20130606.

Murphy, R.J. and Carr, A.J. (2010). Shoulder pain. *BMJ clinical evidence*, [online] 2010, p.1107. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3217726/ [Accessed 18 Mar. 2022].

Murray, C.J.L., Vos, T., Lozano, R., Naghavi, M., Flaxman, A.D., Michaud, C., Ezzati, M., Shibuya, K., Salomon, J.A., Abdalla, S., Aboyans, V., Abraham, J., Ackerman, I., Aggarwal, R., Ahn, S.Y., Ali, M.K., AlMazroa, M.A., Alvarado, M., Anderson, H.R. and Anderson, L.M. (2012). Disability-adjusted Life Years (DALYs) for 291 Diseases and Injuries in 21 regions, 1990–2010: a Systematic Analysis for the Global Burden of Disease Study 2010. *The Lancet*, [online] 380(9859), pp.2197–2223. doi:10.1016/s0140-6736(12)61689-4.

Musculoskeletal Australia (MSK) (2018). *Shoulder Pain — Symptoms, Causes, & Treatment | MSK Australia*. [online] Musculoskeletal Australia (MSK). Available at: https://msk.org.au/shoulder-pain/ [Accessed 6 Mar. 2022].

Must, A. and Tybor, D.J. (2005). Physical activity and sedentary behavior: a review of longitudinal studies of weight and adiposity in youth. *International Journal of Obesity*, [online] 29(S2), pp.S84–S96. Available at: https://doi.org/10.1038/sj.ijo.0803064 [Accessed 30 Mar. 2022].

Nadiah Zamlus (2021). *MBPJ: Public parks, Educational Forest Closed during MCO*. [online] Selangor Journal. Available at: https://selangorjournal.my/2021/01/mbpj-public-parks-educational-forest-closed-during-mco/ [Accessed 20 Aug. 2022].

Namwongsa, S., Puntumetakul, R., Neubert, M.S. and Boucaut, R. (2018). Factors associated with neck disorders among university student smartphone users. *Work*, [online] 61(3), pp.367–378. Available at: https://content.iospress.com/articles/work/wor182819 [Accessed 21 Mar. 2022].

Nayak, B.K. (2010). Understanding the Relevance of Sample Size Calculation. *Indian Journal of Ophthalmology*, [online] 58(6), p.469. doi:10.4103/0301-4738.71673.

Nelson, M.E., Rejeski, W.J., Blair, S.N., Duncan, P.W., Judge, J.O., King, A.C., Macera, C.A. and Castaneda-Sceppa, C. (2007). Physical Activity and Public Health in Older Adults. *Medicine & Science in Sports & Exercise*, [online] 39(8), pp.1435–1445. Available at: https://journals.lww.com/acsm-msse/Fulltext/2007/08000/Physical_Activity_and_Public_Health_in_Older.28.aspx [Accessed 30 Mar. 2022].

Ng, A., Hayes, M. and Polster, A. (2016). Musculoskeletal pain and Working Posture among Dental and Oral Health Students. *Healthcare*, [online] 4(1), p.13. doi:10.3390/healthcare4010013.

Nicot, A.M. (2008). *Women More at Risk of Musculoskeletal pain*. [online] Eurofound. Available at: https://www.eurofound.europa.eu/publications/article/2008/women-more-at-risk-of-musculoskeletal-disorders [Accessed 17 Aug. 2022].

NIOSH (1997). *Musculoskeletal pain and workplace factors. A critical review of epidemiologic evidence for work-related musculoskeletal pain of the neck, upper extremity, and low back.* [online] *U.S. Department of Health & Human Services*. United States of America: Centers for Disease Control and Prevention | National Institute for Occupational Safety and Health. Available at: https://www.cdc.gov/niosh/docs/97-141/pdfs/97-141.pdf?id=10.26616/NIOSHPUB97141 [Accessed 21 Mar. 2022].

Noack, K.L. (2003). *College Student Computer Use and Ergonomics*. [MS Thesis] Available at: http://www.lib.ncsu.edu/resolver/1840.16/2808 [Accessed 21 Mar. 2022].

Noack-Cooper, K.L., Sommerich, C.M. and Mirka, G.A. (2009). College students and computers: Assessment of usage patterns and musculoskeletal discomfort. *Work*, [online] 32(3), pp.285–298. Available at: https://doi.org/10.3233/wor-2009-0827 [Accessed 21 Mar. 2022].

Noor Sam Ahmad, Asma Alhusna Abang Abdullah, Ooi, K.T. and Teong, L.X. (2020). *Musculoskeletal pain Among Dental Students*. [online] *Journal of Research in Medical and Dental Science*, pp.32–38. Available at: https://www.jrmds.in/articles/musculoskeletal-disorders-among-dental-students.pdf [Accessed 22 Feb. 2022].

Nor Azlin, Ajit Singh, D.K. and Lim, K. (2014). Low Back Pain and Associated Risk Factors among Health Science Undergraduates. *Sains Malaysiana*, [online] 43(3), pp.423–428. Available at: http://journalarticle.ukm.my/6928/1/12_Nor_Azlin_Mohd_Nordin.pdf [Accessed 17 Aug. 2022].

Nor Suzila, Izatul Farrita and Nor Atiqah (2021). A Conceptual Framework of Ergonomic Risks among Higher Education Lecturers While Working from Home during the COVID-19 Pandemic Crisis. *International Journal of Academic Research in Business and Social Sciences*, [online] 11(9). doi:10.6007/ijarbss/v11-i9/11068.

Noreen, K., Ali, K., Aftab, K. and Umar, M. (2020). Computer Vision Syndrome (CVS) and its Associated Risk Factors among Undergraduate Medical Students in Midst of COVID-19. *Pakistan Journal of Ophthalmology*, [online] 37(1).

Available at: https://pjo.org.pk/index.php/pjo/article/view/1124 [Accessed 21 Mar. 2022].

Noreen, K., Batool, Z., Fatima, T. and Zamir, T. (2016). Prevalence of Computer Vision Syndrome and Its Associated Risk Factors among Under Graduate Medical Students of Urban Karachi. *Pakistan Journal of Ophthalmology*, [online] 32(3). Available at: https://doi.org/10.36351/pjo.v32i3.106 [Accessed 21 Mar. 2022].

Obembe, A.O., Johnson, O.E., Tanimowo, T.O., Onigbinde, A.T. and Emechete, A.A. (2013). Musculoskeletal pain among undergraduate laptop users in a Nigerian University. *Journal of Back and Musculoskeletal Rehabilitation*, [online] 26(4), pp.389–395. Available at: https://doi.org/10.3233/BMR-130397 [Accessed 5 Mar. 2022].

Ogunlana, M.O., Govender, P. and Oyewole, O.O. (2021). Prevalence and patterns of musculoskeletal pain among undergraduate students of occupational therapy and physiotherapy in a South African university. *Hong Kong Physiotherapy Journal: Official Publication of the Hong Kong Physiotherapy Association Limited = Wu Li Chih Liao*, [online] 41(1), pp.35–43. Available at: https://dx.doi.org/10.1142%2FS1013702521500037 [Accessed 5 Mar. 2022].

Ohayon, M.M. (2004). Specific Characteristics of the pain/depression Association in the General Population. *The Journal of Clinical Psychiatry*, [online] 65 Suppl 12, pp.5–9. Available at: https://pubmed.ncbi.nlm.nih.gov/15315471/ [Accessed 21 Aug. 2022].

Ohayon, M.M. and Schatzberg, A.F. (2003). Using Chronic Pain to Predict Depressive Morbidity in the General Population. *Archives of General Psychiatry*, [online] 60(1), p.39. doi:10.1001/archpsyc.60.1.39.

Ortiz-Hernández, L., Tamez-González, S., Martínez-Alcántara, S. and Méndez-Ramírez, I. (2003). Computer Use Increases the Risk of Musculoskeletal pain among Newspaper Office Workers. *Archives of Medical Research*, [online] 34(4), pp.331–342. doi:10.1016/S0188-4409(03)00053-5.

Osama, M., Ali, S. and Malik, R.J. (2018). Posture related musculoskeletal discomfort and its association with computer use among university students. *JPMA. The Journal of the Pakistan Medical Association*, [online] 68(4), pp.639–641. Available at: https://pubmed.ncbi.nlm.nih.gov/29808057/ [Accessed 21 Mar. 2022].

Osborne, J.W. and Costello, A.B. (2004). Sample Size and Subject to Item Ratio in Principal Components Analysis. *Journal of Biometrics & Biostatistics*, [online] 01(02). Available at: https://doi.org/10.7275/ktzq-jq66 [Accessed 8 Apr. 2022].

OSHA (2018). *Identifying and Addressing Ergonomic Hazards Workbook Midwest Worker Center Ergonomic Training Project*. [online] *Occupational Safety and*

Health Administration. United States: U.S. Department of Labor. Available at: https://www.osha.gov/sites/default/files/2018-12/fy15_sh-27643-sh5_ErgonomicsWorkbook.pdf [Accessed 23 Feb. 2022].

Østerås, N., Elisabeth Ljunggren, A., Gould, K.S., Wærsted, M. and Bo Veiersted, K. (2006). Muscle pain, Physical activity, self-efficacy and Relaxation Ability in Adolescents. *Advances in Physiotherapy*, [online] 8(1), pp.33–40. doi:10.1080/14038190600565093.

Øverås, C.K., Villumsen, M., Axén, I., Cabrita, M., Leboeuf-Yde, C., Hartvigsen, J. and Mork, P.J. (2020). Association between Objectively Measured Physical Behaviour and Neck- and/or Low Back pain: a Systematic Review. *European Journal of Pain*, [online] 24(6), pp.1007–1022. doi:10.1002/ejp.1551.

Owen, N., Healy, G.N., Matthews, C.E. and Dunstan, D.W. (2010). Too Much Sitting. *Exercise and Sport Sciences Reviews*, [online] 38(3), pp.105–113. Available at: https://doi.org/10.1097/jes.0b013e3181e373a2 [Accessed 30 Mar. 2022].

Owen, N., Leslie, E., Salmon, J. and Fotheringham, M.J. (2000). Environmental determinants of physical activity and sedentary behavior. *Exercise and Sport Sciences Reviews*, [online] 28(4), pp.153–158. Available at: https://pubmed.ncbi.nlm.nih.gov/11064848/ [Accessed 30 Mar. 2022].

Padmanathan, V., Joseph, L., Omar, B. and Nawawi, R. (2016). Prevalence of musculoskeletal pain and related occupational causative factors among electricity linemen: A narrative review. *International Journal of Occupational Medicine and Environmental Health*, [online] 29(5), pp.725–734. Available at: https://doi.org/10.13075/ijomeh.1896.00659 [Accessed 21 Mar. 2022].

Pais, V., Meman, S. and Kalal, B. (2017). Physical risk factors for low back pain among young sedentary individuals - A prospective study. *Indian Journal of Pain*, [online] 31(3), p.157. Available at: https://www.indianjpain.org/text.asp?2017/31/3/157/223666 [Accessed 20 Mar. 2022].

Park, D.K. and Rodway, I. (2020). *Cervical Radiculopathy (Pinched Nerve) - OrthoInfo - AAOS*. [online] www.orthoinfo.org. Available at: https://orthoinfo.aaos.org/en/diseases--conditions/cervical-radiculopathy-pinched-nerve/ [Accessed 1 Sep. 2022].

Park, J.H., Moon, J.H., Kim, H.J., Kong, M.H. and Oh, Y.H. (2020). Sedentary Lifestyle: Overview of Updated Evidence of Potential Health Risks. *Korean Journal of Family Medicine*, [online] 41(6), pp.365–373. Available at: https://doi.org/10.4082/kjfm.20.0165 [Accessed 5 Mar. 2022].

Pate, R.R., O'Neill, J.R. and Lobelo, F. (2008). The Evolving Definition of 'Sedentary'. *Exercise and Sport Sciences Reviews*, [online] 36(4), pp.173–178. doi:10.1097/jes.0b013e3181877d1a.

Patel, D.R. and Breisach, S. (2017). Evaluation and Management of Shoulder Pain in Skeletally Immature Athletes. *Translational Pediatrics*, [online] 6(3), pp.18189–18189. doi:https://doi.org/10.21037%2Ftp.2017.04.06.

Pavey, T.G., Peeters, G. (Geeske) and Brown, W.J. (2012). Sitting-time and 9-year all-cause mortality in older women. *British Journal of Sports Medicine*, [online] 49(2), pp.95–99. Available at: https://bjsm.bmj.com/content/49/2/95 [Accessed 30 Mar. 2022].

Pellisé, F., Balagué, F., Rajmil, L., Cedraschi, C., Aguirre, M., Fontecha, C.G., Pasarín, M. and Ferrer, M. (2009). Prevalence of Low Back Pain and Its Effect on Health-Related Quality of Life in Adolescents. *Archives of Pediatrics & Adolescent Medicine*, [online] 163(1), p.65. Available at: https://doi.org/10.1001/archpediatrics.2008.512 [Accessed 20 Mar. 2022].

Peloza, J. (2017). *Lower Back Pain Symptoms, Diagnosis, and Treatment*. [online] Spine-health. Available at: https://www.spine-health.com/conditions/lower-back-pain/lower-back-pain-symptoms-diagnosis-and-treatment [Accessed 6 Mar. 2022].

Peterson, G. and Pihlström, N. (2021). Factors Associated with Neck and Shoulder pain: a cross-sectional Study among 16,000 Adults in Five County Councils in Sweden. *BMC Musculoskeletal pain*, [online] 22(1), p.872. doi:10.1186/s12891-021-04753-0.

Pirnes, K.P., Kallio, J., Hakonen, H., Hautala, A., Häkkinen, A.H. and Tammelin, T. (2022). Physical activity, Screen Time and the Prevalence of Neck and Shoulder Pain in school-aged Children. *Scientific Reports*, [online] 12(1), p.10635. doi:10.1038/s41598-022-14612-0.

Pleis, J.R., Lucas, J.W. and Ward, B.W. (2009). Summary health statistics for U.S. adults: National Health Interview Survey, 2008. *Vital and health statistics. Series 10, Data from the National Health Survey*, [online] (242), pp.1–157. Available at: https://pubmed.ncbi.nlm.nih.gov/20821903/ [Accessed 5 Mar. 2022].

Prime Minister's Office of Malaysia Official Website. 2020. *Restriction of Movement Order - Prime Minister's Office of Malaysia*. [online] Available at: <https://www.pmo.gov.my/2020/03/movement-control-order/> [Accessed 12 February 2022].

Punnett, L. (2014). Musculoskeletal pain and occupational exposures: How should we judge the evidence concerning the causal association? *Scandinavian Journal of*

Public Health, [online] 42(13_suppl), pp.49–58. Available at: https://doi.org/10.1177/1403494813517324 [Accessed 21 Mar. 2022].

Queiroz, L., Lourenço, B., Silva, L., Lourenço, D. and Silva, C., 2018. Musculoskeletal pain and musculoskeletal syndromes in adolescents are related to electronic devices. *Jornal de Pediatria*, [online] 94(6), pp.673-679. Available at: <https://www.sciencedirect.com/science/article/pii/S002175571730565X?via%3Dihub> [Accessed 13 February 2022].

Rakhadani, P.B., Goon, D.T. and Mandeya, A. (2017). Musculoskeletal Problems Associated with University Students Computer Users: A Cross-Sectional Study. *Online Journal of Health and Allied Sciences*, [online] 16(2). Available at: http://www.ojhas.org/issue62/2017-2-7.html [Accessed 21 Mar. 2022].

Rebecca, W., J., J., J., B., N., P., A., S. and R., S. (2018). How do ergonomic factors affect students' online learning in tertiary education? *World safety Journal*, [online] 17(2). Available at: http://hdl.handle.net/20.500.11937/74231 [Accessed 21 Mar. 2022].

Rechardt, M., Shiri, R., Karppinen, J., Jula, A., Heliövaara, M. and Viikari-Juntura, E. (2010). Lifestyle and metabolic factors in relation to shoulder pain and rotator cuff tendinitis: A population-based study. *BMC Musculoskeletal pain*, [online] 11(1). Available at: https://bmcmusculoskeletdisord.biomedcentral.com/articles/10.1186/1471-2474-11-165 [Accessed 18 Mar. 2022].

Reddy, S.C., Low, C., Lim, Y., Low, L., Mardina, F. and Nursaleha, M. (2013). Computer vision syndrome: a study of knowledge and practices in university students. *Nepalese Journal of Ophthalmology*, [online] 5(2), pp.161–168. doi:10.3126/nepjoph.v5i2.8707.

Renninger, M., Hansen, B.H., Steene-Johannessen, J., Kriemler, S., Froberg, K., Northstone, K., Sardinha, L., Anderssen, S.A., Andersen, L.B. and Ekelund, U. (2019). Associations between Accelerometry Measured Physical Activity and Sedentary Time and the Metabolic syndrome: a Meta-analysis of More than 6000 Children and Adolescents. *Pediatric Obesity*, [online] 15(1). doi:10.1111/ijpo.12578.

Rizal, D.M. and Wibowo, R.A. (2022). *View of Changes in Physical Activity among University Students in Indonesia from before to during the COVID-19 Pandemic: a Retrospective Cohort Study*. [online] Tci-thaijo.org. Available at: https://so03.tci-thaijo.org/index.php/jpss/article/view/256641/170906 [Accessed 18 Aug. 2022].

Roberts, J., Yaya, L. and Manolis, C. (2014). The invisible addiction: Cell-phone activities and addiction among male and female college students. *Journal of Behavioral Addictions*, [online] 3(4), pp.254–265. Available at: https://doi.org/10.1556/JBA.3.2014.015 [Accessed 5 Mar. 2022].

Rodríguez-Larrad, A., Mañas, A., Labayen, I., González-Gross, M., Espin, A., Aznar, S., Serrano-Sánchez, J.A., Vera-Garcia, F.J., González-Lamuño, D., Ara, I., Carrasco-Páez, L., Castro-Piñero, J., Gómez-Cabrera, M.C., Márquez, S., Tur, J.A., Gusi, N., Benito, P.J., Moliner-Urdiales, D., Ruiz, J.R. and Ortega, F.B. (2021). Impact of COVID-19 Confinement on Physical Activity and Sedentary Behaviour in Spanish University Students: Role of Gender. *International Journal of Environmental Research and Public Health*, [online] 18(2). doi:10.3390/ijerph18020369.

Rodríguez-Romero, B., Pérez-Valiño, C., Ageitos-Alonso, B. and Pértega-Díaz, S. (2016). Prevalence and Associated Factors for Musculoskeletal Pain and Disability Among Spanish Music Conservatory Students. *Medical Problems of Performing Artists*, [online] 31(4), pp.193–200. doi:10.21091/mppa.2016.4035.

Roggio, F., Trovato, B., Ravalli, S., Di Rosa, M., Maugeri, G., Bianco, A., Palma, A. and Musumeci, G. (2021). One Year of COVID-19 Pandemic in Italy: Effect of Sedentary Behavior on Physical Activity Levels and Musculoskeletal Pain among University Students. *International Journal of Environmental Research and Public Health*, [online] 18(16), p.8680. doi:10.3390/ijerph18168680.

Romaguera, D., Tauler, P., Bennasar, M., Pericas, J., Moreno, C., Martinez, S. and Aguilo, A. (2011). Determinants and patterns of physical activity practice among Spanish university students. *Journal of Sports Sciences*, [online] 29(9), pp.989–997. Available at: https://doi.org/10.1080/02640414.2011.578149 [Accessed 30 Mar. 2022].

Romero-Blanco, C., Rodríguez-Almagro, J., Onieva-Zafra, M.D., Parra-Fernández, M.L., Prado-Laguna, M. del C. and Hernández-Martínez, A. (2020). Physical Activity and Sedentary Lifestyle in University Students: Changes during Confinement Due to the COVID-19 Pandemic. *International Journal of Environmental Research and Public Health*, [online] 17(18), p.6567. doi:10.3390/ijerph17186567.

Ross, R., Chaput, J.-P., Giangregorio, L.M., Janssen, I., Saunders, T.J., Kho, M.E., Poitras, V.J., Tomasone, J.R., El-Kotob, R., McLaughlin, E.C., Duggan, M., Carrier, J., Carson, V., Chastin, S.F., Latimer-Cheung, A.E., Chulak-Bozzer, T., Faulkner, G., Flood, S.M., Gazendam, M.K. and Healy, G.N. (2020). Canadian 24-Hour Movement Guidelines for Adults aged 18–64 years and Adults aged 65 years or older: an integration of physical activity, sedentary behaviour, and sleep. *Applied Physiology, Nutrition, and Metabolism*, [online] 45(10 (Suppl. 2)), pp.S57–S102. Available at: https://doi.org/10.1139/apnm-2020-0467 [Accessed 29 Mar. 2022].

Rossi, M., Pasanen, K., Kokko, S., Alanko, L., Heinonen, O.J., Korpelainen, R., Savonen, K., Selänne, H., Vasankari, T., Kannas, L., Kujala, U., Villberg, J. and Parkkari, J. (2016). Low Back and Neck and Shoulder Pain in Members and non-members of Adolescents' Sports clubs: the Finnish Health Promoting Sports Club

(FHPSC) Study. *BMC Musculoskeletal pain*, [online] 17(1). doi:10.1186/s12891-016-1114-8.

Rouse, P.C. and Biddle, S.J.H. (2010). An ecological momentary assessment of the physical activity and sedentary behaviour patterns of university students. *Health Education Journal*, [online] 69(1), pp.116–125. Available at: https://doi.org/10.1177%2F0017896910363145 [Accessed 30 Mar. 2022].

S, P.V., F, M.M. and V, N.R. (2016). A Cross- Sectional Observational Study on the Prevalence of Mechanical Low Back Pain in Physiotherapy Students: *National Journal of Integrated Research in Medicine*, [online] 7(6), pp.9–12. Available at: http://nicpd.ac.in/ojs-/index.php/njirm/article/view/1384 [Accessed 17 Aug. 2022].

Sagát, P., Bartík, P., Prieto González, P., Tohănean, D. and Knjaz, D., 2020. Impact of COVID-19Quarantine on Low Back Pain Intensity, Prevalence, and Associated Risk Factors among Adult Citizens Residing in Riyadh (Saudi Arabia): A Cross-Sectional Study. *International Journal of Environmental Research and Public Health*, [online] 17(19), p.7302. Available at: <https://www.mdpi.com/1660-4601/17/19/7302> [Accessed 13 February 2022].

Salameh, M.A., Boyajian, S.D., Odeh, H.N., Amaireh, E.A., Funjan, K.I. and Al-Shatanawi, T.N. (2022). Increased Prevalence of Musculoskeletal Pain in Medical Students during Distance Learning Necessitated by the COVID-19 Pandemic. *Clinical Anatomy*, [online] 35(4), pp.529–536. doi:10.1002/ca.23851.

Salmon, J., Owen, N., Crawford, D., Bauman, A. and Sallis, J.F. (2003). Physical Activity and Sedentary behavior: a population-based Study of barriers, enjoyment, and preference. *Health Psychology*, [online] 22(2), pp.178–188. doi:10.1037//0278-6133.22.2.178.

Sammonds, G.M., Fray, M. and Mansfield, N.J. (2017). Effect of long term driving on driver discomfort and its relationship with seat fidgets and movements (SFMs). *Applied Ergonomics*, [online] 58, pp.119–127. Available at: https://doi.org/10.1016/j.apergo.2016.05.009 [Accessed 30 Mar. 2022].

Sany, S.A., Tanjim, T. and Hossain, M.I. (2022). Low back pain and associated risk factors among medical students in Bangladesh: a cross-sectional study. *F1000Research*, [online] 10, p.698. Available at: https://doi.org/10.12688/f1000research.55151.2 [Accessed 20 Mar. 2022].

Sara Avinna, Nur Khairunisa, Wan Firdaus, Ali, Zulkifli, Masshera and Mohd Rizal (2021). Physical Activity among Undergraduate University Students during the Pandemic COVID-19. *International Journal of Academic Research in Business and Social Sciences*, [online] 11(10). doi:10.6007/ijarbss/v11-i10/11164.

Sassos, S. (2020). *How to Fix a Sedentary Lifestyle (Because It's Never Too Late to Get Moving)*. [online] Good Housekeeping. Available at: https://www.goodhousekeeping.com/health/a31448807/what-is-sedentary-lifestyle/ [Accessed 30 Mar. 2022].

Saueressig, I., Oliveira, V., Xavier, M., Santos, L., Silva, K. and Araújo, R., 2015. Prevalence of musculoskeletal pain in adolescents and its association with the use of electronic devices. *Revista Dor*, [online] 16(2). Available at: <http://dx.doi.org/10.5935/1806-0013.20150025> [Accessed 2 September 2022].

Scarabottolo, C.C., Pinto, R.Z., Oliveira, C.B., Zanuto, E.F., Cardoso, J.R. and Christofaro, D.G.D. (2017). Back and Neck Pain Prevalence and Their Association with Physical Inactivity Domains in Adolescents. *European Spine Journal*, [online] 26(9), pp.2274–2280. doi:10.1007/s00586-017-5144-1.

Schlossberg, E.B., Morrow, S., Llosa, A.E., Mamary, E., Dietrich, P. and Rempel, D.M. (2004). Upper extremity pain and computer use among engineering graduate students. *American Journal of Industrial Medicine*, [online] 46(3), pp.297–303. Available at: https://doi.org/10.1002/ajim.20071 [Accessed 5 Mar. 2022].

Schmidt, S.C.E., Anedda, B., Burchartz, A., Eichsteller, A., Kolb, S., Nigg, C., Niessner, C., Oriwol, D., Worth, A. and Woll, A. (2020). Physical Activity and Screen Time of Children and Adolescents before and during the COVID-19 Lockdown in Germany: a Natural Experiment. *Scientific Reports*, [online] 10(1). doi:10.1038/s41598-020-78438-4.

Seghers, J., Jochem, A. and Spaepen, A. (2003). Posture, Muscle Activity and Muscle Fatigue in Prolonged VDT Work at Different Screen Height Settings. *Ergonomics*, [online] 46(7), pp.714–730. doi:10.1080/0014013031000090107.

Sekiguchi, T., Hagiwara, Y., Momma, H., Tsuchiya, M., Kuroki, K., Kanazawa, K., Yabe, Y., Yoshida, S., Koide, M., Itaya, N., Itoi, E. and Nagatomi, R. (2017). Excessive game playing is associated with musculoskeletal pain among youth athletes: a cross-sectional study in Miyagi prefecture. *Journal of Sports Sciences*, 36(16), pp.1801–1807.

Senarath, M., Thalwaththe, S. and Tennakoon, S. (2021). Prevalence of Selected Musculoskeletal pain among the Students of Faculty of Allied Health Sciences, University of Peradeniya. *Journal of Musculoskeletal pain and Treatment*, [online] 7(2). doi:10.23937/2572-3243.1510097.

Sendić, G. (2015). *Musculoskeletal System*. [online] Kenhub. Available at: https://www.kenhub.com/en/library/anatomy/the-musculoskeletal-system [Accessed 4 Mar. 2022].

Shan, Z., Deng, G., Li, J., Li, Y., Zhang, Y. and Zhao, Q. (2013). Correlational Analysis of neck/shoulder Pain and Low Back Pain with the Use of Digital

Products, Physical Activity and Psychological Status among Adolescents in Shanghai. *PLoS ONE*, [online] 8(10), p.e78109. doi:10.1371/journal.pone.0078109.

Shrier, I. (1999). Stretching before Exercise Does Not Reduce the Risk of Local Muscle Injury. *Clinical Journal of Sport Medicine*, [online] 9(4), pp.221–227. doi:10.1097/00042752-199910000-00007.

Shrier, I. (2000). Stretching before exercise: an Evidence Based Approach. *British Journal of Sports Medicine*, [online] 34(5), pp.324–325. doi:10.1136/bjsm.34.5.324.

Shrier, I., Ehrmann Feldman, D., Rossignol, M. and Abenhaim, L. (2002). Risk Factors for the Development of Neck and Upper Limb Pain in Adolescents. *Spine*, [online] 27(5), pp.523–528. Available at: https://pubmed.ncbi.nlm.nih.gov/11296967/ [Accessed 23 Feb. 2022].

Silva, G.R.R., Pitangui, A.C.R., Xavier, M.K.A., Correia-Júnior, M.A.V. and De Araújo, R.C. (2016). Prevalence of Musculoskeletal Pain in Adolescents and Association with Computer and Videogame Use. *Jornal de Pediatria*, [online] 92(2), pp.188–196. doi:10.1016/j.jped.2015.06.006.

Sitthipornvorakul, E., Janwantanakul, P., Purepong, N., Pensri, P. and van der Beek, A.J. (2010). The Association between Physical Activity and Neck and Low Back pain: a Systematic Review. *European Spine Journal*, [online] 20(5), pp.677–689. doi:10.1007/s00586-010-1630-4.

Skrede, T., Steene-Johannessen, J., Anderssen, S.A., Resaland, G.K. and Ekelund, U. (2018). The Prospective Association between Objectively Measured Sedentary time, Moderate-to-vigorous Physical Activity and Cardiometabolic Risk Factors in youth: a Systematic Review and Meta-analysis. *Obesity Reviews*, [online] 20(1), pp.55–74. doi:10.1111/obr.12758.

Smith, D. and Leggat, P. (2007). Back Pain in the Young: A Review of Studies Conducted Among School Children and University Students. *Current Pediatric Reviews*, [online] 3(1), pp.69–77. Available at: http://dx.doi.org/10.2174/157339607779941624 [Accessed 20 Mar. 2022].

Smith, D.R., Leggat, P.A. and Clark, M. (2006). Upper Body Musculoskeletal pain among Australian Occupational Therapy Students. *British Journal of Occupational Therapy*, [online] 69(8), pp.365–372. Available at: https://doi.org/10.1177/030802260606900804 [Accessed 20 Mar. 2022].

Smith, L., Hamer, M. and Gardner, B. (2018). *Chapter 6 - Sedentary Behavior and Mental Health*. [online] ScienceDirect. Available at: https://doi.org/10.1016/B978-0-12-812605-9.00006-X [Accessed 2 Sep. 2022].

Soares Da Silva, S., Coutinho, M., Moura, M., Santos, D., Conceição, S., Vieira, M. and Vilela Heimer, M. (2020). Screen Time and Musculoskeletal Pain In Adolescents: A Systematic Review. *International Journal of Development Research*, [online] 10(5), pp.35745–35749. Available at: http://www.journalijdr.com/sites/default/files/issue-pdf/18767.pdf [Accessed 29 Mar. 2022].

Stamatakis, E., Gale, J., Bauman, A., Ekelund, U., Hamer, M. and Ding, D. (2019). Sitting Time, Physical Activity, and Risk of Mortality in Adults. *Journal of the American College of Cardiology*, [online] 73(16), pp.2062–2072. Available at: http://www.onlinejacc.org/content/73/16/2062 [Accessed 30 Mar. 2022].

Stienen, M., Richter, H., Prochnow, N., Schnakenburg, L. and Gautschi, O. (2011). Beeinflusst Rauchen Rückenschmerzen und spinale Operationsergebnisse? *Zeitschrift für Orthopädie und Unfallchirurgie*, [online] 149(03), pp.317–323. Available at: https://pubmed.ncbi.nlm.nih.gov/21341183/ [Accessed 23 Feb. 2022].

Straker, L., Jones, K.J. and Miller, J. (1997). A Comparison of the Postures Assumed When Using Laptop Computers and Desktop Computers. *Applied Ergonomics*, [online] 28(4), pp.263–268. doi:10.1016/s0003-6870(96)00073-7.

Straker, L.M., O'Sullivan, P.B., Smith, A.J. and Perry, M.C. (2009). Relationships between Prolonged neck/shoulder Pain and Sitting Spinal Posture in Male and Female Adolescents. *Manual Therapy*, [online] 14(3), pp.321–329. doi:10.1016/j.math.2008.04.004.

Strath, S.J., Kaminsky, L.A., Ainsworth, B.E., Ekelund, U., Freedson, P.S., Gary, R.A., Richardson, C.R., Smith, D.T. and Swartz, A.M. (2013). Guide to the Assessment of Physical Activity: Clinical and Research Applications. *Circulation*, [online] 128(20), pp.2259–2279. doi:10.1161/01.cir.0000435708.67487.da.

Sudholz, B., Timperio, A., D. Ridgers, N., W. Dunstan, D., Baldock, R., Holland, B. and Salmon, J. (2016). The Impact and Feasibility of Introducing Height-Adjustable Desks on Adolescents' Sitting in a Secondary School Classroom. *AIMS Public Health*, [online] 3(2), pp.274–287. doi:10.3934/publichealth.2016.2.274.

Suris, J., Akre, C., Piguet, C., Ambresin, A., Zimmermann, G. and Berchtold, A. (2014). Is Internet use unhealthy? A cross-sectional study of adolescent Internet overuse. *Swiss Medical Weekly*.

Szeto, G.P. and Lee, R. (2002). An Ergonomic Evaluation Comparing desktop, notebook, and Subnotebook Computers. *Archives of Physical Medicine and Rehabilitation*, [online] 83(4), pp.527–532. doi:10.1053/apmr.2002.30627.

Tabachnick, B.G. and Fidell, L.S. (2019). *Using multivariate statistics*. 7th ed. United States of America: Boston Pearson.

Tan, S., Tan, C. and Tan, S. (2021). Physical Activity, Sedentary Behavior, and Weight Status of University Students during the COVID-19 Lockdown: A Cross-National Comparative Study. *International Journal of Environmental Research and Public Health*, [online] 18(13), p.7125. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8297249/ [Accessed 30 Mar. 2022].

Tang, K., 2020. Movement control as an effective measure against COVID-19 spread in Malaysia: an overview. *Journal of Public Health*, p.3.

Taspinar, F., Taspinar, B., Cavlak, U. and Celik, E. (2013). Determining the Pain-Affecting Factors of University Students with Nonspecific Low Back Pain. *Journal of Physical Therapy Science*, [online] 25(12), pp.1561–1564. Available at: https://doi.org/10.1589/jpts.25.1561 [Accessed 20 Mar. 2022].

The American Association for Public Opinion Research (2016). *Standard Definitions Final Dispositions of Case Codes and Outcome Rates for Surveys*. [online] *AAPOR*. Washington, DC, USA: AAPOR. Available at: https://www.aapor.org/AAPOR_Main/media/publications/Standard-Definitions20169theditionfinal.pdf [Accessed 11 May 2022].

The Executive Centre (2018). *Technology That Impacts Productivity*. [online] The Executive Centre Japan. Available at: https://www.executivecentre.com/en-jp/blog-article/art-science-design-impact-technology-productivity/ [Accessed 7 Sep. 2022].

The Health and Safety (Display Screen Equipment) Regulations 1992.Legislation.gov.uk. [online] Available at: https://www.legislation.gov.uk/uksi/1992/2792/contents/made [Accessed 7 Sep. 2022].

Thivel, D., Tremblay, A., Genin, P.M., Panahi, S., Rivière, D. and Duclos, M. (2018). Physical Activity, Inactivity, and Sedentary Behaviors: Definitions and Implications in Occupational Health. *Frontiers in Public Health*, [online] 6(288). Available at: https://www.frontiersin.org/articles/10.3389/fpubh.2018.00288/full [Accessed 23 Mar. 2022].

Thorp, A.A., Owen, N., Neuhaus, M. and Dunstan, D.W. (2011). Sedentary Behaviors and Subsequent Health Outcomes in Adults. *American Journal of Preventive Medicine*, [online] 41(2), pp.207–215. doi:10.1016/j.amepre.2011.05.004.

Toprak Celenay, S., Karaaslan, Y., Mete, O. and Ozer Kaya, D., 2020. Coronaphobia, musculoskeletal pain, and sleep quality in stay-at home and continued-working persons during the 3-month COVID-19 pandemic lockdown in Turkey. *Chronobiology International*, [online] 37(12), pp.1778-1785. Available at: <https://www.tandfonline.com/doi/full/10.1080/07420528.2020.1815759> [Accessed 13 February 2022].

Traeger, A.C., Qaseem, A. and McAuley, J.H. (2021). Low Back Pain. *JAMA*, [online] 326(3), p.286. Available at: https://jamanetwork.com/journals/jama/article-abstract/2782184 [Accessed 18 Mar. 2022].

Tremblay, M.S., Colley, R.C., Saunders, T.J., Healy, G.N. and Owen, N. (2010). Physiological and Health Implications of a Sedentary Lifestyle. *Applied Physiology, Nutrition, and Metabolism*, [online] 35(6), pp.725–740. doi:10.1139/h10-079.

Tudor-Locke, C., Craig, C.L., Brown, W.J., Clemes, S.A., De Cocker, K., Giles-Corti, B., Hatano, Y., Inoue, S., Matsudo, S.M., Mutrie, N., Oppert, J.-M., Rowe, D.A., Schmidt, M.D., Schofield, G.M., Spence, J.C., Teixeira, P.J., Tully, M.A. and Blair, S.N. (2011). How many steps/day are enough? for adults. *International Journal of Behavioral Nutrition and Physical Activity*, [online] 8(1), p.79. Available at: https://ijbnpa.biomedcentral.com/articles/10.1186/1479-5868-8-79 [Accessed 5 Mar. 2022].

Tullar, J., Amick III, B.C., Robertson, M.M., Fossel, A.H., Coley, C., Hupert, N., Jenkins, M. and Katz, J.N. (2007). Direct observation of computer workplace risk factors of college students. *Work*, [online] 28(1), pp.77–83. Available at: https://content.iospress.com/articles/work/wor00598 [Accessed 21 Mar. 2022].

Turville, K.L., Psihogios, J.P., Ulmer, T.R. and Mirka, G.A. (1998). The Effects of Video Display Terminal Height on the operator: a Comparison of the 15 Degree and 40 Degree Recommendations. *Applied Ergonomics*, [online] 29(4), pp.239–246. doi:10.1016/s0003-6870(97)00048-3.

U.S. Department of Health and Human Services (2008). *Physical Activity Guidelines for Americans 2008*. [online] Washington, D.C: U.S. Department of Health and Human Services, pp.21–29. Available at: https://health.gov/sites/default/files/2019-09/paguide.pdf [Accessed 4 Mar. 2022].

U.S. Department of Health and Human Services (2018). *Physical Activity Guidelines for Americans 2nd edition*. [online] *Office of Disease Prevention and Health Promotion*, Washington D.C: U.S. Department of Health and Human Services, pp.55–66. Available at: https://health.gov/sites/default/files/2019-09/Physical_Activity_Guidelines_2nd_edition.pdf [Accessed 4 Mar. 2022].

UNESCO. 2020. *1.37 billion students now home as COVID-19 school closures expand, ministers scale up multimedia approaches to ensure learning continuity.* [online] Available at: <https://en.unesco.org/news/137-billion-students-now-

home-COVID-19-school-closures-expand-ministers-scale-multimedia> [Accessed 12 February 2022].

Unruh, A.M. (1996). Gender Variations in Clinical Pain Experience. *Pain*, [online] 65(2), pp.123–167. doi:10.1016/0304-3959(95)00214-6.

Vahdat, I., Rostami, M., Tabatabai Ghomsheh, F., Khorramymehr, S. and Tanbakoosaz, A. (2017). Effects of External Loading on Lumbar Extension Moment during Squat Lifting. *International Journal of Occupational Medicine and Environmental Health*, [online] 30(4), pp.665–679. doi:10.13075/ijomeh.1896.00896.

van den Heuvel, S.G., Heinrich, J., Jans, M.P., van der Beek, A.J. and Bongers, P.M. (2005). The Effect of Physical Activity in Leisure Time on Neck and Upper Limb Symptoms. *Preventive Medicine*, [online] 41(1), pp.260–267. doi:10.1016/j.ypmed.2004.11.006.

van der Ploeg, H.P. and Hillsdon, M. (2017). Is sedentary behaviour just physical inactivity by another name? *International Journal of Behavioral Nutrition and Physical Activity*, [online] 14(1). Available at: https://doi.org/10.1186/s12966-017-0601-0 [Accessed 4 Mar. 2022].

van der Ploeg, H.P., Chey, T., Korda, R.J., Banks, E. and Bauman, A. (2012). Sitting Time and All-Cause Mortality Risk in 222 497 Australian Adults. *Archives of Internal Medicine*, [online] 172(6), p.494. Available at: https://jamanetwork.com/journals/jamainternalmedicine/fullarticle/1108810#:~:text=Sitting%20time%20was%20divided%20into,11%20or%20more%20h%2Fd. [Accessed 29 Mar. 2022].

van DieËn, J.H., De Looze, M.P. and Hermans, V. (2001). Effects of dynamic office chairs on trunk kinematics, trunk extensor EMG and spinal shrinkage. *Ergonomics*, [online] 44(7), pp.739–750. Available at: https://doi.org/10.1080/00140130120297 [Accessed 30 Mar. 2022].

Van Dyck, D., De Bourdeaudhuij, I., Deliens, T. and Deforche, B. (2015). Can Changes in Psychosocial Factors and Residency Explain the Decrease in Physical Activity during the Transition from High School to College or University? *International Journal of Behavioral Medicine*, [online] 22(2), pp.178–186. doi:10.1007/s12529-014-9424-4.

Veerman, J.L., Healy, G.N., Cobiac, L.J., Vos, T., Winkler, E.A.H., Owen, N. and Dunstan, D.W. (2012). Television Viewing Time and Reduced Life expectancy: a Life Table Analysis. *British Journal of Sports Medicine*, [online] 46(13), pp.927–930. doi:10.1136/bjsports-2011-085662.

Verbunt, J.A., Huijnen, I.P.J. and Köke, A. (2009). Assessment of Physical Activity in Daily Life in Patients with Musculoskeletal Pain. *European Journal of Pain*, [online] 13(3), pp.231–242. doi:10.1016/j.ejpain.2008.04.006.

Versus Arthritis (2018). *Shoulder Pain*. [online] Versus Arthritis. Available at: https://www.versusarthritis.org/about-arthritis/conditions/shoulder-pain/ [Accessed 1 Sep. 2022].

Villa-Forte, A. (2021). *Musculoskeletal Pain*. [online] MSD Manuals. Available at: https://www.msdmanuals.com/home/bone,-joint,-and-muscle-disorders/symptoms-of-musculoskeletal-disorders/musculoskeletal-pain [Accessed 21 Mar. 2022].

Villanueva, M.B.G., Jonai, H., Sotoyama, M., Hisanaga, N., Takeuchi, Y. And Saito, S. (1997). Sitting Posture and Neck and Shoulder Muscle Activities at Different Screen Height Settings of the Visual Display Terminal. *INDUSTRIAL HEALTH*, [online] 35(3), pp.330–336. doi:10.2486/indhealth.35.330.

Vitta, A. de, Bento, T.P.F., Perrucini, P. de O., Felippe, L.A., Poli-Frederico, R.C. and Borghi, S.M. (2021). Neck Pain and Associated Factors in a Sample of High School Students in the City of Bauru, São Paulo, Brazil: cross-sectional Study. *Sao Paulo Medical Journal*, [online] 139(1), pp.38–45. doi:10.1590/1516-3180.2020.0168.r1.30102020.

Vujcic, I., Stojilovic, N., Dubljanin, E., Ladjevic, N., Ladjevic, I. and Sipetic-Grujicic, S., 2018. Low Back Pain among Medical Students in Belgrade (Serbia): A Cross-Sectional Study. *Pain Research and Management*, 2018, pp.1-6.

Wagoner, C.W., Choi, S.K., Deal, A.M., Lee, J.T., Wood, W.A., Muss, H.B. and Nyrop, K.A. (2019). Establishing Physical Activity in Breast cancer: self-report versus Activity Tracker. *Breast Cancer Research and Treatment*, [online] 176(2), pp.395–400. doi:10.1007/s10549-019-05263-3.

Wami, S.D., Mekonnen, T.H., Yirdaw, G. and Abere, G. (2020). Musculoskeletal problems and associated risk factors among health science students in Ethiopia: a cross-sectional study. *Journal of Public Health*, [online] 29, pp.943–949. Available at: https://doi.org/10.1007/s10389-020-01201-6 [Accessed 23 Feb. 2022].

Warburton, D.E.R. (2006). Health Benefits of Physical activity: the Evidence. *Canadian Medical Association Journal*, [online] 174(6), pp.801–809. Available at: https://doi.org/10.1503/cmaj.051351 [Accessed 30 Mar. 2022].

Wedderkopp, N., Kjaer, P., Hestbaek, L., Korsholm, L. and Leboeuf-Yde, C. (2009). High-level Physical Activity in Childhood Seems to Protect against Low Back Pain in Early Adolescence. *The Spine Journal*, [online] 9(2), pp.134–141. doi:10.1016/j.spinee.2008.02.003.

Weleslassie, G.G., Meles, H.G., Haile, T.G. and Hagos, G.K. (2020). Burden of Neck Pain among Medical Students in Ethiopia. *BMC Musculoskeletal pain*, [online] 21(1). doi:10.1186/s12891-019-3018-x.

WHO (2009). *Mortality and burden of disease attributable to selected major risks*. [online] *World Health Organization*, Geneva, Switzerland: World Health Organization, pp.16–18. Available at: https://www.who.int/healthinfo/global_burden_disease/GlobalHealthRisks_report_full.pdf [Accessed 5 Mar. 2022].

WHO (2010). *Global Recommendations on Physical Activity for Health*. [online] Geneva, Switzerland: World Health Organization, pp.23–29. Available at: https://www.who.int/dietphysicalactivity/global-PA-recs-2010.pdf [Accessed 4 Mar. 2022].

WHO (2020a). *Physical activity*. [online] Who.int. Available at: https://www.who.int/news-room/fact-sheets/detail/physical-activity [Accessed 4 Mar. 2022].

WHO (2020b). *WHO Guidelines on Physical Activity and Sedentary Behaviour*. [online] *World Health Organization*, Geneva, Switzerland: World Health Organization, pp.43–47. Available at: https://www.who.int/publications/i/item/9789240015128 [Accessed 4 Mar. 2022].

WHO. (2021). *Musculoskeletal conditions*. [online] Available at: <https://www.who.int/news-room/fact-sheets/detail/musculoskeletal-conditions> [Accessed 13 February 2022].

Wiitavaara, B., Fahlström, M. and Djupsjöbacka, M. (2016). Prevalence, diagnostics and management of musculoskeletal pain in primary health care in Sweden – an investigation of 2000 randomly selected patient records. *Journal of Evaluation in Clinical Practice*, [online] 23(2), pp.325–332. Available at: https://doi.org/10.1111/jep.12614 [Accessed 21 Mar. 2022].

Worsted, M., Hanvold, T.N. and Veiersted, K.B. (2010). Computer work and musculoskeletal pain of the neck and upper extremity: A systematic review. *BMC Musculoskeletal pain*, [online] 11(1). Available at: https://pubmed.ncbi.nlm.nih.gov/20429925/ [Accessed 23 Feb. 2022].

Xiang, M., Zhang, Z. and Kuwahara, K. (2020). Impact of COVID-19 Pandemic on Children and adolescents' Lifestyle Behavior Larger than Expected. *Progress in Cardiovascular Diseases*, [online] 63(4). doi:10.1016/j.pcad.2020.04.013.

Yang, S.-Y., Chen, M.-D., Huang, Y.-C., Lin, C.-Y. and Chang, J.-H. (2016). Association between Smartphone Use and Musculoskeletal Discomfort in Adolescent Students. *Journal of Community Health*, [online] 42(3), pp.423–430. doi:10.1007/s10900-016-0271-x.

Yang, Y.J. (2019). An Overview of Current Physical Activity Recommendations in Primary Care. *Korean Journal of Family Medicine*, [online] 40(3), pp.135–142. Available at: Yang Y. J. (2019). An Overview of Current Physical Activity Recommendations in Primary Care. Korean journal of family medicine, 40(3), 135–142. https://doi.org/10.4082/kjfm.19.0038 [Accessed 4 Mar. 2022].

Yaseen, Q.B. and Salah, H. (2021). The impact of e-learning during COVID-19 pandemic on students' body aches in Palestine. *Scientific Reports*, 11(1). doi:10.1038/s41598-021-01967-z.

Yasobant, S. and Batham, C. (2016). A risk assessment study on work-related musculoskeletal pain among dentists in Bhopal, India. *Indian Journal of Dental Research*, [online] 27(3), p.236. Available at: https://doi.org/10.4103/0970-9290.186243 [Accessed 21 Mar. 2022].

Yeun, Y.R. and Han, S.J. (2017). Factors associated with neck/shoulder pain in young adults. *Biomedical Research*, [online] 28(16). Available at: https://www.alliedacademies.org/articles/factors-associated-with-neckshoulder-pain-in-young-adults-8224.html [Accessed 20 Mar. 2022].

Yiswaree Palansamy (2021). *Youth and Sports Ministry: Gyms, Sports and Recreational Centres in MCO Districts Must Close from Tomorrow.* [online] Malay Mail. Available at: https://www.malaymail.com/news/malaysia/2021/05/06/youth-and-sports-ministry-gyms-sports-and-recreational-centres-in-mco-distr/1972181 [Accessed 20 Aug. 2022].

Ylinen, J., Takala, E.P., Nykänen, M., Häkkinen, A., Mälkiä, E., Pohjolainen, T., Karppi, S.L., Kautiainen, H. and Airaksinen, O. (2003). Active Neck Muscle Training in the Treatment of Chronic Neck Pain in Women. *JAMA*, 289(19), p.2509.

Yucel, H. and Torun, P. (2016). Prevalence and Risk Factors of Low Back Pain in Students Studying at a Health University. *Bezmialem Science*, [online] 4(1), pp.12–18. Available at: https://doi.org/10.14235/BS.2016.618 [Accessed 20 Mar. 2022].

Zhang, R., Chomistek, A.K., Dimitrakoff, J.D., Giovannucci, E.L., Willett, W.C., Rosner, B.A. And Wu, K. (2015). Physical Activity and Chronic Prostatitis/Chronic Pelvic Pain Syndrome. *Medicine & Science in Sports & Exercise*, [online] 47(4), pp.757–764. doi:10.1249/mss.0000000000000472.

Zheng, C., Huang, W.Y., Sheridan, S., Sit, C.H.-P., Chen, X.-K. and Wong, S.H.-S. (2020). COVID-19 Pandemic Brings a Sedentary Lifestyle in Young Adults: a Cross-Sectional and Longitudinal Study. *International Journal of Environmental Research and Public Health*, [online] 17(17), p.6035. doi:10.3390/ijerph17176035

APPENDICES

APPENDIX A: Survey Questionnaire

The following contains the survey questionnaire that was used for this study.

The Prevalence of Musculoskeletal Disorders and Associated Risk Factors Among Malaysian University Students During the Covid-19 Pandemic

Dear Participants,

Warm greetings. 🙏

I'm Ugeswaran A/L Jeganathen, a final-year student at Universiti Tunku Abdul Rahman (UTAR) pursuing a Bachelor of Science (Honours) in Environmental, Occupational Safety, and Health. I am currently conducting my final year project titled 'The Prevalence of Musculoskeletal Disorders and Associated Risk Factors Among Malaysian University Students During the Covid-19 Pandemic'.

The primary aim of this study is to understand the symptoms and implications of musculoskeletal disorders, as well as to analyse the relationship between musculoskeletal disorders and online learning among Malaysian university students during the COVID-19 pandemic.

In order to ensure the success of the comprehensive analysis, I, therefore, seek your kind support in completing this survey questionnaire. Rest assured that all data collected will be kept confidential and anonymous.

Yours sincerely,
Ugeswaran A/L Jeganathen
uges.jega2907@1utar.my

---

* Required

1. I hereby consent to my voluntary participation in this survey, which will be conducted anonymously. (In accordance with the Personal Data Protection Statement - UTAR) *

   Mark only one oval.

   ◯ ***YES*** - Proceed to the next section

   ◯ ***NO*** - Response will be discarded

Section A: Demographic Information

2. Gender *

Mark only one oval.

- Male
- Female

3. Age range *

Mark only one oval.

- 18 - 20
- 21 - 23
- 24 - 26
- 27 - 29
- ≥ 30

4. Weight (in kg) *

Mark only one oval.

- 30 - 39
- 40 - 49
- 50 - 59
- 60 - 69
- 70 - 79
- 80 - 89
- 90 - 99
- ≥ 100

Section B: Physical Activity & Sitting Time

Physical Activity

"Physical activity" is any bodily movement produced by skeletal muscles that requires energy expenditure. It refers to all movement e.g. walking, cycling, wheeling, sports, active recreation and play.

5. How much did you exercise on average ***BEFORE*** and ***DURING*** the Covid-19 emergency? *

The phrase "BEFORE the Covid-19 pandemic" refers to the time period before March 2020. The phrase "DURING the Covid-19 pandemic" refers to the period from March 2020 until the present.

Mark only one oval per row.

	I don't exercise (0 minutes per week)	1 - 149 minutes per week	150 - 299 minutes per week	≥300 minutes per week
BEFORE **the Covid-19 pandemic**	⬭	⬭	⬭	⬭
DURING **the Covid-19 pandemic**	⬭	⬭	⬭	⬭

Sitting Time

'Sitting time' refers to the time spent sitting and doing a specific activity, such as office work, driving a vehicle, taking public transportation, watching television, using a laptop or smartphone, etc.

6. How many hours per day did you spend sitting during the day on average ***BEFORE*** and ***DURING*** the Covid-19 pandemic? *

'Sitting time' refers to the time spent sitting and doing a specific activity, such as office work, driving a vehicle, taking public transportation, watching television, using a laptop or smartphone, etc.

Mark only one oval per row.

	Less than 4 hours	4 to less than 8 hours	8 to less than 11 hours	11 hours or more
BEFORE **the Covid-19 pandemic**	⬭	⬭	⬭	⬭
DURING **the Covid-19 pandemic**	⬭	⬭	⬭	⬭

Section C: Musculoskeletal Pain

NECK PAIN

Neck pain refers to pain in or around the spine beneath your head. Neck pain is typically accompanied by one or more symptoms such as stiff neck, sharp pain, general soreness, radicular pain, cervical radiculopathy, difficulty holding or lifting objects, and headaches.

7. *

Mark only one oval per row.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I experienced neck pain *BEFORE* the Covid-19 pandemic	⬭	⬭	⬭	⬭	⬭
I experienced neck pain *DURING* the Covid-19 pandemic	⬭	⬭	⬭	⬭	⬭

8. In which daytime window the neck pain level is greater? *

Mark only one oval.

- ⬭ I don't have any
- ⬭ After waking up in the morning
- ⬭ After several hours of study
- ⬭ In the late evening, when I rest
- ⬭ I don't see any difference regarding the daytime window

9. When do you experience more neck pain? *

Mark only one oval.

- I don't have any
- When I'm sitting
- When I'm standing
- When I'm walking
- When I'm practicing sport
- When I do housework
- There is no particular circumstance

LOW BACK PAIN

Low back pain is defined as pain in or around the lower back that starts below the ribcage. Low back pain is typically characterized by a combination of symptoms such as dull and aching pain, pain that travels to the buttocks, thighs, legs, and feet, pain that worsens after prolonged sitting, pain that improves when changing positions, and pain that worsens after waking up and improves when moving around.

10. *

Mark only one oval per row.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I experienced low back pain *BEFORE* the Covid-19 pandemic	◯	◯	◯	◯	◯
I experienced low back pain *DURING* the Covid-19 pandemic	◯	◯	◯	◯	◯

11. In which daytime window the low back pain level is greater? *

Mark only one oval.

- I don't have any
- After waking up in the morning
- After several hours of study
- In the late evening, when I rest
- I don't see any difference regarding the daytime window

12. When do you experience more low back pain? *

Mark only one oval.

- I don't have any
- When I'm sitting
- When I'm standing
- When I'm walking
- When I'm practicing sport
- When I do housework
- There is no particular circumstance

SHOULDER PAIN

Shoulder pain is any pain that occurs in or around the shoulder joint. It has its own set of symptoms, which include pain deep in the shoulder joint, reduced shoulder movement, shoulder/upper arm weakness, pins and needles (tingling) sensations and burning pain, and lack shoulder movement.

13. *

Mark only one oval per row.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I experienced shoulder pain *BEFORE* the Covid-19 pandemic	◯	◯	◯	◯	◯
I experienced shoulder pain *DURING* the Covid-19 pandemic	◯	◯	◯	◯	◯

14. In which daytime window the shoulder pain level is greater? *

Mark only one oval.

- ◯ I don't have any
- ◯ After waking up in the morning
- ◯ After several hours of study
- ◯ In the late evening, when I rest
- ◯ I don't see any difference regarding the daytime window

15. When do you experience more shoulder pain? *

Mark only one oval.

- ◯ I don't have any
- ◯ When I'm sitting
- ◯ When I'm standing
- ◯ When I'm walking
- ◯ When I'm practicing sport
- ◯ When I do housework
- ◯ There is no particular circumstance

Section D: Ergonomic Risk Factors

The following questions will investigate the ergonomic risk factors that may play a role in the prevalence of musculoskeletal disorders among university students.

16. Choose the option that applies to you ***DURING*** the Covid-19 pandemic. You may select ***more than one*** option from the list below. *

Check all that apply.

- [ ] I'm familiar with the term "ergonomics".
- [ ] I sit in a chair that provides lower back support.
- [ ] I sit in a chair that has a height adjustment.
- [ ] I sit in a chair with armrests.
- [ ] I use a desk that is height-adjustable.
- [ ] I have enough leg room under my desk to rest my legs comfortably.
- [ ] I position the screen of my electronic devices (computer, laptop, smartphone, TV, etc.) horizontally with my eyes
- [ ] I position the screen of my electronic devices (computer, laptop, smartphone, TV, etc.) at least 30cm away from me.
- [ ] My keyboard, mouse, and study surface are all at elbow height, with my elbows positioned at a 90° angle.
- [ ] I spend less than 2 hours/day on my electronic devices (computer, laptop, smartphone, TV, etc.)
- [ ] I take postural breaks every 30 minutes when using my electronic devices (computer, laptop, smartphone, TV, etc.)
- [ ] I do not adopt awkward postures or positions when using my electronic devices (computer, laptop, smartphone, TV, etc.)

APPENDIX B: Statistical Analysis Output (SPSS)

Spearman's Rank Correlation Analysis Result

Nonparametric Correlations

Correlations

			Exercise_DURING	Sitting_DURING	NP_DURING	LBP_DURING	SP_DURING
Spearman's rho	Exercise_DURING	Correlation Coefficient	1.000	-.115**	-.052	-.005	-.046
		Sig. (2-tailed)	.	.004	.191	.891	.249
		N	640	640	640	640	640
	Sitting_DURING	Correlation Coefficient	-.115**	1.000	.169**	.149**	.186**
		Sig. (2-tailed)	.004	.	.000	.000	.000
		N	640	640	640	640	640
	NP_DURING	Correlation Coefficient	-.052	.169**	1.000	.417**	.481**
		Sig. (2-tailed)	.191	.000	.	.000	.000
		N	640	640	640	640	640
	LBP_DURING	Correlation Coefficient	-.005	.149**	.417**	1.000	.342**
		Sig. (2-tailed)	.891	.000	.000	.	.000
		N	640	640	640	640	640
	SP_DURING	Correlation Coefficient	-.046	.186**	.481**	.342**	1.000
		Sig. (2-tailed)	.249	.000	.000	.000	.
		N	640	640	640	640	640

**. Correlation is significant at the 0.01 level (2-tailed).

Regression (Physical Activity vs Neck Pain During the COVID-19 Pandemic)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.054[a]	.003	.001	1.225

a. Predictors: (Constant), Exercise_DURING

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.800	1	2.800	1.866	.172[b]
	Residual	957.394	638	1.501		
	Total	960.194	639			

a. Dependent Variable: NP_DURING

b. Predictors: (Constant), Exercise_DURING

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.513	.127		27.703	.000
	Exercise_DURING	-.080	.058	-.054	-1.366	.172

a. Dependent Variable: NP_DURING

Regression (Physical Activity vs Low Back Pain During the COVID-19 Pandemic)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.010[a]	.000	-.001	1.211

a. Predictors: (Constant), Exercise_DURING

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.093	1	.093	.063	.802[b]
	Residual	935.907	638	1.467		
	Total	936.000	639			

a. Dependent Variable: LBP_DURING

b. Predictors: (Constant), Exercise_DURING

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	3.154	.125		25.155	.000
	Exercise_DURING	-.015	.058	-.010	-.251	.802

a. Dependent Variable: LBP_DURING

Regression (Physical Activity vs Shoulder Pain During the COVID-19 Pandemic)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.056[a]	.003	.002	1.290

a. Predictors: (Constant), Exercise_DURING

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.369	1	3.369	2.025	.155[b]
	Residual	1061.624	638	1.664		
	Total	1064.994	639			

a. Dependent Variable: SP_DURING

b. Predictors: (Constant), Exercise_DURING

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	3.329	.134		24.927	.000
	Exercise_DURING	-.088	.062	-.056	-1.423	.155

a. Dependent Variable: SP_DURING

Regression (Sitting Time vs Neck Pain During the COVID-19 Pandemic)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.157[a]	.025	.023	1.212

a. Predictors: (Constant), Sitting_DURING

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	23.571	1	23.571	16.056	.000[b]
	Residual	936.622	638	1.468		
	Total	960.194	639			

a. Dependent Variable: NP_DURING

b. Predictors: (Constant), Sitting_DURING

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.559	.204		12.552	.000
	Sitting_DURING	.252	.063	.157	4.007	.000

a. Dependent Variable: NP_DURING

Regression (Sitting Time vs Low Back Pain During the COVID-19 Pandemic)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.152[a]	.023	.021	1.197

a. Predictors: (Constant), Sitting_DURING

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	21.511	1	21.511	15.007	.000[b]
	Residual	914.489	638	1.433		
	Total	936.000	639			

a. Dependent Variable: LBP_DURING

b. Predictors: (Constant), Sitting_DURING

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.366	.201		11.746	.000
	Sitting_DURING	.240	.062	.152	3.874	.000

a. Dependent Variable: LBP_DURING

Regression (Sitting Time vs Shoulder Pain During the COVID-19 Pandemic)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.171[a]	.029	.028	1.273

a. Predictors: (Constant), Sitting_DURING

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	31.142	1	31.142	19.218	.000[b]
	Residual	1033.851	638	1.620		
	Total	1064.994	639			

a. Dependent Variable: SP_DURING

b. Predictors: (Constant), Sitting_DURING

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.240	.214		10.459	.000
	Sitting_DURING	.289	.066	.171	4.384	.000

a. Dependent Variable: SP_DURING

APPENDIX C: Ethical Consideration Approval Letter

UNIVERSITI TUNKU ABDUL RAHMAN DU012(A)
Wholly owned by UTAR Education Foundation Co. No. 578227-M

Re: U/SERC/126/2022

23 June 2022

Dr Mohammed J. K. Bashir
Head, Department of Environmental Engineering
Faculty of Engineering and Green Technology
Universiti Tunku Abdul Rahman
Jalan Universiti, Bandar Baru Barat
31900 Kampar, Perak.

Dear Dr Mohammed,

Ethical Approval For Research Project/Protocol

We refer to the application for ethical approval for your students' research projects from Bachelor of Science (Hons) Environmental, Occupational Safety and Health programme enrolled in course UGNB4916. We are pleased to inform you that the application has been approved under Expedited Review.

The details of the research projects are as follows:

	Research Title	Student's Name	Supervisor's Name	Approval Validity
1.	The Prevalence of Musculoskeletal Disorders and Associated Risk Factors Among Malaysian University Students During the Covid-19 Pandemic	Ugeswaran a/l Jeganathen	Ts Chin Yik Heng	23 June 2022 – 22 June 2023
2.	A Study on Fire Safety & Awareness Among the Occupants in Universiti Tunku Abdul Rahman (UTAR), Kampar Campus	Sammi Wong Jia Chyi	ChM Ts Chin Kah Seng	
3.	A Study on Indoor Home Environment, Building Occupants' Activities and Respiratory Symptoms Among Residence in Kampar	Patrick Chong Yao Sheng	Dr Lim Fang Lee	

The conduct of this research is subject to the following:

(1) The participants' informed consent be obtained prior to the commencement of the research;

(2) Confidentiality of participants' personal data must be maintained; and

(3) Compliance with procedures set out in related policies of UTAR such as the UTAR Research Ethics and Code of Conduct, Code of Practice for Research Involving Humans and other related policies/guidelines.

(4) Written consent be obtained from the institution(s)/company(ies) in which the physical or/and online survey will be carried out, prior to the commencement of the research.

Should the students collect personal data of participants in their studies, please have the participants sign the attached Personal Data Protection Statement for records.

Thank you.

Yours sincerely,

Professor Ts Dr Faidz bin Abd Rahman
Chairman
UTAR Scientific and Ethical Review Committee

c.c Dean, Faculty of Engineering and Green Technology
Director, Institute of Postgraduate Studies and Research