อุบัติการณ์และปัจจัยเสี่ยงของการเกิดอาการและการคงอยู่ของอาการ ทางระบบกระดูกและกล้ามเนื้อบริเวณกระดูกสันหลังในนักศึกษามหาวิทยาลัย: การศึกษาแบบติดตามผลไปข้างหน้าในระยะเวลา 1 ปี

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INCIDENCE AND RISK FACTORS FOR DEVELOPMENT AND PERSISTENCE OF MUSCULOSKELETAL SYMPTOMS IN THE SPINE IN UNDERGRADUATE STUDENTS: A 1-YEAR PROSPECTIVE COHORT STUDY

Mrs. Siriluck Kanchanomai

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Thesis Title	Incidence and risk factors for development and persistence of musculoskeletal symptoms in the spine in undergraduate students: A 1-year prospective cohort study
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สิริลักษณ์ กาญจโนมัย : อุบัติการณ์และปัจจัยเสี่ยงของการเกิดอาการและการคงอยู่ของอาการทางระบบกระดูกและกล้ามเนื้อบริเวณกระดูกสันหลังในนักศึกษามหาวิทยาลัย: การศึกษาแบบติดตามผลไปข้างหน้าในระยะเวลา 1 ปี. (Incidence and risk factors for development and persistence of musculoskeletal symptoms in the spine in undergraduate students: A 1-year prospective cohort study) อ. ที่ปรึกษาวิทยานิพนธ์หลัก: รศ.ดร. ประวิตร เจนวรรธนะกุล, อ. ที่ปรึกษาวิทยานิพนธ์ร่วม: ผศ.ดร. ปราณีต เพ็ญศรี, ผศ.นพ.ดร. วิโรจน์ เจียมจรัสรังสี, 269 หน้า.

งานวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาอุบัติการณ์และปัจจัยเสี่ยงของการเกิดอาการและการคงอยู่ของอาการทางระบบกระดูกและกล้ามเนื้อบริเวณคอ หลังส่วนบน และหลังส่วนล่าง ในนักศึกษามหาวิทยาลัย โดยปัจจัยที่ทำการศึกษา ได้แก่ ปัจจัยส่วนบุคคล ปัจจัยที่เกี่ยวกับคอมพิวเตอร์ และปัจจัยทางด้านจิตใจและสังคม การศึกษานี้ใช้ระเบียบวิธีวิจัยการศึกษาแบบติดตามผลไปข้างหน้า (Prospective study) โดยการแจกแบบสอบถามชนิดตอบด้วยตนเองและการตรวจร่างกาย ในนักศึกษามหาวิทยาลัยที่มีสุขภาพดีจำนวน 684 คน และติดตามอาการปวดทุกๆ 3 เดือนเป็นระยะเวลา 1 ปี สำหรับการวิเคราะห์หาความสัมพันธ์ของปัจจัยเสี่ยงกับการเกิดอาการและการคงอยู่ของอาการทางระบบกระดูกและกล้ามเนื้อบริเวณกระดูกสันหลังใช้วิธีการ multiple logistic regression

ผลการศึกษาพบว่า เมื่อติดตามผลไปเป็นระยะเวลา 1 ปี มีผู้เข้าร่วมการศึกษาจำนวน 524 คน (คิดเป็นร้อยละ 77) สำหรับอุบัติการณ์ของการเกิดอาการปวดบริเวณคอ หลังส่วนบน และหลังส่วนล่าง เท่ากับร้อยละ 46, 27 และ 30 ตามลำดับ ในขณะที่อุบัติการณ์การคงอยู่ของอากาทางระบบกระดูกและกล้ามเนื้อบริเวณคอ หลังส่วนบน และหลังส่วนล่าง เท่ากับร้อยละ 33, 23 และ 31 ตามลำดับ โดย เพศ ความยาวของกล้ามเนื้อขาด้านหน้า ความบ่อยของการออกกำลังกายในแต่ละสัปดาห์ และปัจจัยที่เกี่ยวกับคอมพิวเตอร์ มีความสัมพันธ์ต่อการเกิดอาการทางระบบกระดูกและกล้ามเนื้อบริเวณกระดูกสันหลังในนักศึกษาที่ใช้คอมพิวเตอร์แบบตั้งโต๊ะและพกพา ในขณะที่การศึกษาในชั้นปีที่ 2 ความทนทานของกล้ามเนื้องอคอ และปัจจัยที่เกี่ยวกับคอมพิวเตอร์ มีความสัมพันธ์กับการคงอยู่ของอาการทางระบบกระดูกและกล้ามเนื้อบริเวณคอและหลังส่วนบนในนักศึกษาที่ใช้คอมพิวเตอร์แบบตั้งโต๊ะและพกพา

สาขาวิชา ชีวเวชศาสตร์ ลายมือชื่อนิสิต สิริลักษณ์ กาญจโนมัย

ปีการศึกษา 2553 ลายมือชื่อ อ.ที่ปรึกษาวิทยานิพนธ์.................

ลายมือชื่อ อ.ที่ปรึกษาวิทยานิพนธ์ร่วม ปราณีต เพ็ญศรี

ลายมือชื่อ อ.ที่ปรึกษาวิทยานิพนธ์ร่วม.................

4989700320 : MAJOR BIOMEDICAL SCIENCES

KEYWORDS : COMPUTER / MUSCULOSKELETAL PAIN / UNDERGRADUATE STUDENTS

SIRILUCK KANCHANOMAI: THE INCIDENCE AND RISK FACTORS FOR DEVELOPMENT AND PERSISTENCE OF MUSCULOSKELETAL SYMPTOMS IN THE SPINE IN UNDERDGRADUATE STUDENTS: A 1-YEAR PROSPECTIVE COHORT STUDY. ADVISOR : ASSOC. PROF. PRAWIT JANWANTANAKUL, Ph.D., CO-ADVISOR : ASST. PROF. PRANEET PENSRI, Ph.D., ASST. PROF. WIROJ JIAMJARASRANGSI, M.D., Ph.D., 269 pp.

The objectives of this study were to examine the annual incidence of development and persistence of self-reported neck, upper back and low back pain and to explore individual, computer-use related and psychosocial risk factors for the development and persistence of neck, upper back and low back pain in undergraduate students. A prospective study was carried out among 684 healthy undergraduate students. At baseline, a self-administered questionnaire and a standardized physical examination were used to collect data on biopsychosocial factors. At the 3rd, 6th, 9th and 12th months, follow-up data were collected on spinal pain. The regression models were built to find out risk factors for the incidence and persistence of spinal pain in undergraduate students.

A total of 524 (77%) undergraduate students were followed for 1 year. The 12-month incidence rates of neck, upper back and low back pain were 46%, 27% and 30%, respectively. The 12-month persistent rates of neck, upper back and low back pain were 33%, 23% and 31%, respectively. The incidence rate of spinal pain was related to gender, quadriceps muscle length, frequency of weekly exercise session and computer-use related factors in undergraduate students using desktop and notebook computers. The persistent rate of neck and upper back pain was related to being 2nd year students, neck extensor muscle endurance and computer-use related factors in undergraduate students using desktop and notebook computers.

Field of Study : Biomedical sciences	Student's Signature Siriluck Kanchanomai
Academic Year : 2010	Advisor's Signature
	Co-advisor's Signature
	Co-advisor's Signature

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This thesis is dedicated with deepest love and affection to my family. It might be stressful to complete the study without them. Their love, encouragement and understanding have inspired me to be the best I can be. And I hope this thesis is the best thing that represents my thankfulness to all of them.

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LIST OF ABBREVIATIONS

MSD	=	Musculoskeletal disorder
NSP	=	Neck and shoulder pain
VDT	=	Visual display terminal
PC	=	Personal computer
BMI	=	Body mass index
CI	=	Confidence interval
cm	=	Centimeter (s)
kg	=	Kilogram (s)
LBP	=	Low back pain
min	=	Minute (s)
OR	=	Crude odds ratio
OR_{adj}	=	Adjusted odds ratio
SD	=	Standard deviation
yr	=	year (s)
MST	=	Modified Schober test
ULTT	=	Upper limb tension test
ULNT	=	Upper limb nerve tension

CHAPTER I

INTRODUCTION

1.1 Background and rationale

Spinal symptoms are common health problems among adult. About 54%-80% of people experience spine symptoms at least once in their adult life, with a point prevalence of 15% and 1-year prevalence ranging from 4% to 51 % (1). Spinal symptoms cause considerable personal suffering due to pain, disability and impaired quality of work and life in general (2-7). The economic consequences of treating disabling spinal pain are significant (1, 8). Bernaard et al (9) postulated that the total yearly costs of neck and upper limb symptoms in the Netherlands due to decreased productivity, sick leave, chronic disability for work and medical costs were recently estimated at 2.1 billion Euros. Dagenais et al (2) found that the total cost for back pain in the United States could be estimated as low as $ 19.6 billion to as high as $ 624.8 billion. Compared to the neck and low back, upper back has received less attention in terms of clinical and epidemiologic research (10). Pain experienced in the upper back can be equally disabling, imposing similar burdens on the individual, community (10-11) and workforce (12).

Evidence demonstrates that adolescents with spinal pain are at higher risk of having such symptoms in adulthood (13-16). Life-long chronic spinal pain may have it origins in childhood (14). Thus, to reduce the incidence of spinal pain in adults, knowledge regarding factors that can predict the development and persistence of spinal pain in young population is highly important. Such information is necessary for creating evidence-based prevention measures for spinal pain in young population.

Increasing evidence suggests a high prevalence of musculoskeletal symptoms in the spine among undergraduate students, ranging from 48% to 78% in the neck and upper extremity (17-20), 4% to 10% in the upper back (15) and 14% to 50% in the low back (21-23). In a Swedish cohort of university students, 15% developed neck or upper back pain between baseline and the one year follow up (24). Mitchell et al (25) who conducted a 1-year prospective cohort study on 107 female nursing without LBP at baseline found that 29% developed new onset of LBP.

The etiology of musculoskeletal symptoms in the spine is not fully understood. However, musculoskeletal symptoms are assumed to be multi-factorial origin, indicating that individual, physicals and psychosocial factors can contribute to its development and persistence (8). Previous cross-sectional studies have identified several factors associated with the prevalence of musculoskeletal symptoms in spine among undergraduate students, including female (15, 18-19, 26), higher year of study (20, 22, 27), low physical exercise (21-22, 28) and poor mental health (15, 29). There were only two recent prospective studies assessing the association between several risk factors and incidence of spinal pain. Mitchell et al (25) found that smoking, increased physical activity, higher stress, reduced back muscle endurance, greater posterior pelvic rotation in slump sitting and more accurate spinal repositioning in sitting were significant predictors of new onset of LBP. Hanvold et al (17) showed that a high level of physical activity outside working hours gave a lower risk of reporting neck, shoulder and upper back pain at 3 year follow up. There was still a limited number of cohort studies in neck, upper back and low back pain among undergraduate students. Cross-sectional study design of previous studies only allows the association between exposures and outcome to be examined. It is not possible to establish the causal relationship between exposures and outcome. A prospective study was needed to identify factors that can predict the development and persistence of neck, upper back and low back pain in undergraduate students.

Computer use is very common among undergraduate students (24) and consistent evidence suggests that computer use is strongly associated with musculoskeletal in upper extremities (18-19). Computer work increases the tendency to have more sedentary lifestyle and working in prolonged and awkward posture (30). The adverse effect of sedentary lifestyle and prolonged sitting on the lumbar spine has been well documented (31-32). Undergraduate students involved in prolonged computer work with high numbers of years of computer use were related to more frequent report of upper extremity symptoms (18-20, 33). Little is known about the effect of computer use on the development and persistence of spinal pain among undergraduate students.

There is limited evidence of a relationship between clinical risk factors and neck, upper back and low back pain. Most studies investigated the effects of biopsychosocial factors on neck, upper back and low back pain in undergraduate students without due consideration of clinical factors (e.g. muscular strength, endurance, joint mobility and flexibility). Clinical factors may be a valuable diagnostic tool for the early detection of musculoskeletal disorders. Abnormal muscle strength, endurance and flexibility may lead to abnormal biomechanics of body movement, causing abnormal physical load to various tissues, including muscles, ligaments and bone. Thus, individuals with abnormal muscle strength, endurance and flexibility may susceptible to musculoskeletal injury.

Therefore, the aims of this study were: (i) to examine the annual incidence of development and persistence of self-reported neck, upper and low back pain and (ii) to explore biopsychosocial risk factors for development and persistence of spinal pain in undergraduate students.

1.2 Research questions

1.2.1 What was the 1-year incidence of development and persistence of neck, upper back and low back pain in undergraduate students using desktop and notebook computers?

1.2.2 Were there any individual, computer-use related, mental health and clinical factors associated with the development of neck, upper back and low back pain in undergraduate students using desktop and notebook computers?

1.2.3 Were there any individual, computer-use related, mental health and clinical factors associated with the persistence of neck, upper back and low back pain in undergraduate students using desktop and notebook computers?

1.3 Objectives of the study

1.3.1 To examine the 1-year incidence of development and persistence of neck, upper back and low back pain in undergraduate students using desktop and notebook computers.

1.3.2 To explore individual, computer-use related, mental health and clinical factors associated with the development of neck, upper back and low back pain in undergraduate students using desktop and notebook computers.

1.3.3 To explore individual, computer-use related, mental health and clinical factors associated with the persistence of neck, upper back and low back pain in undergraduate students using desktop and notebook computers.

1.4 Hypotheses of the study

1.4.1 The 1-year incidence of development of neck, upper back and low back pain in undergraduate students using desktop and notebook computers would range from 15% to 34%.

1.4.2. The 1-year incidence of persistence of neck, upper back and low back pain in undergraduate students using desktop and notebook computers would range from 20% to 54%.

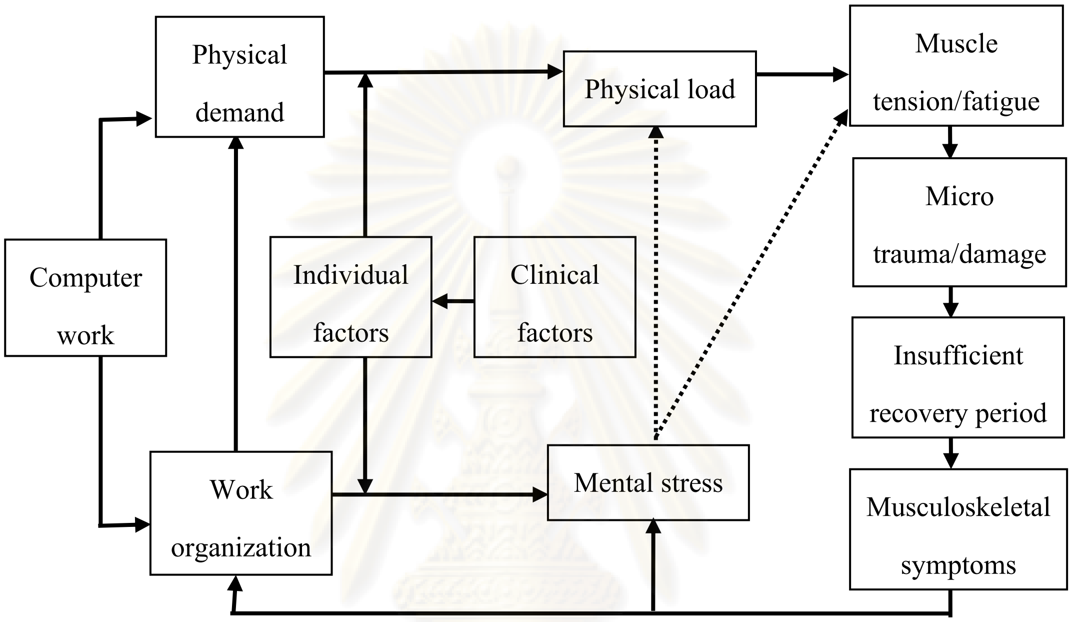
1.4.3. There would be a number of individual, computer-use related, mental health and clinical factors associated with the development of neck, upper back and low back pain in undergraduate students using desktop and notebook computers.

1.4.4 There would be a number of individual, computer-use related, mental health and clinical factors associated with the persistence of neck, upper back and low back pain in undergraduate students using desktop and notebook computers.

1.5 Scope of the study

This study investigated the 1-year incidence of development and persistence of neck, upper back and low back pain among undergraduate students using desktop and notebook computers aged between 18-25 years. A cohort of undergraduate students without neck, upper back and low back pain was assessed by using a self report questionnaire and physical examination at baseline and then prospectively followed every 3 months over a 12-month period.

1.6 Conceptual framework



Adapted from WahlstrÖm (34)

1.7 Benefit of the study

The findings of the present study will provide fundamental information, which will be essential for planning preventive measures to reduce neck, upper back and low back pain in undergraduate students and other populations.

CHAPTER II

LITERATURE REVIEW

2.1 Definition of musculoskeletal disorder

‘‘Musculoskeletal disorders’’ are injury and disorder of muscles, tendons, ligaments, joints, peripheral nerves and blood vessels or spinal discs in the neck, shoulder, elbow, forearm, wrist, hand, abdomen (hernia only), back, knee, ankle, and foot. These include clinical syndromes, such as tendon inflammations and related conditions (tenosynovitis, epicondylitis, bursitis), nerve compression disorders (carpal tunnel syndrome, sciatica) and osteoarthrosis as well as less well standardized conditions such as myalgia, low back pain and other regional pain syndromes not attributable to known pathology (8, 35-37).

2.2 Prevalence and incidence for development and persistence of neck, upper back and low back in undergraduate students

2.2.1 Development of neck, upper back and low back pain

Spinal pain is common among undergraduate students. Several studies have investigated the prevalence and incidence of spinal pain in undergraduate students (21-23, 27-28, 38-41).

Increasing evidence suggests a high prevalence of musculoskeletal symptoms in the neck among undergraduate students, ranging from 48% to 66% (28, 41). Hays et al (28) investigated the 12-month prevalence of MSD among undergraduate dental hygiene students in Australia. The authors reported that the most commonly reported musculoskeletal pain by dental hygiene students was the neck (64%) region, followed by the low back (58%) and shoulder (48%) regions. In a Swedish cohort of university students, 15% developed neck or upper back pain between baseline and the one year follow-up (41).

Prevalence of musculoskeletal symptoms in the upper back is also common among undergraduate student, ranging from 13% to 39% (15, 38-39). Rising et al (38) studied the body distribution and severity of reported musculoskeletal pain in a population of American dental students and found that 13-39% of 1^{st}-4^{th} year dental students experienced upper back pain. Smith et al (39) studied the 12-month prevalence of musculoskeletal disorders in occupational therapy students. The authors found that 39% of students experienced upper back pain. Earlier study found that the point, 12-month and lifetime prevalence for upper back pain in adolescents (13–20 years) was reported to range from 4–41%, 4–10%, and 16–20%, respectively (12).

LBP among adolescent and young adult has increased over recent decades. The prevalence for LBP in undergraduate students was reported to range from 14% to 41%. Cakmak et al (21) found that the lifetime prevalence of LBP among Turkish university students aged between 17-26 years was 41%. Lorusso et al (22) reported that LBP was the most frequently reported symptom (27%) over the previous 12 months among X-ray technology students in Italy. Falavigna et al (23) found that 14% of medical and physiotherapy students had LBP during the survey period. Mitchell et al (25) conducted a 1-year prospective cohort study on 117 female nursing without LBP at baseline and reported that 29% reported at least one new significant episode of LBP over the 12-month follow-up.

2.2.2 Persistence of neck, upper back and low back pain

Little attention has been given to the prevalence and incidence for persistence of neck, upper back and low back pain among undergraduate students (25, 41-42).

High persistent rate of neck or upper back pain has been reported among undergraduate students (41-42). Grimby-Ekman et al (41) found that, among 1204 Swedish undergraduate student, 52% had ongoing neck or upper back pain in 1 year follow up. Hill et al (42) reported 32% of English subjects aged between 18-29 years as having persistence of neck pain in 12 month follow up.

Only one previous study investigated the persistence of low back pain in undergraduate students and revealed that some of them experienced persistent low back pain (25). Mitchell et al (25) conducted a 1-year prospective cohort study on 117 female nursing without LBP at baseline. Of those with new onset of LBP, 19% had experienced ongoing LBP symptoms.

2.3 Pathomechanism of musculoskeletal symptoms due to computer work

A relationship between musculoskeletal symptoms and computer work is shown in Figure 2.1. Computer work has a direct path to physical demands, as defined by the physical coupling between the user and tool, such as workstation ergonomics. There is also a direct path from computer work to work organization. The physical demands from computer work can be influenced by work organization, for example, increasing time pressure leads to a longer hour of computer work, which in turn may increase physical load. It is proposed that various physical factors, such as repetitive motion, forceful exertion, sitting over long periods of time and sustained awkward posture, may increases physical load on the body parts. Increased physical load leads to increased muscle activity and fatigue. If there is insufficient time to allow regeneration of body tissue capacity, then a series of responses (muscle fatigue) may further reduce the available capacity. This may continue until some types of structural tissue deformation occur, leading to musculoskeletal symptoms (36).

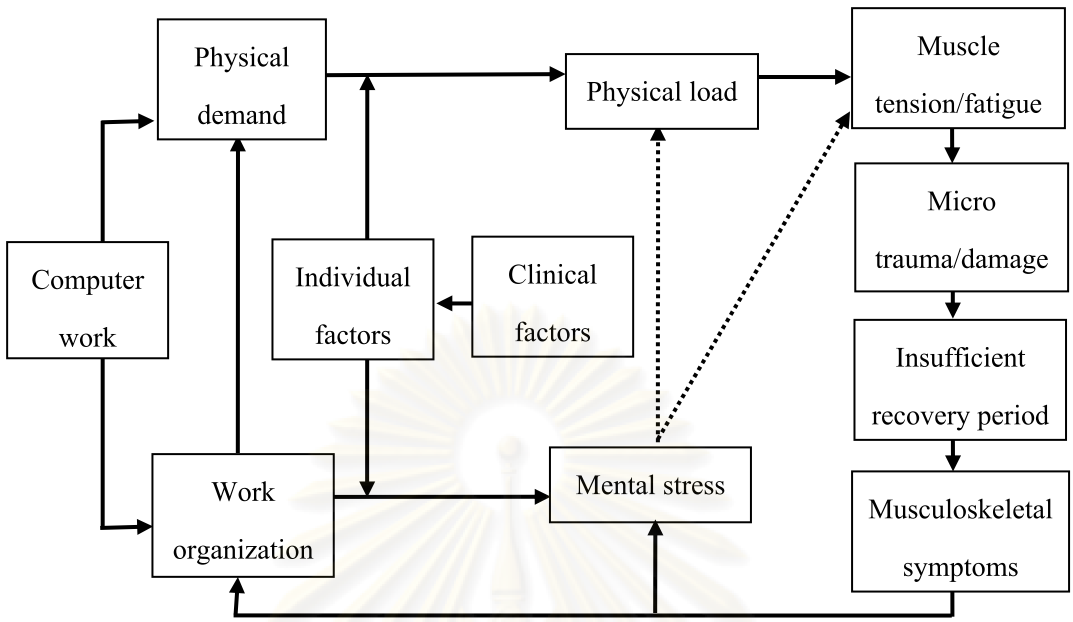


Figure 2.1 A relationship between musculoskeletal disorders and computer work (adapted from WalstrÖm (34)).

Individual factors may also modify the association between physical demands and physical load. For example, gender differences in anthropometrics may result in women working in more extreme postures or using higher relative muscle forces than men (43). At the same time, individual factor such as personality, coping, perception and experience can modify the association between work organization and mental stress.

A clinical factor which is a part of individual factors, such as muscle strength, muscle endurance, muscle length and joint mobility, are also related to the development of musculoskeletal symptoms. Abnormal muscle strength, muscle endurance and muscle length may lead to abnormal biomechanics of movement, causing abnormal physical load to various tissues, including muscles, ligaments and bone. Thus, persons who possess abnormal muscle strength, muscle endurance and muscle length may be susceptible to musculoskeletal injury (44).

Mental stress may increase muscle activity, which compounds physical load induced by physical demands. Mental stress has been hypothesized to moderate the relationship between physical load and musculoskeletal outcomes (i.e. neck and/or low back pain). The reason for having a direct path from mental stress to musculoskeletal outcomes is not well understood. Muscular tension is hypothesized to be an early sign of musculoskeletal symptoms. Finally, the experiences of musculoskeletal symptoms are negative feedback to increase mental stress and to cause alteration in work organization (34).

The nature of computer work is repetitive and involves sustained awkward posture for a prolonged period of time, which may result in the development of musculoskeletal symptoms in computer users (45-49). Prolonged periods of sitting lead to a slackening of the abdominal muscles and alteration of spinal curvature. Such changes may result in poor sitting posture, which may deteriorate the intervertebral discs (50-53). In addition, prolonged viewing the monitor, which involves sustained static muscle activity in the neck, shoulder and spinal areas, can cause the peripheral nerve entrapment, localize muscle fatigue and increased susceptibility of muscles of the upper extremity, neck and back to small microtears and inflammatory changes (43, 46, 54-60). Additional repetitive and forceful movements of the finger and wrists while operating a keyboard or mouse is a significant risk factor for musculoskeletal pain (46, 54, 56-58).

2.4 Characteristic of using desktop and notebook computers

Working with a notebook computer differs considerably from that of a desktop computer. The adjustability of various components of a notebook computer is limited. For example, the screen and keyboard are not separable and therefore cannot be adjusted independently, except for screen inclination (61-62). The general adjustability restrictions of a notebook computer and its design characteristics may adversely affect task performance, user comfort and working postures (62-63). Previous studies have shown that working with a notebook computer resulted in greater neck flexion and downwards head tilt (61, 64-65), greater neck extensor activity (66) and reduced range of neck movement compared with working with a desktop computer (67). Straker et al (61) showed that mean of neck discomfort after using a notebook computer was more than mean of neck discomfort when using desktop computer. The authors (61) hypothesized that increased neck and shoulder flexion during use of a notebook computer increases biomechanical load on surrounding structures, leading to discomfort and possibly the development of musculoskeletal disorders. The findings were later supported by Szeto (67) who found that flexion angles of subjects' cervical and thoracic spine increased progressively while they used a notebook computer compared to a desktop computer. Use of external devices during working with a notebook computer, such as a mouse, a keyboard and an external monitor, have been shown to decrease external rotation and variability of the shoulder (64) as well as ulnar deviation of the wrist (68). As a result, it is recommended to use a notebook computer in a standard desktop configuration with external devices in order to avoid exposure to these potentially harmful postures (69).

2.5 Risk factors for musculoskeletal symptoms

The etiology of musculoskeletal symptoms in the spine is not fully understood. However, musculoskeletal symptoms are assumed to be of multi-factorial origin, indicating that individual, physical and psychosocial factors can contribute to its development and persistence (8). Most studies investigated risk factors for the development of musculoskeletal symptoms (17-19, 25, 31, 39, 43, 70-80) but only a few studies examined risk factors for the persistence of musculoskeletal symptoms (3-4, 41, 58, 81-83).

2.5.1 Individual factors

Individual factors, such as age (3, 78, 82), gender (18-19, 74, 84-85), body mass index (BMI) (3) and exercise (18), have been found to associate with the development and persistence of musculoskeletal symptoms.

2.5.1.1 Age

Age is an important risk factor for the development and persistence of musculoskeletal pain. However, controversy exists regarding the effect of age. Older workers often have been affected by microtrauma accumulated over a long period of time, which may hasten the degenerative process of spine (86). This notion is confirmed by Webb et al (3) who indicated that the prevalence of pain with disability continues to rise with age, whereas all reported pain tends to peak at younger age groups. Leboeuf-Yde et al (78) found that neck and low back pain peaked somewhat around the middle age, while upper back pain was already common at the age of 20, increasing slowly until the middle age and then descending slowly again. In undergraduate students, Smith et al (39) indicated that students aged over 21 years were almost two times more likely to report upper back pain. Wijnhoven et al (82) showed that the prevalence of chronic low back pain increased with increasing age in female Dutch population.

Conversely, Leboeuf-Yde et al (78) showed the opposite effect of age on neck, upper back and low back pain in Danish general population age between 20 to70 years. The authors found that the oldest group did not report pain in more areas than the younger groups, indicating that spinal pain does not accumulate with age. An explanation could be that if there is an inherited or acquired tendency for spinal pain in an individual, it is likely to manifest itself early in life. But if there is no such weakness, it will not occur, regardless of what happens in life. Thus, the simple fact of getting older will not result in an increased burden of spinal pain (78).

2.5.1.2 Gender

Several previous studies have shown that woman is at higher risk for development and persistent of musculoskeletal pain than men (39, 70, 81-82). Leclerc et al (70) conducted a 12-month longitudinal study on 806 active workers from four occupational sectors (office, hospital, warehouse, airport registration of luggage) in France and found that female was a predictor of neck disorders. Mikkelsson et al (81) reported that neck pain was the most persistent musculoskeletal pain symptoms at the 1-year follow-up, especially among 10-year old girls. Smith et al (73), studying in physicians in mainland China, found that female was associated with an increase of upper back pain. Wijnhoven et al (82) report female predominance in the prevalence of chronic musculoskeletal pain in Dutch general population aged between 25-65 years. However, the authors commented that the mechanisms explaining gender difference were poorly understood. Similar associations between female and chronic musculoskeletal pain in other regions of the body were reported by several studies (87-88)

With computer work, female users reported musculoskeletal symptoms in the upper extremity region more frequently than men (18-19, 74, 84-85). Tittiranonda et al (43) hypothesize that differences in anthropometrics may cause women to work with computer in more extreme postures and using higher relative muscle force than men. In addition, several studies (89-92) indicated that gender differences in work technique may play a role in higher prevalence of symptoms among females. However, Nordander et al (93) have not been found difference in trapezius muscle activity while using computer between female and male office workers. Thus, the effect of gender on musculoskeletal disorders in computer use still remains unclear.

2.5.1.3 Body mass index

A number of studies investigated the association between BMI and risk for developing and persistent musculoskeletal symptoms (3, 72, 75, 82, 94-95). Obesity has been found to be a risk factor for back, shoulder, arm, hand and knee pain (75). Koleva et al (72) evaluated the impact of some personal and work-related risk factors for development of musculoskeletal disorder. The results showed that obesity was a risk factor for musculoskeletal disorders in workers. Also, obesity was a predictor of back pain in a UK study (3). Webb et al (3) reported that high BMI was strongly associated with increased levels of intensity, disability and chronicity among those reported back pain. The mechanisms underlying the association between obesity and LBP are not fully known. Obesity may increase the risk of LBP because of lumbar disc disorder (96). Mortimer et al (97) suggested that with increasing body weight the spine must support greater amount of fat, which may increase pressure on the discs and/or other structures. Wijnhoven et al (82) showed that overweight (BMI>25 kg/m^2) was associated more strongly with chronic neck, upper back and low back pain in Dutch general population aged between 25 to 65 years.

However, there were a few studies showing no association between BMI and neck pain. For example, the mini-Finland Health Survey found a weak association between overweight and the prevalence of neck pain (94).

2.5.1.4 Physical exercise

Conflicting evidence exists regarding the association between physical exercise and musculoskeletal pain (17-18, 31). Some studies indicated exercise or vigorous physical activities have a beneficial effect on musculoskeletal pain (17-18, 98-100). Katz et al (18) found that participating in athletics is effective in reducing neck and upper extremity pain in American university students. A prospective study of technical school students showed that a high level of physical activity outside working hours was effective in reducing the risk of neck, shoulder and upper back pain (17). Hay et al (28) found that dental students who undertake regular exercise had lower risk of experiencing LBP. The possible explanation is that exercise can improve muscle strength, thus preventing LBP by reducing instability and the chance of having microtrauma to the lumbar spine (101).

However, a few studies showed no significant association between physical exercise and musculoskeletal pain (31, 102-105). Diepenmaat et al (105) did not find an association between physical activity and musculoskeletal pain in the Netherland adolescents aged 12-16 years. Other studies reported that physical activities were not associated with prevalence of neck, shoulder and low back pain. Thus, the effect of physical activity on neck, upper back and low back pain is still controversial.

Physical inactivity has been found to be associated with chronic musculoskeletal symptoms. Holt et al (83) investigated the association between self-reported physical exercise at baseline and the prevalence of chronic neck, shoulders, elbows, wrist/hands, upper back, low back, hips, knees and/or ankles/feet in Norwegian population. At follow-up 20,223 (51%) reported chronic musculoskeletal complaints. Individuals who exercised at baseline were less likely to report chronic musculoskeletal complaints in 11 years later than inactive persons.

2.5.2 Computer-use related factors

Computer-use related factors include location of computer monitor (65, 67, 106-108), keyboard and mouse (109-110), arm and back support (111-112), posture while using computer (113), type of computer (61, 114), activities performed while using computer (50), typing characteristic (115), duration of computer use (18-19, 33, 71, 115) and years of computer use (51). Several computer-use related factors were significantly related to development of musculoskeletal symptoms in different body regions but only duration of keyboard and mouse use were found to be risk factors for persistence of musculoskeletal symptoms (58, 84).

2.5.2.1 Positioning of the computer monitor

Positioning of computer monitor is one of several factors affecting user comfort (108). Although much research has focused on identifying the optimal screen height, there is to date no consensus on this issue (65). Segher et al (65) showed that lowering screen height, starting from 15 cm above the baseline led to a 50% increase of the neck extensor muscle activity, mainly caused by an increase in forward head posture. Villanueva et al (116) found a strong significant correlation between posture changes caused by different screen heights and muscle activities of neck extensor and trapezius muscles. A decrease in forward head posture caused a reduction in neck extensor muscle activity whereas Kothiyal et al (108) found that comfort ratings for neck and low back regions were significantly higher for the high monitor setting compared to the low monitor setting. However, some studies indicated that the self-preferred monitor positions can result in comfortable conditions for individual users (117-118). Starr et al (106) performed a cross-sectional investigation of the relationship between upper limb posture and musculoskeletal symptoms of back and upper limb among 100 VDT operators. Monitor viewing, neck, trunk, upper arm, forearm, hand and elbow angles were estimated from photographs taken while participants were keying. Musculoskeletal discomfort of the upper back, neck, shoulders, upper arms, elbows, and wrists was assessed with a self-administered questionnaire. Each outcome association was examined individually. Back discomfort was found to be significantly associated with downward monitor viewing angle.

2.5.2.2 Location of keyboard or mouse

Evidence indicates that poor placement of keyboard is a predictor for upper extremity and back pain (77). A prospective study of 180 workers who used video display units found a poor physical work environment and a poor placement of keyboard to be predictors of neck pain (119). Faucett et al (109) found that higher keyboard height (with respect to the elbow height) was associated with increased risk of neck, upper back and upper extremity discomfort. Marcus et al (71) indicated that a seated posture with the keyboard low and some distance away from participants was associated with a lower risk of neck and shoulder symptom than one with the keyboard at or above elbow height and close to participants. On the other hand, Hunting et al (120) showed that lowering keyboard height to below elbow height was associated with elevated risk of neck, shoulder and arm discomfort. Thus, the effect of keyboard height on musculoskeletal symptoms is far from conclusive.

Computer mouse has become an important tool for the control and operation of computers, as operating systems and software applications have evolved to graphics based windowed environments. Mouse use may account for 30–80% of the time spent working at a computer (121). Prolonged force applied to computer mouse and sustained non-neutral postures are two risk factors that may contribute to mouse-related upper extremity musculoskeletal disorders (122). Karlqvist et al (123) demonstrated that mouse work required the use of extended non-neutral postures and muscle activity, which varied with the location of mouse relative to the operator. Dennerlein et al (124) reported that trapezius and medial deltoid muscle activity was highest when the mouse position was at behind the keyboard and 50 mm above the resting surface of the keyboard. Marcus et al (71) showed that elbow angles between 137 and 148 degrees while using the mouse were related to a lower risk of developing neck and shoulder pain in newly hired computer workers. However, Korhonen et al (119) reported that placement of mouse was not a significant risk factor for neck pain among office workers.

2.5.2.3 Arm and back support

Previous studies (34, 77, 111) indicated that supporting the arms, forearm or wrists during keyboard and mouse use was a preferable posture for computer users. Supporting the forearms on the chair armrests had been reported to reduce muscular load and discomfort on the neck and shoulders (90-91, 125). A longitudinal study have also shown that supporting the arms during VDU work was associated with decreased risk of developing neck/shoulder symptoms (71). Following 6 year intervention, Aaras et al (111) reported a significant decrease in static trapezius load as well as neck and shoulder pain in a group of participants, who were able to support their whole forearm and hand on the table top. Nag et al (77) examined the effect of forearm and wrist support on the EMG activity of bilateral forearm, shoulder and lower back muscles and associated to upper extremity postural changes during keyboard and mouse use. The authors found that both forearm and wrist support resulted in an increase in bilateral elbow extension, approaching towards the anatomical posture of the elbow (upper arm and forearm at 90 degrees). As far as EMG activities are concerned, it was noted that the activity of the bilateral forearm muscles decreased with an increase in elbow extension, indicating that supporting the arms (forearm and/or wrists) during keyboard and mouse use might be less strain for computer users. The benefits of the forearm supports is inconsistent. Some researchers reported that the forearm support could be effective to reduce trapezius load, resulting in increased comfort and reduced effort (77, 125). However, Cook et al (112) reported that these supports did not significantly change working posture or reduce neck/shoulder muscle activity.

Beside of the forearm support, sitting in chairs with no back support and working with computer for 1-2 hours may create strain on musculoskeletal system (126). Using chair backrest attenuates the stresses exerted on the vertebral column by relaxing the erector spinae muscle, while maintaining lumbar lordosis and increasing comfort (127). Several studies showed that maintaining the lumbar lordosis has a protective effect on spinal structures in sitting posture (128-129).

2.5.2.4 Posture while using computer

Posture while using computer is one of several factors that may lead to discomfort in computer users. Proper posture while using computer has been extensively reported in ergonomic literature (107, 130). The good sitting posture on computer use are thighs parallel to the floor, feet placed flat on the floor or a footrest, lumbar supported, elbows supported by arm rests and elbows, hip, knees, and ankles positioned in ninety degrees of flexion (113). Simple adjustments of the workstation, such as the height of the chair and monitor, the distance form the seat's back to the keyboard, the distance form the seat's back to the center of the monitor and the placement of the footrest, are capable of reducing discomfort levels in eight body parts, including the lower back, the eyes, the upper back, the right and left shoulders, the neck and the right and left arms (131). In addition, Johnston et al (132) indicated that working with the arm unparallel to the floor, unadjustable-height chair, inadequate leg room and fully unsupported thighs was associated with greater neck disability index scores.

2.5.2.5 Activities performed while using computer

The prevalence of spinal pain was related to activities performed while using computer. Playing game on computer may reduce risk of upper extremity pain. Hakala et al (50) suggested that basic mechanism of game playing, mostly requiring repetitive hand motion in sitting position, relies on dynamic action, where players change postures freely and the loading of the upper extremities is minimized.

2.5.2.6 Typing characteristic

Touch-typing may be a protective factor for upper extremity musculoskeletal disorder (115). Jacob et al (133) showed that students who could touch type were 54% less likely to report neck, upper extremity and back pain than those who did not know how to touch type. They hypothesized that students who could touch type have positioned themselves in a better posture during computer tasks. Another hypothesis is that those who touch type can finish computer tasks quicker and therefore spend less time on the computer than those who cannot touch type (115).

2.5.2.7 Duration of computer use

Several studies indicated that duration of computing, mouse and keyboard use were associated with higher prevalence of musculoskeletal symptoms (18-19, 33, 58-59, 71, 109, 115, 134-136). Katz et al (18) found that the risk of experiencing upper extremity pain was 1.4 fold for those who reported at least 20 hour per week of computer use in comparison with those who had little or no computer use. The finding is in line with Jacobs (115), Amick (136), Schlossberg (19), Jensen (59), Marcus (71) and Chang (33). Three prospective cohort studies assessed the duration of computer use at work and confirmed the positive association between the duration of computer use at work and the onset of neck/shoulder, arm, wrist and hand symptoms. Gerr et al (84) showed that newly hired employees with computer use for more than 15 hours a week had a high incidence of neck shoulder and hand/arm symptoms after 3 years follow up. Nakazawa et al (137) found a significant relationship between duration of daily VDT use and physical symptoms score after adjusting for confounding factors. The physical symptoms score became higher with increasing duration of daily visual display terminal use with no threshold effect. Moreover, the same results were obtained consistently over a 3-year period. In a recent 2-year prospective study on Dutch computer office workers indicated that one of main predictors for occurrence of neck and shoulder complaints was a number of working hours/day with computer (80). A summary of recent longitudinal studies in office workers showed that mouse usage more than 10-20 hour per week is a risk factor for hand/arm, forearm and shoulder symptoms (52, 58, 71, 119, 122, 138-140). Intensive computer work causes continuous contraction of the neck and shoulder muscles which consequently may lead to an accumulation of musculoskeletal overload and/or insufficient time for the natural healing process of injured structures, resulting in neck symptoms (141).

Although duration of computer use is widely known to be associated with musculoskeletal symptoms, particularly in the neck and upper extremity, little attention has been given to the association between duration of computer and musculoskeletal symptoms in low back. Hakala et al (50) showed that computer use more than 5 hour per day caused greater musculoskeletal discomfort of low back in adolescent. It may be related to prolonged sitting posture. Lack of movement during sitting leads to the reduction of fluid exchange in the intervertebral discs and poor blood supply to muscle (141). Evidence suggests that sustained trunk flexion reduces the ability of the spine to resist forces acting upon it (142). Prolonged sitting also induces the shortening of some muscles, such as the abdominal and hamstring muscles, as well as lengthening of other muscles such as back muscles, which result in altered biomechanical loading of the spine during movement (143).

Several studies indicated that increasing duration of mouse and keyboard use tended to increase the risk for persistent neck, shoulder, arm and hand pain but the effect were not statistically significant (58, 84). Moreover, Andersen et al (85) found that mouse and keyboard usage time did not predict the onset of prolonged or chronic pain in the neck or shoulder.

2.5.2.8 Years of computer use

Years of computer use has been found to be associated with musculoskeletal pain. Adedoyin et al (51) revealed that the 12-month prevalence of neck and low back pain in Nigirian computer users increased in those who had over four year experience with computer work. It is plausible that a greater number of year of computer use lead to an accumulation of musculoskeletal changes, resulting in development of musculoskeletal disorder (141).

2.5.3 Psychosocial factors

Although numerous physical, physiologic and clinical factors contribute to the cause of musculoskeletal symptoms, the state of chronic musculoskeletal disorders, persisting pain and its accompanying behaviors should preferably be viewed from a psychological or even social standpoint, rather than purely focusing on the pathophysiological mechanisms that underlie musculoskeletal symptoms (144). The biopsychosocial model is now widely accepted as the model for the development of chronic musculoskeletal disorders. There is extensive clinical evidence that symptoms and illness may originate from a health condition but the incidence and development of chronicity and disability often also depends on psychosocial factors (4, 145)

Psychosocial factor has been associated with the development and persistence of neck pain. In the study by Diepenmaat et al (105), an association existed between neck pain, stress and depressive symptoms among adolescents aged 12–16-years. Feldman et al (146) demonstrated that a lower mental health score was a risk factor for the development of weekly neck pain in a one-year follow-up among adolescents. Siivola et al (13) showed that psychosomatic stress symptoms in adolescence predicted neck and shoulder pain in early adulthood, which agree with the study of Vikat et al (147). Grimby-

Ekman et al (41) found that perceived stress was a risk factor for developing and persistent neck or upper back pain in Swedish undergraduate students.

Psychosocial factors have been reported in the literature to be associated with upper back pain (12). For example, Smith et al (73) found a significant association between too much overtime, high mental pressure, inadequate work support as well as inadequate work discussion and the 12-month prevalence of upper back pain.

Psychosocial factors have been shown to play an important role in experiencing low back pain (148). Smith et al (29) reported that high mental pressure was a strong risk factor for low back symptoms among medical students. Diepenmatt et al (105) showed that stress was associated with a high prevalence of neck/shoulder and low back pain among adolescents. A number of cohort studies reported an association between back pain and psychological factors (25, 148-150). Croft et al (149) found that psychological distress, as measured by the General Health Questionnaire, was predictive of low back pain. Perez (150) reported an association between psychological factors and back pain among healthy workers using prospective data from the Canada's National Population Health Survey. In Mitchell's study, higher stress was a significantly predictor of new onset LBP in nursing students (25).

Evidence suggests that psychosocial factor also play a contributing role in the persistence of back pain. Pincus et al (151) conducted a systematic review regarding the effect of psychological factors in the development of chronicity in low back pain. The authors found that the influence of psychological factors with regard to the correlation between psychological distress/depressive moods increased the risk of chronicity.

2.5.4 Clinical factors

Clinical factors, such as muscle strength, endurance, joint mobility or flexibility, are related to spinal posture (147, 152) or spinal stability (153), both of which may have an association with spinal pain (152, 154). Hamberg-van Reenen et al (155) stated that an imbalance between exposure and clinical factors was a risk factor for musculoskeletal pain in the long term. However, these associations were not consistently found for several exposures and clinical factors. In short term, an imbalance between exposure factors and clinical factors may lead to musculoskeletal discomfort in and around active and passive structures (i.e. muscles, tendons and joints). Musculoskeletal discomfort can manifest as tension, fatigue, soreness, heat or tremor. Perceived musculoskeletal discomfort is generally used as a subjective indicator of short-term effects. In the case of insufficient recovery, short-term effects may end as more permanent effects, that is, persistence of musculoskeletal pain (156-157).

2.5.4.1 Neck muscle performance

Very few studies reported on the relation between clinical factors (muscle performance) and the risk of developing neck pain (79, 158-159).

Neck mobility as a risk factor for neck pain has been investigated in previous studies but with conflicting results. Haughie et al (159) found that office workers who complained of neck pain demonstrated an association between forward head posture and reduced neck extension range of motion. Hush et al (79) reported that increased neck flexion and extension decreased risk of neck pain in Australian office workers. Similarly, Hagen et al (160) found that subject who reported neck pain had significantly lower neck range of motion, especially neck rotation and neck extension, than subjects who reported no neck pain. However, in a higher quality study of male student fighter pilots, the incidence of neck pain was not predicted by neck flexion and extension range of motion (158).

Non-specific neck pain results from poor posture, arising through the long-termed abnormal physiological loads on the neck, with a consequent reduction in neck muscle strength and endurance (161). Currently, an association between neck pain and neck muscle endurance have been established (162-163). Neck extensor muscle endurance (162) and neck flexor muscle endurance (163) were found to be a significantly less in subjects who reported neck pain than subjects who report no neck pain.

2.5.4.2 Back muscle performance

Insufficient muscle endurance leads to physical fatigue, which may contribute to increased risk of major trauma or cumulative injuries (164). Luoto et al (164) revealed that the risk of developing LBP is much higher among persons with poor performance in static back endurance test than in those with medium or good performance results. Several longitudinal studies reported on the relation between clinical factors (muscle performance) and risk of developing low back pain. Biering-Sorensen et al (165-166) found that decreased trunk muscle endurance was a predictor of first-time occurrence of low back pain in middle aged general population. Mitchell et al (25) found the same association in Australian female nursing students. Alranta et al (167) revealed an odds ratio of 3 in low back pain workers who had poor trunk muscle endurance compared to those with good performance.

Based on anatomic position and function of the abdominal muscles, it has been speculated that abdominal muscle weakness produces an anterior pelvic tilt and lumbar hyperlordosis, resulting in LBP (168). Salminen et al (169) evaluated muscle endurance in trunk flexors and extensors in 15-year old teenagers and showed that children with low back pain had lower trunk flexor muscle endurance than a control group. In contrast to these findings, Bernard et al (170) showed no significant difference in trunk flexors endurance between healthy teenagers and teenagers with chronic low back pain.

Spinal flexibility appears to be a risk indicator for developing LBP in the study population. Jones et al (171) reported that spinal flexibility was identified as significant risk indicators of recurrent low back pain in adolescent aged 12-16 years, this finding was supports by previous studies (172). Takala et al (173) and Adams et al (174) found that reduction in lumbar flexion increased risk of developing low back pain in working population.

Nerve tension is another factor that has also been found to associate with musculoskeletal symptoms. Peripheral nerve dysfunction has been found to relate with upper limb pain in computer operator (175-176). Some studies (176) found that keyboard users had an abnormal upper limb tension test when compared to non-keyboard users.

Muscle tightness is one of the most common findings in patients with LBP. Due to attachments of hamstrings to the ischial tuberosity, hamstrings tightness generates posterior pelvic tilt and decreases lumbar lordosis, which can result in LBP (168, 177). Poor hamstrings flexibility has been associated with low back pain in cross-sectional studies in both adolescents and adults (169, 178-179), although longitudinal research in a cohort of workers has not confirmed this finding (180). In addition, some researchers found decreased quadriceps and iliopsoas muscle flexibility in patient with LBP (16, 181-182). Fledman et al (16) found that decreased quadriceps flexibility was associated with the development of low back pain among high school students.

2.6 Tools and measurements

Impaired muscle function is closely related to pathogenesis of development and persistence of musculoskeletal pain (183-184). Thus, many studies have been performed to evaluate muscle function by using various methodologies (165, 185). In order to evaluate muscle function, reliable measures are needed for use in clinical and community setting (186).

2.6.1 Neck mobility measurement

There are several instruments used to measure neck mobility, including of rangiometer, fluid-filled goniometer, electronic goniometer, gravity goniometer, the cervical range of motion device (CROM), inclinometer and tape measurement (187-189). CROM device showed a good reliability for assessing neck range of motion (190). However, this device is expensive. Myrin goniometer is reliable device to measure neck mobility (191). Malmstrom et al (191) demonstrated moderate to good intratester reliability of Myrin goniometer scores ranging from 0.77 to 0.95. In addition, Myrin goniometer is a simple tool for clinical use (192).

2.6.2 Neck muscle endurance measurement

Muscle endurance can be defined as the ability to produce work over time or the ability to sustain effort (193). Isometric muscle endurance test has been found to be a reliable tool for measuring neck muscle endurance (194). Harris et al (163) examined both symptomatic and asymptomatic subjects and reported moderate interrater reliability for neck flexor endurance test in symptomatic subjects (ICC = 0.67). The interrater reliability of the test in asymptomatic subjects was moderate to good (ICC = 0.67-0.78) and the intrarater reliability was good to excellent (ICC = 0.82-0.91). Edmondston et al (194) determine the reliability of isometric neck flexion and neck extension muscle endurance test in subjects with postural neck pain. Reliability was excellent for the neck flexor test (ICC=0.93) and good for the neck extensor test (ICC = 0 88).

2.6.3 Trunk muscle endurance measurement

There are several types of back muscle endurance testing, such as isometric endurance test, active measures of endurance, isokinetic and electromyographic testing (186). Most clinicians select isometric endurance testing for measuring trunk muscle endurance (195). The reliability of the Biering-Sørensen test has been evaluated but different results have been reported (193, 196-199). Mayer et al (198) and Ljungquist et al (197) found a low reliability of the test in healthy persons and patients with low back pain whereas others concluded that its reliability was high (200).

Researchers have attempted to find techniques for assessing trunk flexor muscle endurance with a variety of machines, such as electromyography (201) and computerize dynamometer (198). The disadvantages of these machines are time-consuming and expensive. Thus, Ito et al (193) developed isometric trunk endurance test for assessing trunk flexor muscle endurance to overcome these disadvantages. They found that isometric trunk flexor endurance test reproduced highly reliable scores as well as was safe and easy for use (193).

2.6.4 Trunk flexibility measurement

Clinicians have attempted to quantify lumbar spine range of motion with a variety of techniques and instruments, such as tape measurement method, goniometer, inclinometer and back range of motion (BROM) device. Method frequently used in clinical setting to measure lumbar active range of motion is tape measurement method or Modified Schober test (MST). Previous research found a very high correlation between MST and gold standard (202-203).

2.6.5 Muscle length measurement

There are numerous methods for assessing hamstring length, such as straight leg raise (SLR), sit and reach test, toe-touch test and active knee extension test (AKET) (204-207). AKET was selected to measure hamstring length because the test stabilizes the hip joint, sacroiliac joint and lumbar spine (207). Rakos et al (207) also showed good interrater reliability of AKET with ICC [2,1] of 0.79.

There is little evidence documenting the reliability of the modified Thomas test. The most commonly instrument used for quantifying the results of this test is a goniometer. Winters et al (208) reported that modified Thomas test has a good reliability for the quadriceps muscle length assessment in healthy subjects.

2.6.6 Nerve tension measurement

Studies on reliability and validity of upper limb tension test (ULTT) has been limited. Selvaratnam et al (209) examined the reliability of ULTT and found that the ULTT had an intra-examiner reliability of 0.83.

Hsieh et al (210) compared three instruments in the assessment of passive straight-leg-raising test: a standard plastic goniometer, a flexometer, and a tape measure. Hip flexion angles at the initial point of pelvic tilt were measured in 10 healthy subjects. All three methods showed excellent intrasession reliability with alpha coefficients greater than 0.94.

CHAPTER III

MATETIALS AND METHODS

3.1 Research design

A prospective cohort study for 1-year follow up was conducted to determine the incidence and risk factors for development and persistence of musculoskeletal symptoms. A cohort of undergraduate students without neck, upper back and low back pain in the previous 3 months was assessed by using a self-administered questionnaire and physical examination at baseline and then prospectively followed every 3 months over a 12-month period. The study was approved by the Thammasat University Human Ethics Committee (Appendix C).

3.2 Participants

3.2.1 Sample size calculation

Since the design of this research is the cohort design, which studies the incidence of spinal symptoms in students aged 18-25 years old who currently use desktop or laptop computers, the number of the sample size can be appropriately calculated by the following equation

$$n_1 = \frac{(Z_\alpha + Z_\beta)^2 \times \overline{PQ} \times (r+1)}{(P_1 - P_0)^2 \times r}, \quad \overline{P} = \frac{P_1 + rP_0}{1+r} \quad \text{and} \quad r = \frac{n_0}{n_1}$$

Where n_1 = Number of exposed group

n_0 = Number of non-exposed group

r = Ratio of number of non-exposed group versus exposed group

Z_α = Z-score at α level : α level at 0.05 Therefore, Z-score equals 1.96

Z_β = Z-score at β level : β level at 0.90 Therefore, Z-score equals 1.28

Q = 1-P

P_1 = Probability of the event occurring in the exposed group

P_0 = Probability of the event occurring in the non-exposed group

According to a study of incidence and prevalence of work-related musculoskeletal disorder at shoulder, elbow and low back regions in office workers, who worked with computer for more than 20 hours per week, the results revealed that the occurrence of work-related musculoskeletal disorder at those regions in office workers was 23%, which was detected with 90% statistical power and at 95% of Confidence Interval (CI). It was also found that office workers who worked with computer for more than 20 hours per week was at 1.5–time greater risk of developing work-related musculoskeletal disorder at shoulder, elbow and low back regions than office workers, who worked with computer equal to or less than 20 hours per week. Although the target population of the present study was not office workers, postures or activities while working with computer were comparable. Thus, the above mentioned information was used to determine the sample size for this study. The ratio of number of exposed group and non-exposed group was set at 1:4 (r = 4).

Due to P_1 = 0.23 and Relative Risk (RR) = 1.5

Therefore P_0 = 0.23 /0.15 = 0.153

$\overline{P}$ = (0.23+(4 x 0.1533))/ (1+4) = 0.1686

Q = 1-0.1686 = 0.8314

$$n_1 = \frac{(1.96 + 1.28)^2 \times (0.1686 \times 0.8314) \times (4+1)}{(0.23-0.1533)^2 \times 4}$$

= 313.646 = 314

Therefore, the number of participants of exposed group required were 314 and participants of non-exposed group required were 314 × 4 = 1,256. The total number of participants required was 314 + 1,256 = 1,570. Furthermore, non-response rate was expected to be 20% of the total number of participants required, which were 314. Therefore, the total number of sample required for this study was 1,570 +314 = 1,884.

3.2.2 Study population

In this study, subjects were included if they were undergraduate students at Thammasat University, aged between 18-25 years old and currently used desktop or notebook computers. Subjects were excluded from the study if they had neck, upper and low back pain in the previous 3 months, had any known central/peripheral neurological or musculoskeletal disorders, which were confirmed by a doctor, and had a history of upper extremity, lower extremity or spinal surgery. A cohort of undergraduate students was assessed at baseline and prospectively followed every three months over a 12-month period.

3.3 Instrumentations

3.3.1 Self-administered questionnaire which consisted of four sections: individual, computer-use related and psychosocial factors as well as musculoskeletal symptoms in the neck, upper back and low back regions (Appendix B)

3.3.2 A Myrin goniometer (Sammons Preston, Patterson Medical, USA)

3.3.3 A Plurimeter (Dr.Rippstein, Switzerland)

3.3.4 Standard goniometer

3.3.5 Tape measurement

3.3.6 Stopwatch

3.3.7 Plinth and belts

3.3.8 Chair

3.3.9 Cross bar

3.4 Outcome measurement

3.4.1 Dependent variable

Dependent variable was musculoskeletal symptoms in the neck or upper back or low back regions lasting more than one day in the past 3 months. The area of each body regions was defined by the standardized Nordic questionnaire (Figure 3.1) (211).

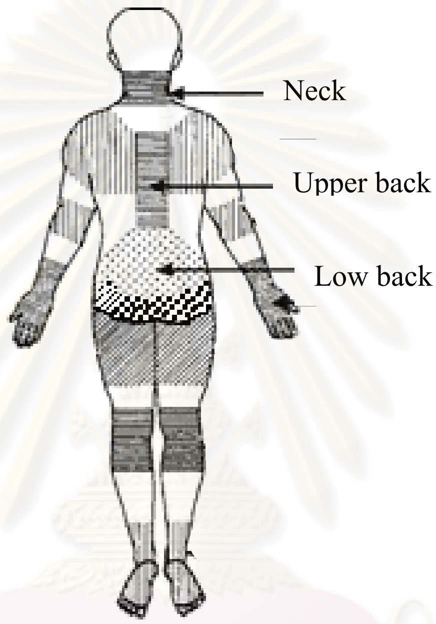


Figure 3.1 Defined anatomical areas of the neck, upper back and low back regions in self-administered questionnaire (211).

3.4.2 Independent variables

Independent variables were measured by using a self-administered questionnaire and physical examination. Independent variables assessed by using a self-administered questionnaire included:

a) Individual factors included gender (male or female), age, height, body weight, year of study (1^{st} to 5^{th} year), chronic diseases (yes or no), field of study (art/humanities or science) and frequency of weekly exercise sessions (regularly, occasionally or never).

b) Computer-use related factors included type of computer (desktop, notebook or both), years of computer use and average number of daily computer use (hours/day). Respondents were asked whether during computer use their neck, upper back, low back and arm were supported, their feet were flat on the floor and their elbows, hips, knees and ankles were positioned at 90 degree flexion (yes or no). The questionnaire asked respondents to self-rate the appropriateness of position of computer screen, keyboard and mouse/touch pad during computer use (suitable, too high or too low) and to specify the percentage time of computer use for study and entertainment as well as the percentage of duration using keyboard, mouse/touch pad. Information about a habitual posture while using a computer.

c) Psychosocial factors included the Thai Mental Health Indicator Questionnaire (TMHI15). The test was developed by Apichai et al (212) for assessing mental health status in the Thai population. The test consists of 15 questions assessing general well being, confidence in coping, kindness and altruism, self-esteem and supporting factors. Each question was rated by the subject according to four levels (0 = completely disagree, 1 = somewhat disagree, 2 = somewhat agree, 3 = completely agree). Respondents were asked whether the statements applied to them during the preceding 1 month. The total score of the test ranged from 0 to 45. The mental health score was scaled into three groups (less than 27 = worse-than-normal, 28-34 = normal, 35-45 = better-than-normal).

Independent variables collected by using physical examination included neck range of motion (flexion, extension, lateral flexion and rotation), upper and lower extremity muscle length (pectoralis major, quadriceps and hamstrings), muscle endurance (neck extensor, neck flexor, trunk extensor and trunk flexor), trunk flexibility (flexion, extension and lateral flexion), nerve tension (upper limb tension and straight leg raising tests).

3.5 Procedure

Step 1 - Preparation

Literature relevant to this study was reviewed. A self-administered questionnaire for data collection was developed. After completion of drafted questionnaire, two experts reviewed the drafted questionnaire to improve the validity of questionnaire. Questionnaire was pre-tested by using a focus group, consisting of 30 undergraduate students, who met the inclusion criteria of the study. The aim of the pre-test was to clarify the questionnaire. The questionnaire was revised based on the recommendations made by the focus group.

Also, a researcher reviewed details of each physical examination, which was performed in the study. Each physical examination was standardized and two research assistants were trained to help a research in performing a physical examination.

Step 2 - Data collection

A prospective cohort study was conducted with a convenience sample of 684 undergraduate students. All students enrolled in Thammasat University, which is a large public university in Thailand with an average total number of 33000 students annually. The subjects were asked if they wish to participate in this study. The details of the study were then fully explained to the subjects (Appendix E). The agreed subjects gave consent in writing (Appendix F). A self-administered questionnaire was distributed to each student by hand. The researcher returned to collect the completed questionnaire after a few days. Subjects then underwent physical examination, which took a 60-minute single session to complete.

Physical examination

Each participant underwent a physical examination, conducted by a researcher according to standardized protocol. The physical examination included the following:

1. Neck range of motion assessment Active range of motion was assessed for neck flexion, extension, rotation and lateral rotation using a Myrin goniometer (213).

1.1 Neck flexion: Subject sat on chair, looking directly forward with the neck in a neutral position (Figure 3.2a). A Velcro strap was fixed around the skull, level with the top of the ears. A Myrin goniometer was placed on the Velcro strap above the tip of the left ear. Subject was asked to flex the head forward as far as possible, bringing the chin to the chest as shown in Figure 3.2b. The examiner recorded the degrees of neck flexion.

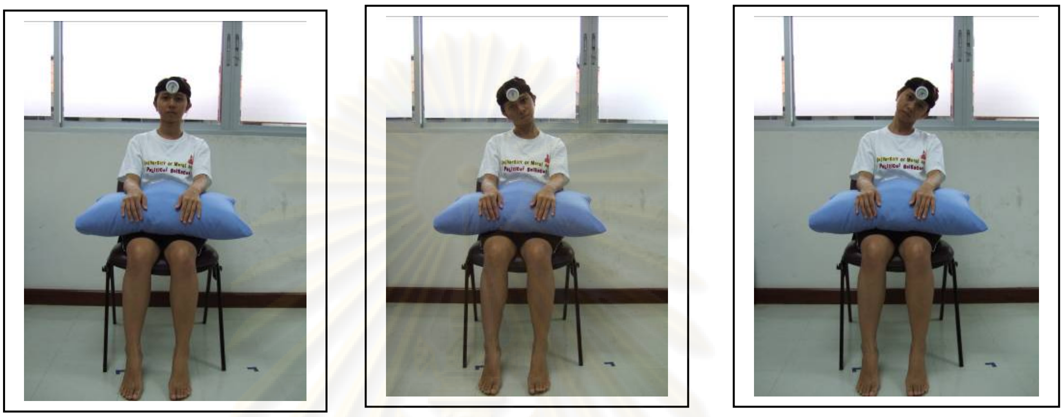
1.2 Neck extension: Subject sat on chair, looking directly forward with the neck in a neutral position (Figure 3.2a). A Velcro strap was fixed around the skull, level with the top of the ears. A Myrin goniometer was placed on the Velcro strap above the tip of the left ear. Subject was asked to extend the head backward as far as possible as shown in Figure 3.2c. The examiner recorded the degrees of neck extension.

(a) (b) (c)

Figure 3.2 Neck flexion and extension range of motion assessment. (a) Neutral position, (b) Neck flexion, (c) Neck extension

1.3 Neck lateral flexion: Subject sat on chair, looking directly forward with the neck in a neutral position (Figure 3.3a). A Velcro strap was fixed around the skull, level with the top of the ears. A Myrin goniometer was placed on the Velcro strap at forehead.

Subject was asked to move the right ear to the right shoulder as shown in Figure 3.3b. The examiner recorded the degrees of neck right lateral flexion. After that, subject was asked to move the left ear to the left shoulder as shown in Figure 3.2c. The examiner recorded the degrees of neck left lateral flexion.



(a) (b) (c)

Figure 3.3 Neck lateral flexion range of motion assessment. (a) Neutral position, (b) Right lateral, (c) Left lateral flexion

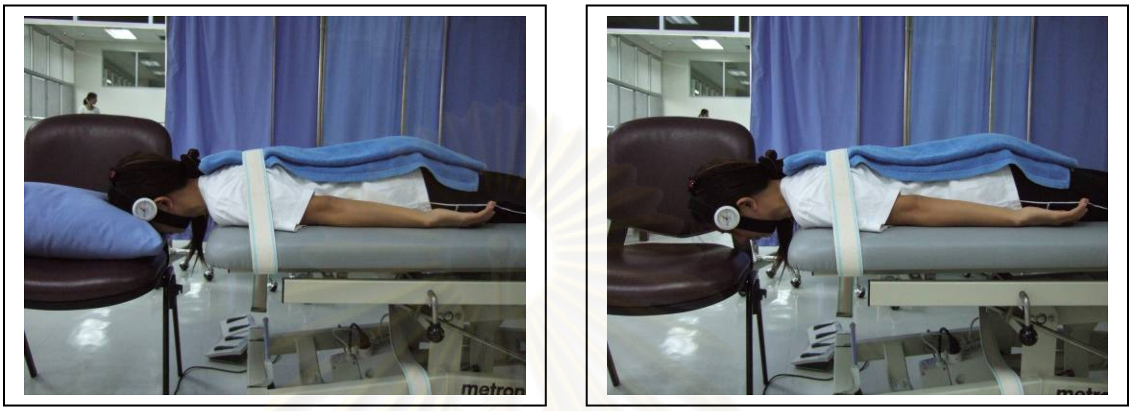
1.4 Neck rotation: Subject sat on chair, looking directly forward with the neck in a neutral position (Figure 3.4a). A Velcro strap was fixed around the face, level of the Velcro strap passed the ears. A Myrin goniometer was placed on the Velcro strap on vertex. Subject was asked to right and left rotate as far as possible as shown in Figure 3.4b and c, respectively. The examiner recorded the degrees of neck rotation in each direction.

(a) (b) (c)

Figure 3.4 Neck rotation range of motion assessment. (a) Neutral position, (b) Right rotation, (c) Left rotation

2. *Neck extensor and flexor muscles endurance assessment* Neck extensor and flexor muscles endurance was assessed according to the procedures described by Lee (214) and Harris et al (163), respectively.

2.1 Neck extensor muscles endurance Subject lied prone on a plinth, with their head and neck initially supported over the end and arms alongside their trunk. A strap placed across the T2 level. A Velcro strap was fixed around the skull, level with the top of the ears. A Myrin goniometer was placed on the Velcro strap immediately above the tip of the right ear (Figure 3.5a). Subject was instructed to hold the head steady in a cervical spine horizontal position. The test was started by removing the support, then requiring the subject to hold the head steady in a position with the chin retracted and the cervical spine horizontal as shown in Figure 3.5b. The test was discontinued if the subject terminated it because of fatigue or pain, or if the subject lost more than 5 degrees of upper cervical spine retraction for more than 5 seconds. The examiner then recorded neck extensor endurance in seconds.



(a) (b)

Figure 3.5 Neck extensor muscles endurance assessment. (a) Starting position for neck extensor muscles endurance assessment, (b) Measurement of neck extensor muscles endurance

2.2 Neck flexor muscles endurance Subject lied supine, hook lying on a plinth (Figure 3.6a). Subject lifted the head and neck until the head is approximately 2.5 cm above the plinth while keeping the chin retracted to the chest as shown in Figure 3.6b. The test was discontinued if subject’s head touch the plinth for more than 1 second. The examiner then recorded neck flexor endurance in seconds.

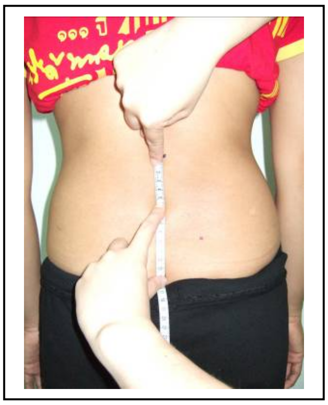
 

(a) (b)

Figures 3.6 Neck flexor muscles endurance assessment. (a) Starting position for neck flexor endurance muscles assessment, (b) Measurement of neck flexor muscles endurance

3. Upper limb nerve tension (ULNT) assessment ULNT was assessed according to the procedure described by Butler (215). Subject lied supine on the bed. Examiner depresses the shoulder girdle to stabilize shoulder girdle depression. With this position maintained, one examiner abducted, laterally rotated subject's shoulder and extended the subject's wrist and fingers and then subsequently extends the subject's elbow. The range of elbow extension was measured with standard goniometer aligned along the mid-humeral shaft, medial epicondyle and ulnar styloid. Measurements of elbow extension were taken with the arm in the upper limb tension test position.

4. Lumbar mobility assessment Lumbar flexion/extension was assessed by using the Schober test, which measured the difference in the distance between 5 cm below and 10 cm above S1/S2 in the neutral position (Figure 3.7a and b) and a position of maximum flexion/extension (216) as shown in Figure 3.7c and d. Lumbar mobility in side-bending to the left and right was measured as the distance between the points of the tips of the fingers on the thighs in a neutral standing posture and in maximal lateral bending as shown in Figure 3.8a and b (217).



(a) (b)

(c) (d)

Figure 3.7 Lumbar mobility in flexion/extension assessment. (a) The distance between 5 cm below and 10 cm above S1/S2 in the neutral position, (b) Starting position, (c) lumbar flexion mobility, (d) lumbar extension mobility

(a) (b)

Figure 3.8 Lumbar mobility in side bending assessment. (a) Starting position for lumbar mobility in side bending, (b) Measurement of lumbar mobility in side bending assessment

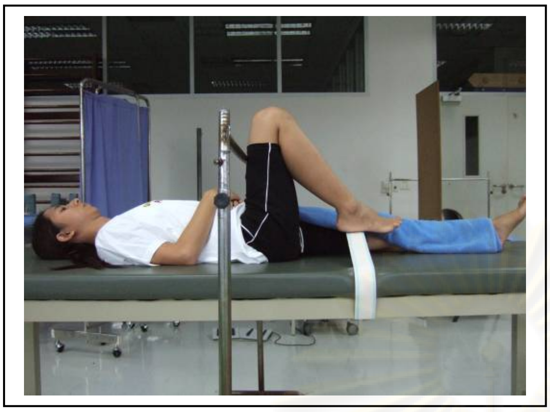
5. Muscle length assessment Quadriceps and Hamstring muscle length on both sides was assessed by the modified Thomas test (218) and the supine active knee extension test (219), respectively.

5.1 Quadriceps muscles length assessment Subject sat on the end of the plinth, rolled back on the plinth, and held both knees to the chest (Figure 3.9a). This ensured that the lumbar spine was flat on the plinth and the pelvis was in posterior rotation. The subject held the contralateral hip in maximal flexion with the arm, while the tested limb was hanged unsupported off the plinth as shown in Figure 3.9b. The examiner measured angle of knee flexion. The stationary arm of the goniometer was placed on the lateral femur in line with the greater trochanter, the moving arm was parallel to the midline of the fibula in line with the lateral malleous, and the axis was placed over the lateral condyle of the femur.

(a) (b)

Figure 3.9 Quadriceps muscle length assessment. (a) Starting position for Quadriceps muscles length assessment, (b) Measurement of quadriceps muscles length

5.2 Hamstring muscles length assessment Subject lied supine on the plinth. The subject was positioned so that the anterior test thigh was resting against the cross bar. Examiners confirmed the angle of the hip of the tested leg to be 90 degrees (Figure 3.10a). One examiner maintained the subject's tested thigh against the horizontal bar. One of the examiners positioned a Velcro strap across both anterior superior iliac spines, and a second Velcro strap around the proximal opposite thigh for stabilization. The subject was then instructed to actively extend the right knee until the subject's limit of knee extension as shown in Figure 3.10b. The angle of the tested knee was measured with the fulcrum at the lateral epicondyle of the femur and the arms of universal goniometer aligned with the greater trochanter of the femur and the apex of the lateral malleoli.



(a) (b)

Figure 3.10 Hamstring muscles length assessment. (a) Starting position for Hamstring muscles length assessment, (b) Measurement of hamstring muscles length

6. *Trunk muscles endurance assessment* Trunk extensor and flexor muscles endurance was assessed according to the procedures described by Biering-Sorensen et al (165) and Ito et al (193), respectively.

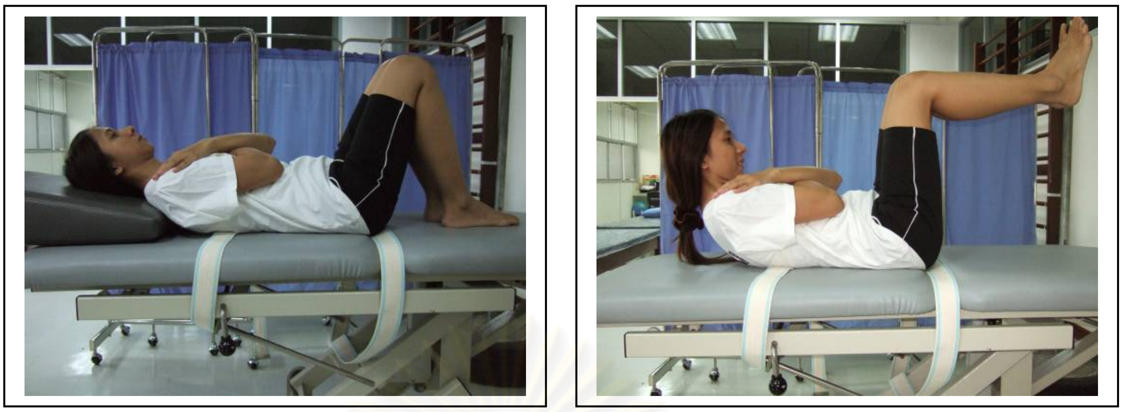
6.1 Trunk extensor muscles endurance assessment Subject lied prone on a plinth. The upper edge of the iliac crests aligned with the edge of the plinth. A strap placed across the pelvis, knee and ankle. A gravity inclinometer was placed on the back above the level of T4 (Figure 3.11a). The test started by removing the support, then requiring the subject to hold the upper body in a horizontal position as shown in Figure 3.11b. The test was discontinued if the subject terminated it because of fatigue or pain, or if subject lost more than 5-10 degree of upper body horizontal. The examiner then recorded trunk extensor muscles endurance in seconds.

(a)

(b)

Figure 3.11 Trunk extensor muscles endurance assessment. (a) Starting position for trunk extensor muscles endurance assessment, (b) Measurement of trunk extensor muscles endurance

6.2 Trunk flexor muscles endurance assessment Subject lied supine on a plinth. Subject flexed hip and knee in 90 degree and flexed cervical spine until the inferior angle of scapular above the plinth (Figure 3.12a). Endurance was measured by removing the support, then requiring the subject to hold the trunk in a flexion position, as shown in Figure 3.12b. The test was discontinued if the subject terminated it because of fatigue or pain, or if their scapular touches the plinth. The examiner then recorded trunk flexor endurance in seconds.



(a) (b)

Figure 3.12 Trunk flexor muscle endurance assessment. (a) Starting position for trunk flexor muscles endurance assessment, (b) Measurement of trunk flexor muscles endurance

7. Lower limb nerve tension assessment Straight leg rising was assessed according to the procedure described by Butler (215). Subject was asked to lay supine and completely relaxes the leg to be measured (Figure 3.13a) whilst the examiner lifted the leg off the plinth with the knee extended, as shown in Figure 3.13b. At the first point of reported stretch or discomfort, the angle between the leg and the horizontal was recorded using standard goniometer.

(a) (b)

Figure 3.13 Sciatic nerve assessment. (a) Starting position for Sciatic nerve assessment, (b) Measurement of Sciatic nerve

Follow up

Subjects were followed up every 3 months for 12 months by telephone. The yes/no question asked at each follow-up was "Have you experienced any neck, upper or low back pain lasting more than 24 hours during the past 3 months?" Those who reported neck, upper or low back pain for at least two consecutive occasions were defined as having persistent neck, upper or low back pain. Flow of procedure through the study was shown in Figure 3.12.

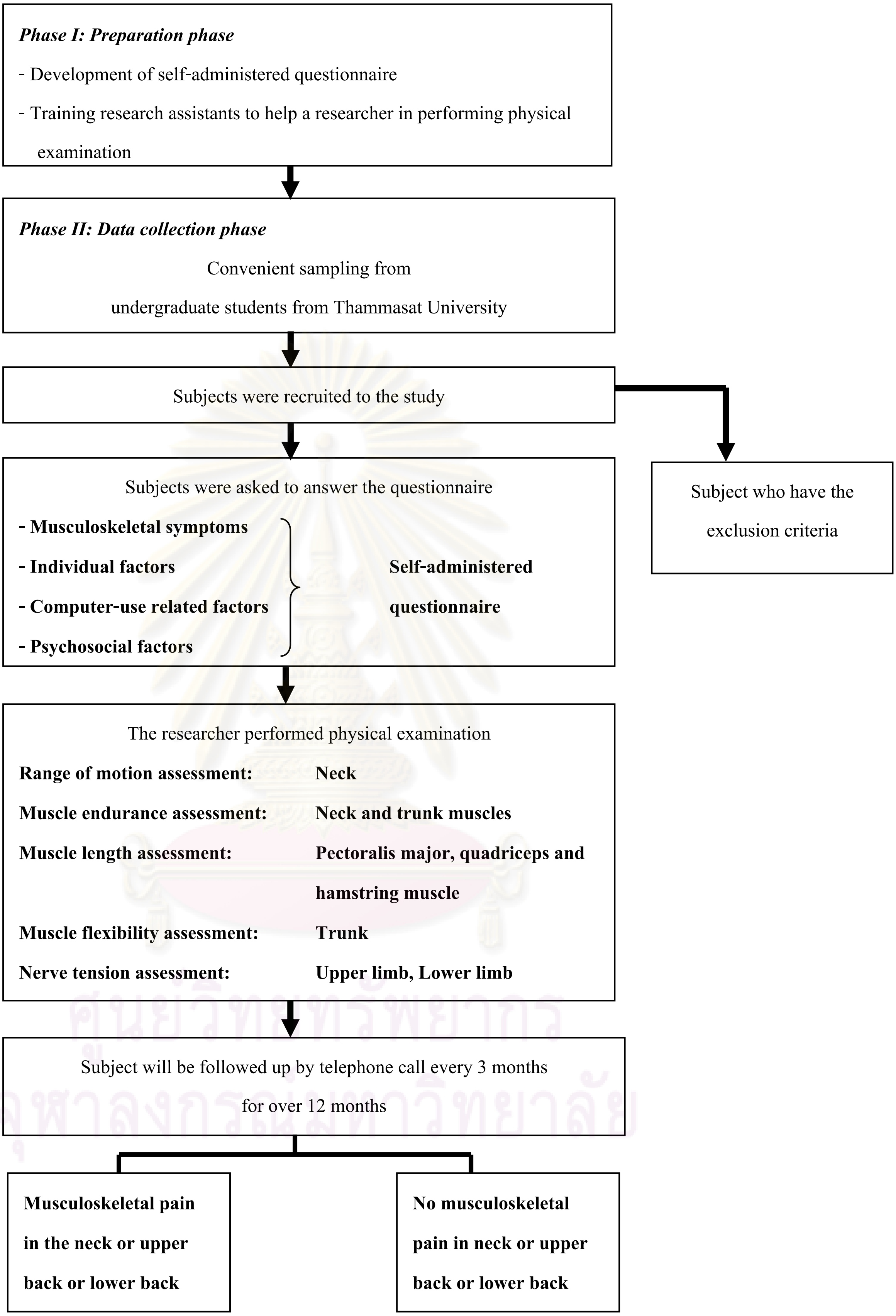


Figure 3.14 Flow of procedure through the study.

3.6 Statistical analysis

Subject characteristics were described using means or proportions. The percentage of missing data in all factors ranged from 0.2-10%. To retain the statistical power of the database, missing data were handled using the 'hot-deck imputation' procedure. A respondent was selected at random from the total sample of the study and the value for that person was assigned to the case in which this information was missing. This procedure was conducted repeatedly for each missing value until the dataset was complete (220).

Univariate analysis was carried out first to determine significant differences in the incidence and persistence of each body part with various individual, computer-related, clinical and psychosocial characteristics. The univariate analysis was conducted separately for those who reported using desktop computer, notebook computer and both. The factors with p-value ≤ 0.2 from univariate analyses were included in backward stepwise multivariate logistic regression analyses. The adjusted odds ratios (OR) and their 95% confidence intervals (95% CI) were calculated. Statistical significance was set at the 5% level.

CHAPTER IV

RESULTS

4.1 Demographic data of participants

Six hundred eighty four participants agreed to participate in this study. One hundred and sixty of the participants were lost because they could not be contacted during the 12-month follow-up period. The remaining participants were 524. The flow of number of participants though the study is illustrated in Figure 4.1. The demographic characteristics of participants are presented in Table 4.1. Most respondents were female students. This finding correlates with the University's demographic information, in which high female to male ratios were reported. With regard to age, respondents had an average age of 19 years, with the highest response receiving from the 2^{nd} year students. We also found that students in health science areas were interested in taking part of the research more than students in physical or social sciences. The respondents had an average of 2.9$\pm$ 1.8 hours computer use per day.

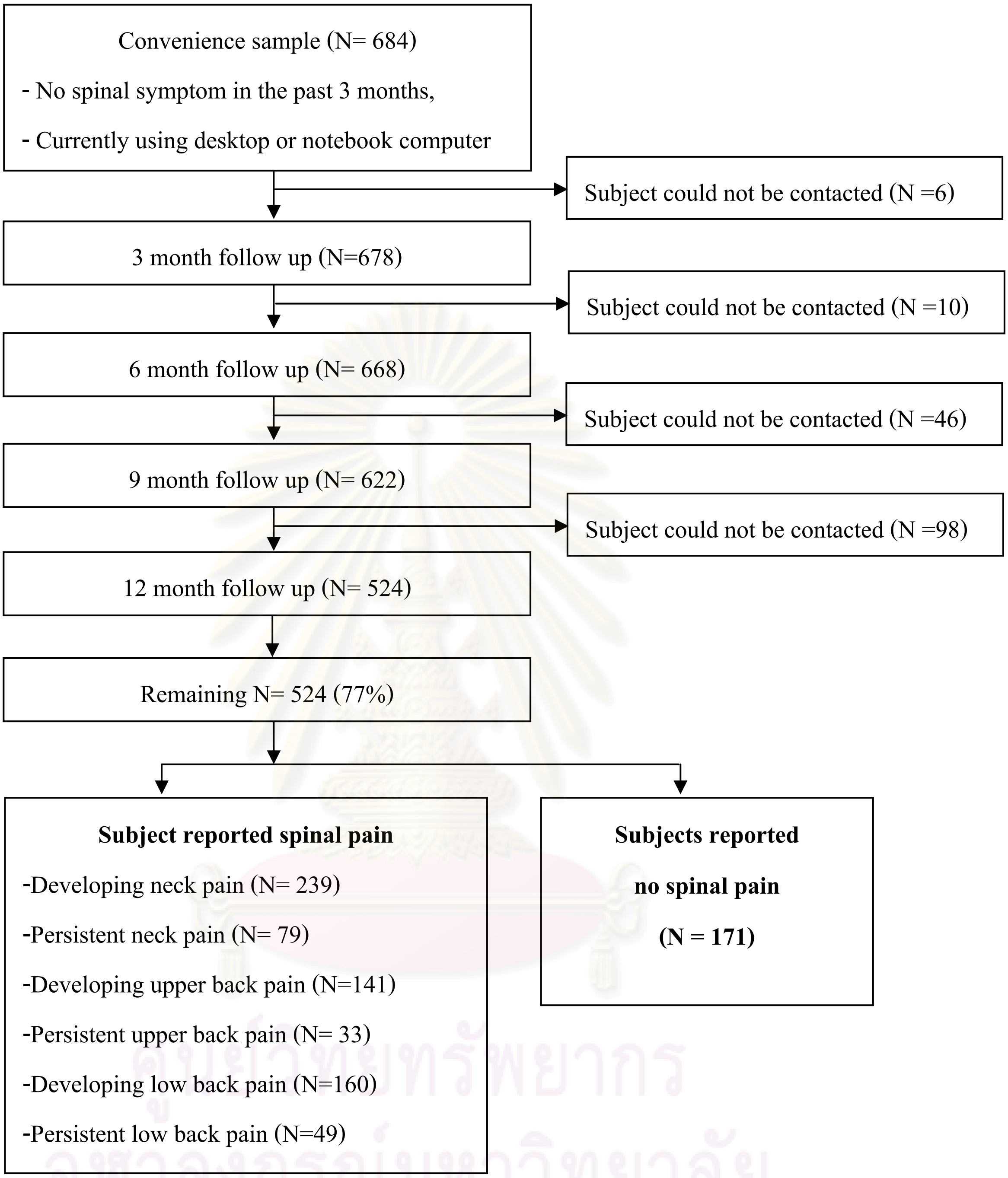


Figure 4.1 Flow of participants through the study.

Table 4.1 Characteristics of undergraduate students (n=524)

Characteristics	n	%	Mean	SD
Gender				
-Male	138	26.3		
-Female	386	73.7		
Age (years)			19.4	1.1
Year of study				
-Year 1	183	34.9		
-Year 2	247	47.1		
-Year 3	91	17.4		
-Year 4	0	0		
-Year 5	3	0.6		
Field of study				
- Art/Humanities	175	33.4		
- Science/Health science	349	66.6		
Hours of daily computer use			2.9	1.8

4.2 Annual incidence for development and persistence of neck, upper back and low back pain in undergraduate student using desktop and notebook computers

In total, there were 353 (67.4%) students who reported spinal symptoms during the one year follow up. The sites of the symptoms, in order of incidence, were neck (46%), low back (31%) and upper back (27%). Seventy-nine students (33%) who reported developing neck pain had persistent neck pain. Thirty-three students (23%) who reported developing upper back pain had persistent upper back pain. Forty-nine students (31%) who reported developing low back pain had persistent low back pain.

For those who reportedly used desktop computer, there were 130 (62.8%) students who reported spinal symptoms during the one year follow up. The sites of the symptoms, in order of incidence, were neck (42%), low back (29%) and upper back (23%). Thirty-three students (38%) who reported developing neck pain had persistent neck pain. Twelve students (21%) who reported developing upper back pain had persistent upper back pain. Eighteen students (30%) who reported developing low back pain had persistent low back pain.

For those who reportedly used notebook computer, there were 225 (71.0%) students who reported spinal symptoms during the one year follow up. The sites of the symptoms, in order of incidence, were neck (48%), low back (32%) and upper back (29%). Forty-six students (30%) who reported developing neck pain had persistent neck pain. Twenty-one students (23%) who reported developing upper back pain had persistent upper back pain. Thirty-one students (31%) who reported developing low back pain had persistent low back pain.

4.3 Risk factors for neck pain in undergraduate student using desktop computer

4.3.1 Development of neck pain

When performing unvariate analyses, factors showing p-value ≤0.2 were gender, frequency of exercise sessions, neck flexor endurance, positions of elbows, knees and ankles during computer use, positions of computer screen, keyboard and mouse as well as mental health status. Thus, these factors were selected for further analysis. Multivariable logistic regression analyses revealed that gender, frequency of exercise sessions, position of keyboard were associated with neck pain (Table 4.2).

Female students had a higher risk for developing neck pain than their male counterparts (adjusted OR = 2.57, 95%CI =1.24-5.34)

Frequency of exercise sessions was categorized into three categories (1= regularly, 2= occasionally, 3= never). Never exercise increased risk of developing neck pain compared to regularly exercise (adjusted OR = 3.60, 95%CI =1.13-11.44)

Self-rated keyboard position was categorized into three levels (1 = suitable, 2 = too high, 3= too low). Students reporting that the keyboard position was too low were at lower risk of experiencing developing neck pain than those reporting the keyboard position to be suitable (adjusted OR = 0.28, 95%CI =0.09-0.83).

Table 4.2 Incidence of neck symptoms in undergraduate student using desktop computer and adjusted odds ratio (OR_{adj}) with 95% confidence intervals (95% CI) with respect to factors in the final modeling (n=207)

Factors	N	Incidence n (%)	OR_{adj}	95%CI	*P*
Gender					
- Male	59	16 (27.1)	1.00		
- Female	148	71 (48.0)	2.57	1.24-5.34	0.012*
Frequency of weekly exercise sessions					
- Regularly	39	11 (28.2)	1.00		
- Occasionally	145	62 (42.8)	1.33	0.57-3.13	0.507
- Never	23	14 (60.9)	3.60	1.13-11.43	0.030*
Ankles are positioned at 90 degree angle					
- Yes	74	25 (33.8)	1.00		
- No	133	62 (46.6)	1.75	0.94-3.25	0.079
Keyboard height					
- Suitable	162	70 (43.2)	1.00		
- Too high	21	12 (57.1)	1.80	0.69-4.71	0.233
- Too low	24	5 (20.8)	0.28	0.09-0.83	0.021*

Significance and OR_{adj} with 95%CI from the multivariate analysis, *$P \leq 0.05$

4.3.2 Persistence of neck pain

When performing unvariate analyses, factors showing p-value ≤0.2 were gender, neck right and left lateral flexion range of motion, neck flexor endurance, neck extensor endurance, year of computer use, percentage of computer use for entertainment, positions of ankles during computer use, whether they had upper back and arm support characteristic of typing, positions of keyboard and mouse as well as mental health status. Thus, these factors were selected for further analysis. Multivariable logistic regression analyses revealed that neck extensor muscle endurance were associated with persistent neck pain (Table 4.3).

Neck extensor muscle endurance was categorized into two groups (1= > 522 sec, 2 = ≤ 522 sec). Students who had neck extensor endurance ≤ 522 sec were at greater risk of persistent neck pain than those student who had neck extensor endurance > 522 sec (adjusted OR = 2.53, 95%CI =1.06-6.05).

Table 4.3 Rate of persistent neck symptoms in undergraduate student using desktop computer and adjusted odds ratio (OR_{adj}) with 95% confidence intervals (95%CI) with respect to factors in the final modeling (n=207)

Factors	N	Persistent rate n (%)	OR_{adj}	95%CI	*P*
Neck Rt. Lateral flexion					
- > 44 degrees					
- ≤ 44 degrees	103	20 (19.4)	1.00		
	104	13 (12.5)	0.48	0.21-1.10	0.083
Neck extensor muscle endurance					
- > 522 sec	161	21 (13.0)	1.00		
- ≤ 522 sec	46	12 (26.1)	2.53	1.06-6.05	0.038*
Ankle is positioned at 90 degree angle					
- Yes	74	8 (10.8)	1.00		
- No	133	25 (18.8)	2.45	0.99-6.10	0.054
Keyboard height					
- Suitable	162	26 (16.0)	1.00		
- Too high	21	6 (28.6)	2.37	0.78-7.15	0.127
- Too low	24	1 (4.2)	0.18	0.02-1.41	0.101

Significance and OR_{adj} with 95%CI from the multivariate analysis, $*P \leq 0.05$

4.4 Risk factors for neck pain in undergraduate student using notebook computer

4.4.1 Development of neck pain

When performing univariate analyses, factors showing p-value $\leq$0.2 were gender, year of computer use, hours of daily compute use, position of elbows during computer use, upper back and elbow support as well as positions of computer screen and keyboard. Thus, these factors were selected for further analysis. Multivariable logistic regression analyses revealed that position of computer screen was associated with developing neck pain (Table 4.4).

Perception of computer screen position was categorized into two categories (1 = the computer screen was positioned at a level horizontal with the eyes, 2 = the computer screen was not positioned at a level horizontal with the eyes). Students reporting that computer screen position was not level with the eyes were at greater risk of developing neck pain than those reporting that computer screen position was level with the eyes (adjusted OR =1.72, 95%CI =1.09-2.72).

Table 4.4 Incidence of neck symptoms in undergraduate student using notebook computer and adjusted odds ratio (OR_{adj}) with 95% confidence intervals (95% CI) with respect to factors in the final modeling (n=317)

Factors	N	Incidence n (%)	OR_{adj}	95%CI	*P*
Computer screen is positioned at a level horizontal with the eyes					
- Yes	121	48 (39.7)	1.00		
- No	196	104 (53.1)	1.72	1.09-2.72	0.021*

Significance and OR_{adj} with 95%CI from the multivariate analysis, *$P \leq 0.05$

4.4.2 Persistence of neck pain

When performing univariate analyses, factors showing p-value ≤0.2 were year of study, body mass index, year of computer use, positions of computer screen, keyboard and mouse as well as habitual posture while using a computer. Thus, these factors were selected for further analysis. Multivariable logistic regression analyses revealed that year of study and positions of keyboard were associated with persistent neck pain (Table 4.5).

Year of study was divided into 5 groups (1st year to 5th year). Second year students were at higher risk of experiencing persistent neck pain than first year students (adjusted OR = 2.52, 95%CI = 1.10-5.77).

Self-rated keyboard position was categorized into three levels (1 = suitable, 2 = too high, 3= too low). Students reporting that keyboard position was too high were at greater risk of experiencing persistent neck pain than those reporting keyboard position to be suitable (adjusted OR = 2.31, 95%CI =1.13-4.71).

Table 4.5 Rate of persistent neck symptoms in undergraduate student using notebook computer and adjusted odds ratio (OR_{adj}) with 95% confidence intervals (95%CI) with respect to factors in the final modeling (n=317)

Factors	**N**	**Persistent rate n (%)**	**OR_{adj}**	**95%CI**	***P***
Year of study					
- 1^{st} year	87	8 (9.2)	1.00		
- 2^{nd} year	167	33 (19.8)	2.52	1.10-5.77	0.029*
- 3^{rd} year	62	5 (8.1)	0.98	0.30-3.21	0.978
- 5^{th} year	1	0 (0)	0	0	1.000
Keyboard height					
- Suitable	208	26 (12.5)	1.00		
- Too high	64	16 (25.0)	2.31	1.13-4.71	0.021*
- Too low	45	4 (8.9)	0.72	0.23-2.17	0.557

Significance and OR_{adj} with 95%CI from the multivariate analysis, *$P \leq 0.05$

4.5 Risk factors for upper back pain in undergraduate student using desktop computer

4.5.1 Development of upper back pain

When performing univariate analyses, factors showing p-value ≤ 0.2 were gender, year of study, neck flexion range of motion, neck flexor endurance, percentage of computer use for study, position of elbows and knee during computer use, whether they had arm and wrist support as well as positions of keyboard and mouse. Thus, these factors were selected for further analysis. Multivariable logistic regression analyses revealed that gender and position of keyboard were associated with upper back pain (Table 4.6).

Female students had a higher risk for developing upper back pain than their male counterparts (adjusted OR = 2.66, 95%CI =1.07-6.59)

Self-rated keyboard position was categorized into three levels (1 = suitable, 2 = too high, 3= too low). Students reporting that the keyboard position was too high were at greater risk of experiencing developing upper back pain than those reporting the keyboard position to be suitable (adjusted OR = 5.22, 95%CI =1.94-14.08).

Table 4.6 Incidence of upper back symptoms in undergraduate student using desktop computer and adjusted odds ratio (OR_{adj}) with 95% confidence intervals (95% CI) with respect to factors in the final modeling (n=207)

Factors	**N**	**Incidence n (%)**	**OR_{adj}**	**95%CI**	***P***
Gender					
- Male	59	7 (11.9)	1.00		
- Female	148	41 (27.7)	2.66	1.07-6.59	0.035*
Neck flexion					
- > 52 degrees	100	29 (29.0)	1.00		
- ≤ 52 degrees	107	19 (17.8)	0.53	0.26-1.09	0.083
Keyboard height					
- Suitable	162	32 (19.8)	1.00		
- Too high	21	21 (52.4)	5.22	1.94-14.08	0.001*
- Too low	24	24 (20.8)	0.93	0.32-2.76	0.902

Significance and OR_{adj} with 95%CI from the multivariate analysis, *$P \leq 0.05$

4.5.2 Persistence of upper back pain

When performing univariate analyses, factors showing p-value ≤0.2 were gender, year of study, neck extension range of motion, right neck rotation range of motion, percentage of computer use for study, whether they had elbow and arm support as well as positions of keyboard and mouse. Thus, these factors were selected for further analysis. Multivariable logistic regression analyses revealed that percentage of computer use for study and mouse position were associated with persistent neck pain (Table 4.7).

Percentage time of computer use for study was scaled into two classes (1= ≤70% of computer use for study, 2= >70% of computer use for study). Students who reportedly used a computer for study >70% were at higher risk of experiencing persistent upper back pain compared to those who used a computer for study ≤70%. (adjusted OR = 11.91, 95%CI =1.94-73.12).

Self-rated mouse position was categorized into three levels (1 = suitable, 2 = too high, 3= too low). Students reporting that mouse position was too high were at greater risk of persistent upper back pain than those reporting mouse position to be suitable (adjusted OR = 13.04, 95%CI = 2.83-60.11).

Table 4.7 Rate of persistent upper back symptoms in undergraduate student using desktop computer and adjusted odds ratio (OR_{adj}) with 95% confidence intervals (95%CI) with respect to factors in the final modeling (n=207)

Factors	N	Persistent rate n (%)	OR_{adj}	95%CI	*P*
Year of study					
- 1styear	96	3 (3.1)	1.00		
- 2ndyear	80	9 (11.3)	4.43	0.99-19.13	0.052
- 3rdyear	29	0 (0)	0.00	0	0.998
- 5thyear	2	0 (0)	0.00	0	1.000
Percentage time of computer use for study					
- ≤70%	194	9 (4.6)	1.00		
- >70%	13	3 (23.1)	11.91	1.94-73.12	0.007*
Mouse height					
- Suitable	154	5 (3.2)	1.00		
- Too high	38	6 (15.8)	13.04	2.83-60.11	0.001*
- Too low	15	1 6.7)	1.51	0.13-18.22	0.745

Significance and OR_{adj} with 95%CI from the multivariate analysis, *$P \leq 0.05$

4.6 Risk factors for upper back pain in undergraduate student using notebook computer

4.6.1 Development of upper back pain

When performing univariate analyses, factors showing p-value ≤0.2 were body mass index, neck extension range of motion, left neck rotation range of motion, neck extensor muscle endurance, year of computer use as well as habitual posture while using a computer. Thus, these factors were selected for further analysis. Multivariable logistic regression analyses revealed that none of risk factors was associated with developing upper back pain (Table 4.8).

Table 4.8 Incidence of upper back symptoms in undergraduate student using notebook computer and adjusted odds ratio (OR_{adj}) with 95% confidence intervals (95% CI) with respect to factors in the final modeling (n=317)

Factors	**N**	**Incidence n (%)**	**OR_{adj}**	**95%CI**	***P***
Neck flexion					
- > 52 degrees	168	57 (33.9)	1.00		
- ≤ 52 degrees	149	36 (24.2)	0.61	0.37-1.01	0.053
Neck Lt. Rotation					
- > 71 degrees	146	50 (34.2)	1.00		
- ≤ 71 degrees	171	43 (25.1)	0.63	0.39-1.03	0.066

Significance and OR_{adj} with 95%CI from the multivariate analysis, *$P \leq 0.05$

4.6.2 Persistence of upper back pain

When performing univariate analyses, factors showing p-value ≤0.2 were year of study, right upper limb tension, year of computer use, position of computer screen and characteristic of typing. Thus, these factors were selected for further analysis. Multivariable logistic regression analyses revealed that none of risk factors was associated with persistent upper back pain (Table 4.9).

Table 4.9 Rate of persistent upper back symptoms in undergraduate student using notebook computer and adjusted odds ratio (OR_{adj}) with 95% confidence intervals (95% CI) with respect to factors in the final modeling (n=317)

Factors	N	Incidence n (%)	OR_{adj}	95%CI	*P*
Computer screen is positioned at a level horizontal with the eyes					
- Yes					
- No	121	4 (3.3)	1.00		
	196	17(8.7)	2.92	0.95-8.94	0.061
Touch typing					
- Yes	61	7 (11.5)	1.00		
- No	256	14 (5.5)	0.42	0.16-1.10	0.077

Significance and OR_{adj} with 95%CI from the multivariate analysis, $*P \leq 0.05$

4.7 Risk factors for low back pain in undergraduate student using desktop computer

4.7.1 Development of low back pain

When performing univariate analyses, factors showing p-value ≤0.2 were frequency of weekly exercise sessions, year of study, left quadriceps muscle length, left hamstring muscle length, trunk extensor endurance, year of compute use, position of elbows during computer use, whether they had low back support, position of keyboard as well as habitual posture while using a computer. Thus, these factors were selected for further analysis. Multivariable logistic regression analyses revealed that left quadriceps muscle length, whether they had low back support and position of keyboard were associated with back pain (Table 4.10).

Quadriceps muscle length was categorized into two categories (1 = ≤115 degrees of knee extension, 2 = >115 degrees of knee extension). Students who had knee extension >115 degrees (i.e. tightness of Quadriceps muscle) were at greater risk of developing LBP than those student who had knee extension ≤115 degrees (adjusted OR =2.50, 95%CI =1.22-5.10).

Regarding low back support, it was categorized into two categories (1= having low back support, 2 = not having low back support). Students using chairs with no low back support during computer work were at greater risk of developing LBP than those using chairs with the low back support (adjusted OR = 3.29, 95%CI = 1.60-6.77).

Self-rated keyboard position was categorized into three levels (1 = suitable, 2 = too high, 3= too low). Students reporting that keyboard position was too high were at greater risk of experiencing developing low back pain than those reporting keyboard position to be suitable (adjusted OR = 3.32, 95%CI =1.11-9.95).

Table 4.10 Incidence of low back symptoms in undergraduate student using desktop computer and adjusted odds ratio (OR_{adj}) with 95% confidence intervals (95% CI) with respect to factors in the final modeling (n=207)

Factors	N	Incidence n (%)	OR_{adj}	95%CI	*P*
Year of study					
- 1st year	96	29 (30.2)	1.00		
- 2nd year	80	17 (21.3)	0.67	0.31-1.46	0.315
- 3rd year	29	14 (48.3)	2.59	0.98-6.84	0.054
- 5th year	2	0 (0)	0.00	0	0.999
Left quadriceps muscle length					
- ≤115 degree	108	24 (22.2)	1.00		
- >115 degree	99	36 (36.4)	2.50	1.22-5.10	0.012*
Low back is supported					
- Yes	118	24 (20.3)	1.00		
- No	89	36 (40.4)	3.29	1.60-6.77	0.001*
Keyboard height					
- Suitable	162	43 (26.5)	1.00		
- Too high	21	11 (52.4)	3.32	1.11-9.95	0.032*
- Too low	24	6 (25.9)	0.68	0.21-2.17	0.520
A Habitual posture					
- Posture 1	51	13 (25.5)	1.00		
- Posture 2	14	3 (21.4)	0.96	0.19-4.88	0.956
- Posture 3	68	15 (22.1)	0.73	0.27-2.01	0.546
- Posture 4	63	27 (49.2)	2.59	0.99-6.67	0.052
- Posture 5	9	2 (22.2)	0.39	0.05-2.76	0.343
- Posture 6	2	0 (0)	1.71	0.71-4.12	0.234

Significance and OR_{adj} with 95%CI from the multivariate analysis, $*P \leq 0.05$

4.7.2 Persistence of low back pain

When performing univariate analyses, factors showing p-value $\leq$0.2 were year of study, trunk flexor muscle endurance, left straight leg rising, whether they had arm and low back support, Thus, these factors were selected for further analysis. Multivariable logistic regression analyses revealed that none of risk factors was associated with persistent low back pain (Table 4.11).

Table 4.11 Rate of persistent low back symptoms in undergraduate student using desktop computer and adjusted odds ratio (OR_{adj}) with 95% confidence intervals (95% CI) with respect to factors in the final modeling (n=207)

Factors	N	Incidence n (%)	OR_{adj}	95%CI	*P*
Trunk flexor muscle endurance					
- > 38 sec	88	4 (4.5)	1.00		
- ≤ 38 sec	119	14 (11.8)	2.73	0.86-8.66	0.088
Lt hip flexion from SLR					
- > 73 degrees					
- ≤ 73 degrees	103	5 (4.9)	1.00		
	104	13 (12.5)	0.74	0.93-8.03	0.067

Significance and OR_{adj} with 95%CI from the multivariate analysis, $*P \leq 0.05$

4.8 Risk factors for low back pain in undergraduate student using notebook computer

4.8.1 Development of low back pain

When performing univariate analyses, factors showing p-value ≤0.2 were left hamstring muscle length, left straight leg rising, percentage of computer use for study, whether they had elbow and wrist support as well as mental health. Thus, these factors were selected for further analysis. Multivariable logistic regression analyses revealed that none of risk factors was associated with developing low back pain (Table 4.12).

Table 4.12 Incidence of low back symptoms in undergraduate student using notebook computer and adjusted odds ratio (OR_{adj}) with 95% confidence intervals (95% CI) with respect to factors in the final modeling (n=317)

Factors	N	Incidence n (%)	OR_{adj}	95%CI	*P*
Percentage time of computer use for study					
- ≤70%	296	90 (30.4)	1.00		
- >70%	21	10 (47.6)	2.22	0.90-5.50	0.084
Elbow is supported					
- Yes	64	25 (39.1)	1.00		
- No	253	75 (29.6)	0.61	0.34-1.10	0.095
Wrist is supported					
- Yes	200	56 (28.0)	1.00		
- No	117	44 (37.6)	1.63	0.99-2.66	0.053

Significance and OR_{adj} with 95%CI from the multivariate analysis, $^{*}P \leq 0.05$

4.8.2 Persistence of low back pain

When performing univariate analyses, factors showing p-value ≤0.2 were right and left quadriceps muscle length, right trunk lateral flexion, year of computer use and percentage of computer use for study. Thus, these factors were selected for further analysis. Multivariable logistic regression analyses revealed that none of risk factors was associated with persistent upper back pain (Table 4.13).

Table 4.13 Rate of persistent low back symptoms in undergraduate student using notebook computer and adjusted odds ratio (OR_{adj}) with 95% confidence intervals (95% CI) with respect to factors in the final modeling (n=317)

Factors	**N**	**Incidence n (%)**	**OR_{adj}**	**95%CI**	***P***
Left quadriceps muscle length					
- ≤115 degree	193	15 (7.8)	1.00		
- >115 degree	124	16 (12.9)	1.97	0.93-4.18	0.077

Significance and OR_{adj} with 95%CI from the multivariate analysis, *$P \leq 0.05$

The findings of the present study are summarized in Table 4.14.

Table 4.14 Summarize finding of spinal symptom in undergraduate student using desktop/notebook computer and risk factors

Region	Type of computer	Symptoms	Significant factors
Neck	Desktop	Development	- Female - Never exercise - A keyboard position self-rated as too low
		Persistence	- Decrease neck muscle endurance
	Notebook	Development	- Computer screen position not being at the eye level
		Persistence	- 2^{nd} year of student - A keyboard position self-rated as too high
Upper back	Desktop	Development	- Female - A keyboard position self-rated as too high
		Persistence	- A higher percentage time of computer use for study - A mouse position self-rated as too high
	Notebook	Development	- None
		Persistence	- None
Low back	Desktop	Development	- A keyboard position self-rated as too high - Tightness of quadriceps - Low back not being support
		Persistence	- None
	Notebook	Development	- None
		Persistence	- None

CHAPTER V

DISCUSSION

5.1 Sample size

The sample size calculation suggested that 1,884 undergraduate students were required in the study. However, during the eight-month recruitment period (June 2009 to January 2010), only 684 from 2,511 students met the inclusion criteria and agreed to take part in the study. Each subject was required to complete both self-administered questionnaire and physical examination, which took about 1 hour, and was followed up for one year. Various strategies were undertaken to recruit more participants, including advertisements through the university's website and newspapers and through public notices. However, the recruitment was proven to be challenging. The recruitment period included the examination period and semester break and this could partly be a reason for a limited number of students participated in the study. Another possible reason could be the fact that data collection was conducted at the laboratory located far away from the students' dormitory. Travelling to the laboratory was inconvenient for many students. As a result, the number of participants in the current study was significantly less than that expected. The small sample size may reduce the statistic power and consequently increases the probability of type II error.

5.2 Annual incidence for development and persistence of neck, upper back and low back pain in undergraduate students

The first aim of the present study was to determine the annual incidence of the development and persistence of the spinal pain among undergraduate students using desktop and notebook computers. Most previous researches have reported on estimates of prevalence rather than incidence. Information about incidence is useful for assessing the effectiveness of preventive measure (42).

5.2.1 Incidence for development of neck, upper back and low back pain

a) Neck pain

The annual incidence of neck pain among undergraduate students using desktop and notebook computers was high (46%). The annual incidence of neck pain among undergraduate students in this study was higher than a previous study (41). Grimby-Ekman et al (41) reported the annual incidence of neck or upper back pain in Swedish undergraduate students to be 15%. It is possible that the discrepancy between the previous and present studies was due to the difference in frequency of data collection during the follow-up period and the definition of a symptomatic case. Grimby-Ekman et al (41) followed their subjects on a yearly basis, whereas in this study subjects were followed up every 3 months for one year. Data collection regarding disease every 3 months would reduce a threat of recall bias. This bias may result in an under- or overestimation of the incidence. Also, in the previous study a symptomatic case was defined as an individual who had experienced pain for a period of longer than 7 days while in the current study a symptomatic case was defined as an individual who had experienced pain for a period of greater than 1 day. Consequently, there is likelihood that a greater number of subjects were identified as symptomatic cases in the present study.

b) Upper back pain

The annual incidence of upper back pain among undergraduate students using desktop and notebook computers was 27%. The incidence of upper back pain in this study is lower than Chang et al (33), who reported that 40 % of undergraduate students developed upper back pain. It is possible that the discrepancy between the previous and present studies was due to the differences in the follow-up method of musculoskeletal symptoms. Chan et al (33) used a personal digital assistant (PDA) to record upper back symptoms, which alarmed participants to complete a questionnaire 10 times per day, whereas this study used a telephone call every three months to collect upper back symptoms. Follow up of musculoskeletal symptoms with PDA would reduce a recall bias compared to using a telephone call.

c) Low back pain

The incidence of new-onset LBP over a 12-month period in undergraduate students using desktop and notebook computers was 31%, which is similar to a previous study on nursing students (25). Kopec et al (221) reported the annual incidence of LBP in general population aged between 18-24 years to be 34%.

5.2.2 Incidence for persistence of neck, upper back and low back pain

a) Neck pain

Slightly more than a quarter of students (31%), who reported new onsets of neck pain, experienced persistent neck pain in undergraduate students using desktop and notebook computers. Earlier studies showed that persistent musculoskeletal symptoms were quite common among young population (17, 41, 222). Grimby-Ekman et al (41) reported 52% of Swedish undergraduate students as having ongoing neck or upper back pain. Hanvold et al (17) showed that technical school students who reported neck, shoulder and upper back pain at baseline had 3-fold higher risk of reporting such symptoms at the 3-year follow up. Stahl et al (222) found that 5% of schoolchildren aged between 9-12 years had persistent neck pain.

b) Upper back pain

We found that 23% of students, who reported new onset of upper back pain, experienced persistent symptoms in undergraduate students using desktop and notebook computers. The incidence of persistent upper back pain among undergraduate students in this study was lower than a previous study by Grimby-Ekman et al (41) who reported that, among 1,204 Swedish undergraduate students, 52% had ongoing neck or upper back pain in 1 year follow up. It is possible that the discrepancy between the previous and present studies was due to the definition of a symptomatic case. In previous study, a symptomatic case was defined as those who experienced pain in the neck or upper back regions while, in the current study, those who had symptoms only in the upper back region was defined as cases. Since the definition of cases in the previous study (41) was wider than the present study, greater numbers of cases may be identified in the previous study than the present study.

c) Low back pain

We found that 31% of students, who reported new onset of LBP, experienced persistent symptoms in undergraduate students using desktop and notebook computers. Persistent LBP was quite common among young population, ranging from 4%-20% (25, 223-224). Mitchell et al (25) conducted a 1-year prospective cohort study on 117 female nursing students without LBP at baseline and reported that 19% of students, who reported new onset of LBP, experienced ongoing symptoms. Hestbaek et al (225) surveyed almost

10,000 Danish twins born between 1972 and 1982 and found that those aged between 12 to 22 years with persistent LBP during the previous year had a 3.5-fold increase risk of having LBP eight years later.

In summary, it is generally accepted that spinal pain is a chronic episodic condition characterized by episodes of persistent, recurrent or fluctuating pain and disability (225-226). Conceivably, our findings suggest that undergraduate students with spinal pain may become symptomatic adults, highlighting an urgent need for stakeholders to pay more attention to the problem of spinal pain in young population to reduce the impact of spinal pain in adults.

5.3 Risk factors for the development and persistence of spinal pain in undergraduate student using desktop computer

5.3.1 Development and persistence of neck pain

The findings showed that individual factors and computer-use related factors were significantly correlated to the development of neck pain whereas only individual factors contribute significantly to the persistence of neck pain

a) Development of neck pain

In the present study, we found that female, no regular exercise and too-low keyboard position were significantly associated with the development of neck pain. Female and no regular exercise increased the risk of developing neck pain while the keyboard position self-rated as too low decreased the risk of developing neck pain in undergraduate students using desktop computer.

Female undergraduate students using desktop computer were at higher risk of developing neck pain than male counterparts. Previous studies showed that the prevalence of neck and upper extremity disorders related to computer work is higher among females in both working and student population (18, 84). The first explanation may relate to gender differences in anthropometrics. Evidence suggests that women work in awkward postures and using higher relative muscle force than men during computer use (92). In our study, higher percentage of women (84%) reported working in poor postures compared to men (75%). Wahlstrom et al (91) found that women had higher muscular activity in the right and left trapezius muscles and had the highest ratings of perceived exertion in the neck and shoulder than men when operating a computer mouse during a text selection and deletion task. The second possible explanation, in general, males has a higher background level of physically demanding sporting activities. Evidence suggests that exercise or vigorous physical activities have a beneficial effect on musculoskeletal pain (227). Conceivably, high physical activities may lead to lower incidence of musculoskeletal symptoms in male undergraduate students. The third possible explanation relates to the differences in the understanding of ‘‘pain.’’ Females may be more sensitive to their bodily responses and consider it more acceptable to report complaints (17, 228).

The benefit of exercise for prevention of neck pain in undergraduate student using desktop computer was observed in this study. The risk of developing neck pain was increased 3.6-fold for those who reported no regular exercise. Previous studies showed the positive effect of physical activity or exercise on neck pain in undergraduate students. Katz et al (18) found an association between a low prevalence of neck/upper extremity and participation in intercollegiate athletics. A positive effect of physical activity has also been found by Hanvold et al (17), indicating that a high level of physical activity outside working hours gave a lower risk of reporting neck, shoulder and upper back pain at 3 year follow-up. However, inconsistent evidence related to an effect of physical activity or exercise on neck pain among working population has also been reported (31). Hildebrandt et al (31) found no association between subjects participating in physical activity in leisure time and neck pain. A possible explanation for inconsistent findings among studies may relate to the difference in the definitions of exercise used. As a result, the comparison between the studies should be made with caution.

A keyboard position self-rated as too low decreased the risk of developing neck pain in undergraduate students using desktop computer. The finding was contrary to the common conception of “good computer posture” often described as a position in which the arm is perpendicular to the floor, the elbow is at a right angle and the forearm is parallel to the floor (229). However, Marcus et al (71) showed that keying with an elbow angle > 121 degrees while using keyboard was associated with lower risk of neck or shoulder symptoms in newly hired computer workers. Although the exact elbow angles while using a keyboard was not measured in the present study, it is plausible that keyboard position self-reported as too low may correlate with elbow angles of greater than 90 degrees. This hypothesis warrants further investigation.

b) Persistence of neck pain

The results of this study indicated that only neck extensor muscle endurance was a risk factor associated with persistent neck pain in undergraduate students using desktop computer.

Students who had neck extensor endurance time ≤ 522 seconds were at greater risk of persistent neck pain than those who had neck extensor endurance time > 522 seconds. The finding was supported by previous studies (162, 214, 216). Previous studies in a general population showed that subjects with neck pain had lower neck extensor muscle endurance than healthy subjects (162, 214, 216). For example, a longitudinal study among 1,357 blue and white collars showed that subjects with low static neck extensor muscle endurance had a 1.2-fold risk of developing neck pain compared with a control group (216). A cross-sectional study among 55 subjects with and without neck pain showed that neck muscle endurance were significantly lower in subjects with neck pain compared with those without neck pain (214). However, a 1-year longitudinal study investigated muscle endurance in 53 Australian university office workers and found that the incidence of neck pain was not predicted by cervical extensor endurance (79). It may be possible that a small sample size was included in the study. Consequently, the type II error may occur.

Computer work continuously requires static contraction of neck and shoulder muscles (230). Sustained muscle activity has been previously identified as a risk factor for developing musculoskeletal symptoms (231-232). Continuous low-intensity contraction of the neck and shoulder muscles has been shown to induce Ca2+ accumulation and homeostatic disturbances in the active muscles due to poor blood circulation and an impaired metabolic waste removal mechanism (233) These pathological changes in the active muscles lead to micro-lesions, overuse injury and pain due to the absence of oxygenation and nutrition (141). Thus, enhanced neck extensor muscle endurance may hypothetically prevent neck pain among undergraduate students using desktop computer.

5.3.2 Development and persistence of upper back pain

The findings showed that individual and computer-use related factors contribute significantly to the development of upper back pain whereas only computer-use related factors contribute significantly to the persistence of upper back pain.

a) Development of upper back pain

The risk of developing upper back pain in undergraduate students using desktop computer was significantly associated with female and too high keyboard position.

Female undergraduate students using desktop computer were at higher risk of developing upper back pain than males. The results of the present study is consistent with the findings by Hanvold et al (17), who found that a higher number of female technical school students reported neck, shoulder and upper back pain compared to their male counterparts. However, Rising et al (38) demonstrated that a higher proportion of male dental students reported pain in the upper and low back regions compared to their female counterparts. These conflicting results make it difficult to ascertain whether gender actually represents a true upper back pain risk factor or not, although several previous studies indicated that gender is a risk factor for the development of musculoskeletal pain (39, 52, 70, 82)

A keyboard position self-rated as too high increased the risk of developing upper back pain in undergraduate students using desktop computer. The results was consistent with Faucett et al (109) who investigated the relationship between upper torso symptoms and a computer user's posture and psychosocial factors among 70 employees of a newspaper editorial department and found that keyboard height above elbow height was significantly associated with risk of neck, upper back and upper extremity symptoms. In addition, Mekhora et al (131) investigated the long-term effects of ergonomic intervention on neck, shoulder, arm, upper and low back discomfort among computer users with symptoms of tension neck syndrome. The authors found that neck, shoulder, arm, upper and low back discomfort significantly declined when the keyboard level was adjusted to suit the individual's comfort. However, in the literature, there is lack evidence over the EMG measurements on the association between position of keyboard height and muscle of upper back. Thus, the association between position of keyboard height and muscle of upper back pain should also be taken into consideration accordingly.

b) Persistence of upper back pain

We found that a higher percentage time of computer use for study and too-high mouse position elevated the risk of persistent upper back pain in undergraduate students using desktop computer.

A higher percentage time of computer use for study increased the risk of persistent upper back pain in undergraduate students using desktop computer. There is no direct report about the relationship between percentage time of computer use for study and the persistence of upper back pain among undergraduate students. It is hypothesized that high percentage time of computer use for study involves the completion of assignment on time. The pressure to generate work on time may contribute to the persistence of musculoskeletal symptoms (234). Another hypothesis explaining this relationship is that computer use for study may increase stress, which induces changes in blood pressure, peripheral neurotransmitters, stress hormones and muscle tension. Evidence indicates that mental stress increases muscle activity (235) and the force applied to performing physical activity (236), which compounds physical load to body structures and consequently increases the risk of musculoskeletal symptoms (34, 237). However, the pathomechanism of such hypothesis is still unclear (34). Alternatively, students who reported a higher percentage time of computer use for study may be exposed to the static prolonged sitting in poor posture. Previous studies reported a positive relationship between sitting duration and self-reported neck, upper limb and back pain (230, 238). Computer work usually results in poor sitting posture for a long period of time (239). Sitting increases thoracic kyphosis and decreases lumbar lordosis (240) which, in turn, leads to the compression of the anterior annulus and the nucleus pulposus of intervertebral discs as well as stretching of the posterior annulus of intervertebral discs, joint capsules and posterior ligaments and muscles (239). According to the tissue strain concept, external loads applied to tendons during repetitive work will elongate the tendon and create micro-tears in the tissue. Repetitive computer use may lead to inadequate time for complete recovery. Consequently, a residual strain develops in the tendons and creates a chronic inflammatory response in the tendon (44). Lack of movement during sitting also leads to the reduction of fluid exchange in the intervertebral discs and poor blood supply to muscle (141). Evidence suggests that sustained trunk flexion reduces the ability of the spine to resist forces acting upon it (142). Prolonged sitting also induces the shortening of some muscles, such as the abdominal and hamstring muscles, as well as lengthening of other muscles such as back muscles, which result in altered biomechanical loading of the spine during movement (143). The adverse effect of prolonged sitting accumulated over years may predispose the spine to injury during forceful loading.

A mouse position self-rated as too high increased the risk of persistent upper back pain in undergraduate students using desktop computer. Andersen et al (122) demonstrated that prolonged force applied to computer mouse and sustained non-neutral postures are two risk factors that may contribute to mouse-related upper extremity musculoskeletal disorders. The non-optimal position of mouse use is the mouse positioned at behind the keyboard and 50 mm above the resting surface of the keyboard. In this position, trapezius and medial deltoid muscle activity increase. Awkward, static postures tend to reduce blood circulation to the muscles, decreasing the flow of nutrients and removal of wastes, which can lead to muscle fatigue and pain (107).

5.3.3 Development and persistence of low back pain

The findings demonstrated that individual and computer-use related factors were correlated to the development of low back pain. No risk factor was identified as the risk factor for the persistence of low back pain.

a) Development of low back pain

We found that quadriceps muscle length, keyboard position and whether a chair used during computer work had low back support were risk factors for the development of low back pain in undergraduate students using desktop computer.

In undergraduate students using desktop computer, the risk of developing LBP was elevated 2.5-fold for those who had left quadriceps muscle tightness. Our data showed that mean left and right knee angles, assessed by the modified Thomas test, in this sample of undergraduate students were equivalent (115 degrees). The percentage of students who had left quadriceps tightness and reported LBP (48%) was similar to the percentage of those who had right quadriceps tightness and reported LBP (46%). However, no significant association between right quadriceps muscle tightness and LBP was found. This may be due to limited statistic power resulting from the small sample size in this study. An increased risk of developing LBP with quadriceps muscle tightness as observed in this study was in agreement with an earlier study by Feldman et al (16) who found that decreased quadriceps flexibility was associated with the development of low back pain in high school students. Structural factors, such as the amount of lumbar lordosis, pelvic tilt, leg length discrepancy and length of quadriceps and iliopsoas muscles, have been found to relate to the occurrence of LBP (181-182). Based on the anatomy of the lumbo-pelvic-hip complexes, changes in the pelvic tilt affect the size of the lumbar lordosis as all the parts that are associated (182). Because the quadriceps muscle attach to the pelvis, tightness of the quadricep muscle may increase lumbar lordosis. Excessive lumbar lordosis generates amount of forces on posterior articular joints and probably excessive mechanical stresses on the discs, connective tissues and muscles, consequently leading to low back pain (182, 241). Christie et al (242) found that patients with chronic low back pain had a significantly increased lumbar lordosis compared with healthy subjects.

The low back not being supported while performing computer work was identified as a risk factor for the development LBP in undergraduate students using desktop computer. In the literature, there is a lack of evidence over the association between low back support and low back pain. However, there are a number of hypotheses explaining the advantages of use of a backrest. Previous studies showed that using a chair backrest or lumbar support attenuates the stresses exerted on the vertebral column by relaxing the erector spinae musculature. When an individual is sitting in a reclined position, the backrest supports the weight of the thorax resulting in a reduction in lumbar muscle activity and consequently reducing the lumbar load (243). In addition, the use of a chair with backrest maintains lumbar lordosis and increases comfort (244-246). Maintaining spine postures near a neutral posture, avoiding excessive spine flexion and minimizing joint loading by adopting an upright posture are important factors in preserving back health and preventing LBP (247).

A keyboard position self-rated as too high increased the risk of developing LBP in undergraduate students using desktop computer. In the literature, there is a lack of evidence over the association between position of keyboard and low back pain. In computer work, the neck and shoulder regions are often the most common location of discomfort. Karlqvist et al (248) reported a neck/shoulder monthly discomfort prevalence of 45% compared with 32% for back and 30% for forearm/hands. Hakala et al (50) observed the association between neck, shoulder and low back pain and computer use. The authors found that pain while working with a computer was more easily felt in the neck and shoulder than low back regions. However, Mekhora et al (131) found that, after modification of workstation which included monitor, document and keyboard positions, the greatest discomfort reduction was in the low back region. They explained that the discomfort reduction in other areas was a function of the intervention. Because the human body is a complex system, adaptation of individuals to any intervention will involve multiple adjustments of anatomical segments and postural change (131).

5.4 Risk factors for the development and persistence of spinal pain in undergraduate student using notebook computer

5.4.1 Development and persistence of neck pain

The findings revealed that only computer-use related factors was significantly associated with the development of neck pain whereas individual and computer-use related factors were significantly associated with the persistence of neck pain.

a) Development of neck pain

We found a relationship between computer screen position and the development of neck pain in undergraduate students using notebook computer.

Perception of computer screen position not being level with the eyes increased the risk of developing neck pain in undergraduate students using notebook computer. The result was consistent with previous studies, showing the association between level of computer screen position of notebook computer and neck pain (61, 65). Previous studies demonstrated that computer screen position was one of several factors affecting user comfort (108, 249). Low computer screen height has been found to lead to head forward posture, which in turn increases neck and shoulder muscle activities (61, 107, 116). Head forward posture also results in stretching of ligaments, joint capsules and other structures around the neck region (108). On the other hand, high computer screen height results in the neck being more erect and a more backward-leaning trunk position (116). A simultaneous increase in muscle activity of the neck extensor and sternocleideomastoid muscle has been reported in this posture and prolonged computer use in this position may be harmful (65). Evidence suggests that the optimal monitor position is that meets the needs of an individual user (117-118).

b) Persistence of neck pain

Factors associated with the persistence of neck pain in undergraduate students using notebook computers were year of study and mouse position.

The risk of persistent neck pain was 2.5-fold for the second year students using notebook computer in comparison with the first year students. Ndetan et al (27) examined the prevalence, distribution, severity, risk factors and response to musculoskeletal injuries to the low back, hand/wrist and neck/shoulder among chiropractic students and found that chiropractic students were predominantly exposed to injury during the first, third and sixth trimesters. However, the finding may not necessarily reflect other student populations. To our knowledge, this study is the first study demonstrating that year of undergraduate study significantly correlated with neck pain. This information may be of importance for developing viable preventive strategies of neck pain in young population. Further study is needed to better understand how a year of study exposure interacts with each other in causing persistent neck pain.

A keyboard position self-rated as too high increased the risk of persistent neck pain in undergraduate students using notebook computer. The finding was supported by previous studies (109, 131), which found that higher keyboard height (with respect to the elbow height) was associated with increased risk of neck, upper back and upper extremity discomfort.

5.4.2 Development and persistence of upper back pain

The findings showed that none of investigated risk factors was associated with developing and persistent upper back pain in undergraduate student using notebook computer.

Previous studies indicated that lack of separated keyboard and screen position of notebook computer appeared to increase stress around a user's neck and shoulders and likely to result in increased discomfort in those regions (61-62, 69). In this study, there was no association between students using notebook computer and upper back pain. It is possible that students usually use a notebook computer in various places, which may increase variation of working postures and reduce static muscle load.

5.4.3 Development and persistence of low back pain

The findings showed that none of risk factors was associated with developing and persistent low back pain in undergraduate students using notebook computer. There is a lack evidence of the association between notebook computer and low back pain. The possible reasons to explain this finding may relate to various postures while using notebook computer.

5.6 Proposed mechanism of development and persistence of neck, upper back and low back in undergraduate students

The results of current study found that individual, computer-use related and clinical factors are potentially risk and protective factors for the development and persistent of musculoskeletal pain in undergraduate students. It is obvious that there have been some similarities of risk and protective factors for neck, upper back and low back pain in students and adults.

Computer-use related factor seem to play a significant role in the development and persistence of spinal pain. Therefore, the conceptual model of relationship between musculoskeletal disorder and computer work, adapted from WahlstrÖm (Figure 2.1), is then modified to accommodate the findings of the present study (see Figure 5.1). In the new model, physical demand, derived from environment such as workstation ergonomics, is the risk factor that elevates risk of musculoskeletal pain. For example, an inappropriate workstation, including monitor, mouse and keyboard position as well as back support may influence physical load by forcing an individual to hold an uncomfortable posture. Evidence suggests that frequently working in uncomfortable posture (32, 230) may shorten soft tissues and cause muscle tension, weakness and fatigue. When load applies on the shorten structures, it may cause pain and increase risk of musculoskeletal pain (47).

Individual factors, such as gender, year of study, physical exercise, neck extensor muscle endurance and quadriceps muscle length, contribute to musculoskeletal pain.

Individual factors may affect physical load, which subsequently influence the pathway of musculoskeletal pain in undergraduate students. Therefore, the role of individual factors on influencing physical load is highlighted in the new model.

No psychosocial factor has been found to play a significant role for developing or persistent neck, upper back and low back pain in undergraduate students using both type of computer. While there is currently accepted that a large index number within psychosocial dimensions contributes to the development and persistent of musculoskeletal symptoms in adults (52, 221), evidence for such effect in the young population is far from conclusive. Grimby-Ekman et al (41) found that perceived stress is a risk factor for developing neck or upper back pain and for persistent neck or upper back pain in Swedish undergraduate students. However, Hanvold et al (17) reported no association between stress level and incidence of neck pain during 3-year follow up among technical school students. Only one earlier study by Mitchell et al (25) investigated the association between psychosocial status and the prevalence of LBP in nursing students and demonstrated that higher stress is an independent predictor of new onset LBP. From the findings, a selected group of psychosocial assessed in the present study are non-dominant contributors for the development and persistence of musculoskeletal pain in the target population of this study. Other important psychosocial may be identified in future work. Another plausible explanation is that the TMHI-15 employed in the present study may not have been sensitive enough to detect subtle differences.

Even though this study found no direct relationship between psychosocial factors and spinal pain in students, it has been found that the percentage of computer usage for study is a factor that increased persistence of upper back pain. Computer usage for study may affect your mental status in a way that increases stress, muscle tension and, consequently, increase the risk of persistence of upper back pain.

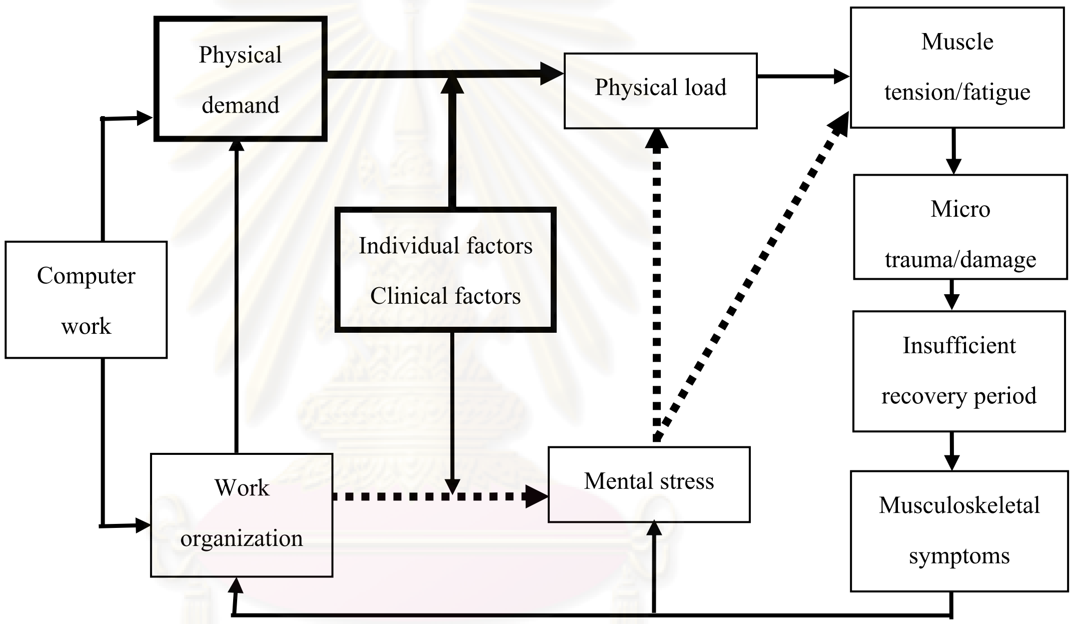


Figure 5.1 Conceptual model of relationship between musculoskeletal disorder and computer work in undergraduate students. Solid line defined as significant relationship. Dotted line defined as uncertain evidence relationship.

5.6 Clinical implication

The health of undergraduate students deserves consideration because they are future workforce. Consequently, preventive measures aimed at reducing the occurrence of spinal pain in undergraduate students may focus on the following areas:

For desktop computer user

- Neck muscle strengthening or endurance exercise is recommended.
- For students who frequently use a computer and keyboard, the keyboard should be positioned so that the elbow is at a 90 degree angle.
- For students whose work mostly involves a computer and mouse, the mouse should be placed so that the elbow is at a 90 degree angle.
- When working with a computer for a long time, there should be changes in postures or brief movement occasionally.
- When working with a computer, chair with a backrest should be used.
- Stretching of quadriceps muscle should be regularly performed.

For notebook computer user

- A computer screen should be appropriately set so that the upper frame is at eye level.

- For students who frequently use a computer and keyboard, the keyboard should be positioned so that the elbow is at a 90 degree angle.
- There should be education concerning key principles of how to appropriately use the computer, especially for 2^{nd} year students.

5.7 Strength/Limitation of this study and suggestion for further study

The major strength of this study is its prospective design and the evaluation of broad biopsychosocial factors, including demographic, computer-use related, psychosocial and clinical factors, for their contribution to the development and persistence of spinal pain. The information regarding the relative associations between such factors and the development and persistence of spinal pain would be useful for stakeholders in decision making about prevention and treatment of spinal pain in undergraduate students. However, the current study has several weak points. First, the nature of several biopsychosocial factors and the diagnosis of spinal pain were subjective, which may have led to inaccuracy. Future studies should consider the inclusion of objective information in order to increase the accuracy of information. Second, information regarding frequency and severity of pain was not collected in this study. Further study should gather this information in order to enhance understanding regarding the relationship between risk factors and musculoskeletal symptoms in undergraduate students. Third, TMHI-15 employed in the present study may not cover all domains of psychosocial factors. Further study should include other important psychosocial factors. Forth, the sample size in this study was small, which may reduce the statistic power and consequently increase the probability of type II error. Last, the subjects in this study were recruited only from one university. Thus, generalization of the results from this study to other undergraduate student populations should be made with caution.

CHAPTER VI

CONCLUSION

In summary, 46% of this sample of undergraduate students reported neck pain during a 1-year period, of whom 33% experienced persistent neck pain. For those who reportedly used desktop computer, 42% of this sample reported neck pain, of whom 38% experienced persistent neck pain. For those who reportedly used notebook computer, 48% of this sample reported neck pain, of whom 30% experienced persistent neck pain. According to the results, several factors increased risk of development and persistence of neck pain in undergraduate students using desktop and notebook computers, including female, 2nd year of students, never exercise, decrease neck extensor muscle endurance, computer screen position not being with the eye level and keyboard position self-rated as too high whereas keyboard position self-rated as too low decreased risk of development of neck pain in undergraduate students using desktop computer.

27% of this sample of undergraduate students reported upper back pain during a 1-year period, of whom 31% experienced persistent upper back pain. For those who reportedly used desktop computer, 23% of this sample reported upper back pain, of whom

21% experienced persistent upper back pain. For those who reportedly used notebook computer, 29% of this sample reported upper back pain, of whom 23% experienced persistent upper back pain. Female, keyboard and mouse position self-rated as too high and a higher percentage time of computer use for study are significantly associated to high development and persistence of upper back pain in undergraduate student using desktop computer whereas none of risk factors was associated with developing upper back pain in undergraduate students using notebook computer.

31 % of this sample of undergraduate students reported LBP during a 1-year period, of whom 31% experienced persistent LBP. For those who reportedly used desktop computer, 29% of this sample reported LBP, of whom 30% experienced persistent LBP. For those who reportedly used notebook computer, 32% of this sample reported LBP, of whom 31% experienced persistent LBP. Quadriceps muscle tightness, the low back not being supported during computer work and a keyboard position self-rated as too high was a significant risk factor for the development of LBP in undergraduate students using desktop computer.

Our findings support the notion that the association between clinical factor and neck/low back pain among undergraduate students is a strong one. Certain aspects related to computer use were significant risk factors for developing and persisting neck, upper and low back pain in undergraduate students.

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APPENDICES

APPENDIX A

TEST FOR RELIABILITY OF

THE SELF-ADMINISTERED QUESTIONNAIRE

A test-retest design was used to investigate the reliability of outcomes from the self-administered questionnaire. The reliability study was conducted in 20 undergraduate students, who met the inclusion criteria of the study. Subjects were asked to complete the questionnaire twice with 1-week lapse between the first and second sessions.

A I Data analysis

The reliability of outcomes from the questionnaire was examined by using correlation coefficient. The intraclass correlation coefficient (ICC (1,1)) was used for continuous variables and the Spearman's rho (ρ) was used for ordinal and nominal data. A level of strength of association will be determined using the following criteria (1):

- 0.00 to 0.25 Little or no relationship
- 0.25 to 0.50 Fair relationship
- 0.50 to 0.75 Moderate to good relationship
- Above 0.75 Good to excellent relationship

A II Results

Of 20 undergraduate students, 20 (100%) completed the questionnaire twice on two separate days with 7 days lapse between the measurements. The results demonstrated moderate to good repeatability of the outcomes with the ICC (1,1) scores ranging from 0.69 to 1.00 and the ρ ranging from 0.60 to 1.00. The intraclass correlation coefficient (ICC (1,1)) and Spearman's rho (ρ) of all data were showed in Tables A.1-A.4.

Table A.1 The intraclass correlation coefficient (ICC (1,1)) and Spearman's rho (ρ) of individual data (n = 20)

Factors	The statistical analysis used	The results of data analysis
Gender	ρ	1.00
Age	ICC (1,1)	1.00
Weight	ICC (1,1)	0.99
Height	ICC (1,1)	0.99
Faculty	ρ	1.00
Year of study	ρ	1.00
History of chronic diseases	ρ	0.73
History of surgery	ρ	1.00
History of musculoskeletal disorder/disease	ρ	1.00
Frequency of exercise sessions	ρ	1.00
Frequency of regular exercise	ρ	0.87

Table A.2 The intraclass correlation coefficient (ICC (1,1)) and Spearman's rho (ρ) of computer-use related data (n = 20).

Factors	The statistical analysis used	The results of data analysis
Type of computer use	ρ	1.00
Year of computer use	ICC (1,1)	0.73
Duration of computer use (Monday-Friday)	ICC (1,1)	0.75
Duration of compute use (Saturday-Sunday)	ICC (1,1)	0.83
First activity on computer	ρ	0.74
Second activity on computer	ρ	0.61
Third activity on computer	ρ	0.76
Percentage time for study	ρ	0.60
Percentage time for entertainment	ρ	0.61
Feet on floor	ρ	0.97
Hip position	ρ	0.90
Knee position	ρ	0.89
Ankle position	ρ	0.84
Elbow position	ρ	0.79
Neck, upper and low back support	ρ	0.86
Elbow support	ρ	0.79
Arm support	ρ	0.67
Wrist support	ρ	0.82
Computer screen position	ρ	0.81
Keyboard position	ρ	0.76
Mouse position	ρ	0.88
Touch pad position	ρ	0.61
Percent of mouse use on desktop	ICC (1,1)	0.88

Table A.2 The intraclass correlation coefficient (ICC (1,1)) and Spearman's rho (ρ) of computer-use related data (n = 20) (continued)

Factors	The statistical analysis used	The results of data analysis
Percent of keyboard use on desktop	ICC (1,1)	0.71
Percent of mouse use on notebook	ICC (1,1)	0.94
Percent of keyboard use on notebook	ICC (1,1)	0.69
Percent of mouse use on notebook	ICC (1,1)	0.92
Typing characteristic	ρ	0.72
Habitual posture while using computer	ρ	0.85

Table A.3 The intraclass correlation coefficient (ICC (1,1)) and Spearman's rho (ρ) of psychosocial data (n = 14).

Factors	The statistical analysis used	The results of data analysis
Mental health status	ρ	0.81

Table A.4 The intraclass correlation coefficient (ICC (1,1)) Spearman's rho (ρ) of spinal pain data (n = 20)

Factors	The statistical analysis used	The results of data analysis
Have trouble (ache, pain, discomfort, numbness, weakness) in neck, upper or low back during the last 3 months	ρ	0.65
Neck pain caused by computer, household, sports, hobbies or other	ρ	0.71
Upper back pain caused by computer, household, sports, hobbies or other	ρ	0.89
Low back pain caused by computer, household, sports, hobbies or other	ρ	0.79
Pain scale at neck	ρ	0.78
Pain scale at upper back	ρ	0.68
Pain scale at low back	ρ	0.79
Treatment	ρ	0.71

A III Conclusion

It was concluded that the self-administered questionnaire provided reliable outcomes.

A IV References

(1) Portney, L.G., and Watkins, M.P. Correlation. Foundation of clinical research. In *Application to practice*, pp. 523-38. New Jersy, 2000.

APPENDIX B

TEST FOR RELIABILITY OF THE PHYSICAL EXAMINATION

A test-retest design was used to investigate the intra-tester reliability of examiner. The reliability study was conducted in 20 undergraduate students, who met the inclusion criteria of the study. Subjects were asked to perform the physical examination which including neck range of motion, neck flexor and extensor muscle endurance, upper limb nerve tension, trunk mobility, trunk flexor and extensor muscle endurance, quadriceps and hamstring muscle length as well as lower limb nerve tension twice with 1-day lapse between the first and second sessions.

B I Data analysis

The statistic analysis was calculated by using SPSS for windows release 17.0. Intratester reliability was determined by using the intraclass correlation coefficients (ICCs). The formula of ICC (3,1) was chosen. Statistical significance for this study was based on p-value less than 0.05. The ICC value was interpreted as follows (1):

- 0.00 to 0.25 Little or no relationship
- 0.25 to 0.50 Fair relationship

- 0.50 to 0.75 Moderate to good relationship
- Above 0.75 Good to excellent relationship

B II Results

Of 20 undergraduate students, 20 (100%) was performed the physical examination twice on two separate days with 1 days lapse between the measurements. The results demonstrated moderate to good repeatability of the physical examination with the ICC (3,1) scores ranging from 0.71 to 0.91. The intraclass correlation coefficient (ICC (3,1)) of all physical examination were showed in Tables B.1.

Table B.1 The intraclass correlation coefficient (ICC (3,1)) of physical examination data (n = 20)

Factors	The statistical analysis used	The results of data analysis
Neck range of motion		
- Flexion	ICC (3,1)	0.84
- Extension	ICC (3,1)	0.86
- Right lateral flexion	ICC (3,1)	0.76
- Left lateral flexion	ICC (3,1)	0.71
- Right rotation	ICC (3,1)	0.72
- Left rotation	ICC (3,1)	0.83
Trunk mobility		
- Flexion	ICC (3,1)	0.74
- Extension	ICC (3,1)	0.76

Table B.1 The intraclass correlation coefficient (ICC (3,1)) of physical examination data (n = 20) (continued)

Factors	**The statistical analysis used**	**The results of data analysis**
- Right lateral flexion	ICC (3,1)	0.89
- Left lateral flexion	ICC (3,1)	0.86
Neck muscle endurance		
- Neck flexor muscle endurance	ICC (3,1)	0.74
- Neck extensor muscle endurance	ICC (3,1)	0.74
Trunk muscle endurance		
- Trunk flexor muscle endurance	ICC (3,1)	0.79
- Trunk extensor muscle endurance	ICC (3,1)	0.75
Muscle length		
- Right quadriceps muscle	ICC (3,1)	0.71
- Left quadriceps muscle	ICC (3,1)	0.73
- Right hamstring muscle	ICC (3,1)	0.91
- Left hamstring muscle	ICC (3,1)	0.89
Upper limb nerve tension		
- Right upper limb nerve tension	ICC (3,1)	0.72
- Left upper limb nerve tension	ICC (3,1)	0.73
Lower limb nerve tension		
- Right straight leg raising	ICC (3,1)	0.74
- Left straight leg raising	ICC (3,1)	0.72

B III Conclusion

It was concluded that the physical examination provided reliable outcomes.

B IV References

(1) Portney, L.G., and Watkins, M.P. Correlation. Foundation of clinical research. In *Application to practice*, pp. 523-38. New Jersy, 2000.

APPENDIX C

ETHICAL APPROVAL FOR THE STUDY

คณะอนุกรรมการจริยธรรมการวิจัยในคน มหาวิทยาลัยธรรมศาสตร์ ชุดที่ 2

....

รหัสโครงการ 006/52

ชื่อโครงการวิจัย การศึกษาอุบัติการณ์ในระยะ 1 ปี และปัจจัยเสี่ยงของการเกิดอาการทางระบบกระดูกและกล้ามเนื้อ บริเวณคอ/บ่า หลังส่วนบนและหลังส่วนล่าง อันเนื่องมาจากการใช้คอมพิวเตอร์ ในนักศึกษาระดับอุดมศึกษามหาวิทยาลัยธรรมศาสตร์

ชื่อผู้วิจัยหลัก อาจารย์สิริลักษณ์ กาญจโนมัย

หน่วยงานที่รับผิดชอบ คณะสหเวชศาสตร์ มหาวิทยาลัยธรรมศาสตร์

คณะอนุกรรมการจริยธรรมการวิจัยในคน มหาวิทยาลัยธรรมศาสตร์ ชุดที่ 2 ได้พิจารณาอนุมัติด้านจริยธรรมการวิจัยในคนให้ดำเนินการวิจัยตามโครงการวิจัยข้างต้นได้

ลงชื่อ	ลงชื่อ ....
(ผู้ช่วยศาสตราจารย์ พันเอก ดร. ถวัลย์ ฤกษ์งาม)	(อาจารย์ ดร. วีระชัย เอื้อสิทธิชัย)
ประธานอนุกรรมการ	อนุกรรมการและเลขานุการ

อนุมัติ ณ วันที่ 16 มิถุนายน พ.ศ. 2552

APPENDIX D

QUESTIONNAIRE

คำชี้แจงแบบสอบถาม

- แบบสอบถามนี้ประกอบไปด้วยแบบสอบเกี่ยวกับข้อมูลส่วนตัว ข้อมูลอาการบาดเจ็บทางระบบกระดูกและกล้ามเนื้อ ข้อมูลเกี่ยวกับการใช้คอมพิวเตอร์และข้อมูลเกี่ยวกับสภาพจิตใจของท่าน
- กรุณาตอบแบบสอบถามทุกข้อตามความเป็นจริง ในกรณีที่ท่านไม่เข้าใจในคำถาม กรุณาสอบถามกับเจ้าหน้าที่
- คำถามอาจจะเป็นการขอให้ท่านเขียนข้อความสั้นๆ หรือให้ท่านเลือกคำตอบ โดยการทำเครื่องหมาย ✓ ในช่องสี่เหลี่ยมที่ตรงกับคำตอบของท่าน
- ในกรณีที่ท่านเลือกคำตอบไม่ตรงกับความต้องการของท่าน กรุณาทำเครื่องหมายดังแสดงในตัวอย่างข้างล่างและทำการเลือกคำตอบใหม่

ตัวอย่าง

2. เพศ ~~☑~~1. ชาย ☑2. หญิง

ข้อมูลที่ท่านตอบในแบบสอบถามนี้จะถูกเก็บเป็นความลับ และจะเปิดเผยเฉพาะผลการวิจัยในภาพรวม โดยไม่ระบุชื่อบุคคลใดบุคคลหนึ่งเป็นการเฉพาะ

ขอขอบพระคุณเป็นอย่างยิ่งสำหรับความร่วมมือในการตอบแบบสอบถามนี้

<u>ส่วนที่1 ข้อมูลส่วนตัว</u>

<u>คำชี้แจง</u> กรุณาตอบคำถามทุกข้อตามความเป็นจริง โดยเขียนข้อความสั้นๆ หรือเลือกคำตอบที่สอดคล้องกับตัวท่านมาก ที่สุดเพียง 1 คำตอบ

1. ชื่อ………………..นามสกุล………………………รหัสประจำตัวนักศึกษา…………………….

2. เบอร์โทรศัพท์ที่สามารถติดต่อได้…………………………………………………………………

3. เพศ ☐1. ชาย ☐2. หญิง

4. วัน/เดือน/ปีเกิด…………………………………………………………………………………

5. น้ำหนัก……………..กิโลกรัม, ส่วนสูง……………..เซนติเมตร

6. คณะ…………………………………………..สาขาวิชา/ภาควิชา……………………………..

7. ระดับการศึกษา

☐ 1. ปริญญาตรีปีที่ 1 ☐ 2. ปริญญาตรีปีที่ 2 ☐ 3. ปริญญาตรีปีที่ 3

☐ 4. ปริญญาตรีปีที่ 4 ☐ 5. ปริญญาตรีปีที่ 5 ☐ 6. ปริญญาตรีปีที่ 6

8. ท่านมีโรคประจำตัวหรือความผิดปกติทางร่างกายแต่กำเนิดใดๆ หรือไม่

☐ 1. ไม่มี

☐ 2. มี โปรดระบุรายละเอียด…………………………………………………

9. ท่านมีประวัติของการผ่าตัดในบริเวณคอ/บ่า หลังส่วนบน หรือหลังส่วนล่างและเอวหรือไม่

☐ 1. ไม่มี

☐ 2. มี โปรดระบุรายละเอียด…………………………………………………

10. ท่านมีประวัติโรคทางระบบกระดูกและกล้ามเนื้อในบริเวณคอ/บ่า หลังส่วนบน หรือหลังส่วนล่างและเอว ที่เกิดจากอุบัติเหตุ หรือเป็นโรคเรื้อรังที่มีสาเหตุมาจากพยาธิสภาพที่รุนแรง เช่น โรครูมาตอยด์ โรคโปลิโอ โรคข้อสันหลังอักเสบเรื้อรัง ซึ่งได้รับการวินิจฉัยยืนยันจากแพทย์แผนปัจจุบัน

☐ 1. ไม่มี

☐ 2. มี โปรดระบุรายละเอียด…………………………………………………

11. ท่านออกกำลังกายบ่อยแค่ไหนในช่วง 3 เดือนที่ผ่านมา

☐ 1. สม่ำเสมอ โปรดระบุจำนวนครั้งที่ออกกำลังกาย ....ครั้ง/สัปดาห์

☐ 2. ไม่สม่ำเสมอ

☐ 3. ไม่เคยออกกำลังกายเลย

<u>ส่วนที่ 2 ข้อมูลเกี่ยวกับอาการบาดเจ็บทางระบบกระดูกและกล้ามเนื้อ</u>

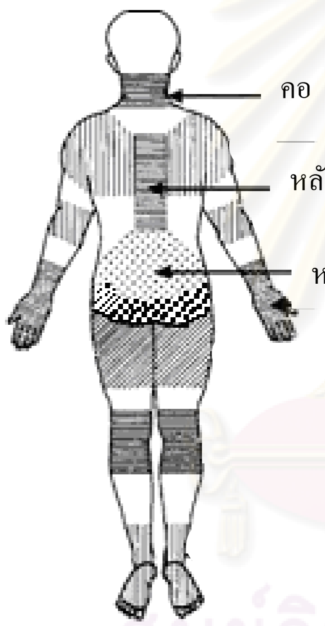
วัตถุประสงค์

แบบสอบถามในส่วนนี้มีวัตถุประสงค์เพื่อต้องการทราบถึงอาการบาดเจ็บทางระบบกระดูกและกล้ามเนื้อในส่วน ของคอ/บ่า หลังส่วนบน และหลังส่วนล่างของท่านในช่วง 3 เดือนที่ผ่านมา

นิยาม

อาการบาดเจ็บทางระบบกระดูกและกล้ามเนื้อ คือ "อาการเจ็บหรือปวดหรือเมื่อยหรือ ตึงหรือมีความรู้สึกที่ผิดปกติ เช่น ชาหรืออ่อนแรง"

ภาพแสดงบริเวณอาการบาดเจ็บทางระบบกระดูกและกล้ามเนื้อตามส่วนต่างๆ ของร่างกายโดยใช้เป็นภาพอ้างอิงในการตอบคำถามข้อ 1-4



<u>คำชี้แจง</u> กรุณาตอบคำถามทุกข้อตามความเป็นจริง โดยใส่ข้อความสั้นๆ หรือเขียนเครื่องหมาย ✓ ลงในช่องที่ท่านเลือก คำตอบที่สอดคล้องกับความคิดเห็นของท่าน มากที่สุดเพียง 1 คำตอบ **ยกเว้นบางคำถามสามารถเลือกตอบได้ มากกว่า 1 คำตอบ ซึ่งจะระบุไว้ตอนท้ายของคำถามนั้น**

1. **ในช่วง 3 เดือน**ที่ผ่านมา ท่านมีอาการบาดเจ็บทางระบบกระดูกและกล้ามเนื้อ **ติดต่อกันมากกว่า 1 วัน** ที่บริเวณใดของร่างกายบ้าง **(สามารถตอบได้มากกว่า 1 คำตอบ)**

☐ 1. ไม่มีอาการบริเวณใดเลย (ให้ข้ามไปตอบคำถามใน**<u>ส่วนที่ 3 หน้า 6</u>**)

☐ 2. คอ

☐ 3. หลังส่วนบน

☐ 4. หลังส่วนล่างและเอว

2. โปรดระบุ สาเหตุที่ทำให้เกิดอาการผิดปกติในบริเวณของร่างกายที่ท่านตอบ*ในข้อ 1* **(1 ส่วนของร่างกาย สามารถตอบได้มากกว่า 1 คำตอบ)**

2.1 คอ	☐ 1. การใช้คอมพิวเตอร์ (โปรดตอบคำถามในข้อ 3-5)		☐ 2. งานบ้าน
	☐ 3. การเล่นกีฬา	☐ 4. งานอดิเรกอื่นๆ	☐ 5. สาเหตุอื่นๆ.........
2.2 หลังส่วนบน	☐ 1. การใช้คอมพิวเตอร์ (โปรดตอบคำถามในข้อ 3-5)		☐ 2. งานบ้าน
	☐ 3. การเล่นกีฬา	☐ 4. งานอดิเรกอื่นๆ	☐ 5. สาเหตุอื่นๆ.........
2.3 หลังส่วนล่างและเอว	☐ 1. การใช้คอมพิวเตอร์ (โปรดตอบคำถามในข้อ 3-5)		☐ 2. งานบ้าน
	☐ 3. การเล่นกีฬา	☐ 4. งานอดิเรกอื่นๆ	☐ 5. สาเหตุอื่นๆ.........

3. อาการผิดปกติที่เกิดขึ้นในบริเวณของร่างกาย**อันเนื่องมาจากการใช้คอมพิวเตอร์** มักจะเกิดขึ้นเมื่อใด **(สามารถตอบได้มากกว่า 1 คำตอบ)**

3.1 คอ

☐ 1. ก่อนใช้คอมพิวเตอร์ ☐ 2. ระหว่างใช้คอมพิวเตอร์ ☐ 3. หลังใช้คอมพิวเตอร์

3.2 หลังส่วนบน

☐ 1. ก่อนใช้คอมพิวเตอร์ ☐ 2. ระหว่างใช้คอมพิวเตอร์ ☐ 3. หลังใช้คอมพิวเตอร์

3.3 หลังส่วนล่างและเอว

☐ 1. ก่อนใช้คอมพิวเตอร์ ☐ 2. ระหว่างใช้คอมพิวเตอร์ ☐ 3. หลังใช้คอมพิวเตอร์

4. โปรดระบุระดับอาการบาดเจ็บทางระบบกระดูกและกล้ามเนื้อ ใน 3 เดือนที่ผ่านมา ขณะที่ท่านมีอาการมากที่สุดโดยให้ทำเครื่องหมาย ○ รอบตัวเลขที่แสดงถึงระดับความรู้สึก แบ่งเป็นตัวเลขตั้งแต่ 0-10 กำหนดให้ 0 หมายถึง "ไม่มีอาการเลย" ในขณะที่ 10 หมายถึง "มีอาการมากจนไม่สามารถทนได้"

4.1 บริเวณคอ

ระดับความรู้สึก

0 1 2 3 4 5 6 7 8 9 10

ไม่มีอาการเลย **อาการมากจนไม่สามารถทนได้**

4.2 บริเวณหลังส่วนบน

ระดับความรู้สึก

0 1 2 3 4 5 6 7 8 9 10

ไม่มีอาการเลย **อาการมากจนไม่สามารถทนได้**

4.3 บริเวณหลังส่วนล่างและเอว

ระดับความรู้สึก

0 1 2 3 4 5 6 7 8 9 10

ไม่มีอาการเลย **อาการมากจนไม่สามารถทนได้**

5. การรักษาที่ท่านได้รับ เมื่อมีอาการบาดเจ็บทางระบบกระดูกและกล้ามเนื้ออันเนื่องมาจากการใช้คอมพิวเตอร์คือ **(สามารถตอบได้มากกว่า 1 คำตอบ)**

☐ 1. ไม่ได้รับการรักษา

☐ 2. รักษาด้วยตนเอง โปรดระบุ...

☐ 3. พบแพทย์

☐ 4. พบนักกายภาพบำบัด

☐ 5. อื่นๆ โปรดระบุ...

<u>ส่วนที่ 3 ข้อมูลเกี่ยวกับการใช้คอมพิวเตอร์</u>

วัตถุประสงค์

แบบสอบถามนี้มีวัตถุประสงค์เพื่อต้องการทราบถึงข้อมูลเกี่ยวกับการใช้คอมพิวเตอร์ของท่าน

<u>คำชี้แจง</u> กรุณาตอบคำถามทุกข้อตามความเป็นจริง โดยเขียนข้อความสั้นๆ หรือเลือกคำตอบที่สอดคล้องกับความคิดเห็นของท่าน มากที่สุดเพียง 1 คำตอบ **ยกเว้นบางคำถามสามารถเลือกตอบได้มากกว่า 1 คำตอบ ซึ่งจะระบุไว้ตอนท้ายของคำถามนั้น**

1. ประเภทของคอมพิวเตอร์<u>ส่วนมาก</u>ที่ท่านใช้

☐ 1. คอมพิวเตอร์แบบตั้งโต๊ะ (PC) ☐ 2. คอมพิวเตอร์แบบพกพา (Laptop/Notebook)

2. ท่านใช้คอมพิวเตอร์มานาน.......................ปี………………..เดือน

3. ท่านใช้คอมพิวเตอร์ในช่วงวันจันทร์ถึงวันศุกร์<u>ติดต่อกัน</u>เฉลี่ยวันละ..........ชั่วโมง…………..นาที

4. ท่านใช้คอมพิวเตอร์ในช่วงวันเสาร์และอาทิตย์<u>ติดต่อกัน</u>เฉลี่ยวันละ..........ชั่วโมง…………..นาที

5. ท่านมักจะใช้คอมพิวเตอร์เพื่อทำกิจกรรมดังนี้ ให้เลือก 3 กิจกรรมที่ใช้บ่อยที่สุด **โดยเรียงลำดับจาก 1 ถึง 3 หน้าข้อ**

............5.1 ค้นคว้าข้อมูลจากอินเตอร์เน็ต

............5.2 chat

............5.3 เช็ค e-mail

............5.4 ทำการบ้าน, รายงานโดยใช้โปรแกรมโปรดระบุ……………………………

............5.5 เล่นเกมส์

............5.6 ฟังเพลง

............5.7 ดูหนัง

............5.8 อื่นๆ โปรดระบุ…………………………………

6. เปอร์เซนต์ในการใช้คอมพิวเตอร์ในการศึกษา..............% + ความบันเทิง......................% = 100%

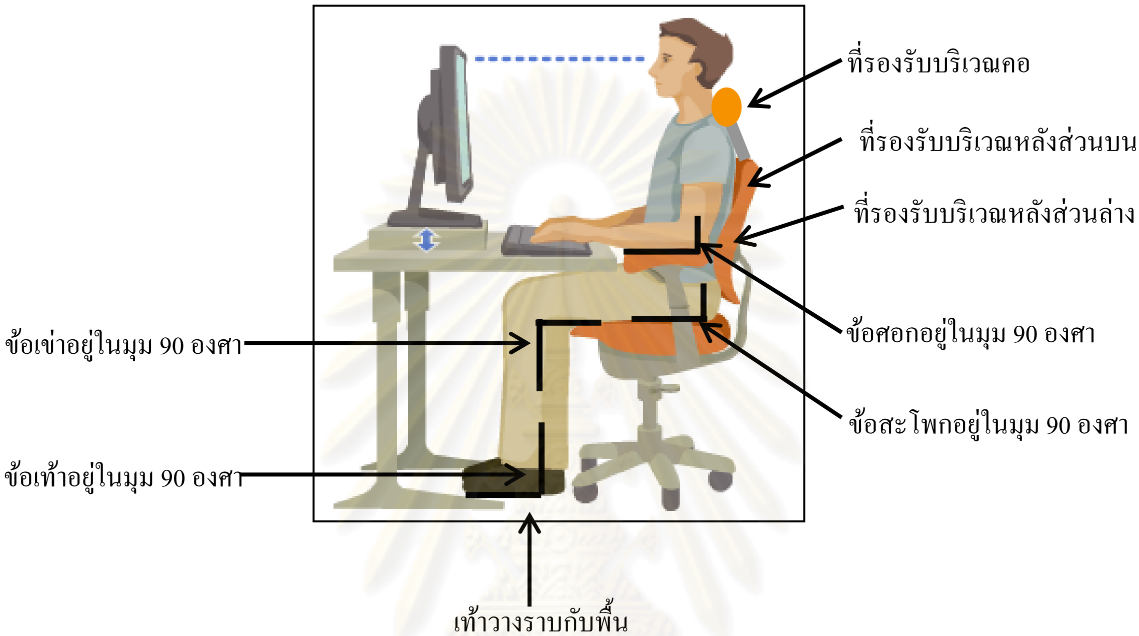
7. ส่วนมากที่ท่านใช้คอมพิวเตอร์ท่านมักจะ

☐ 1. นั่งบนเก้าอี้

☐ 2. นั่งบนพื้น (ข้ามไปตอบข้อ 10)

☐ 3. อื่นๆ โปรดระบุ…………………….. (ข้ามไปตอบข้อ 13)

ภาพต่อไปนี้ใช้เป็นภาพประกอบในการพิจารณาในการตอบคำถามข้อ 8-11



8. ขณะใช้คอมพิวเตอร์ ถ้าท่านนั่งบนเก้าอี้ เท้าของท่านมักจะวางราบกับพื้นหรือที่วางเท้าหรือไม่

☐ 1. วาง ☐ 2. ไม่วาง

9. ขณะใช้คอมพิวเตอร์ ถ้าท่านนั่งบนเก้าอี้ ส่วนต่างๆของร่างกายต่อไปนี้ ส่วนมากอยู่ในมุม 90 องศาหรือไม่

9.1 ข้อสะโพก ☐ 1. อยู่ ☐2. ไม่อยู่

9.2 ข้อเข่า ☐ 1. อยู่ ☐2. ไม่อยู่

9.3 ข้อเท้า ☐ 1. อยู่ ☐2. ไม่อยู่

9.4 ข้อศอก ☐ 1. อยู่ ☐2. ไม่อยู่

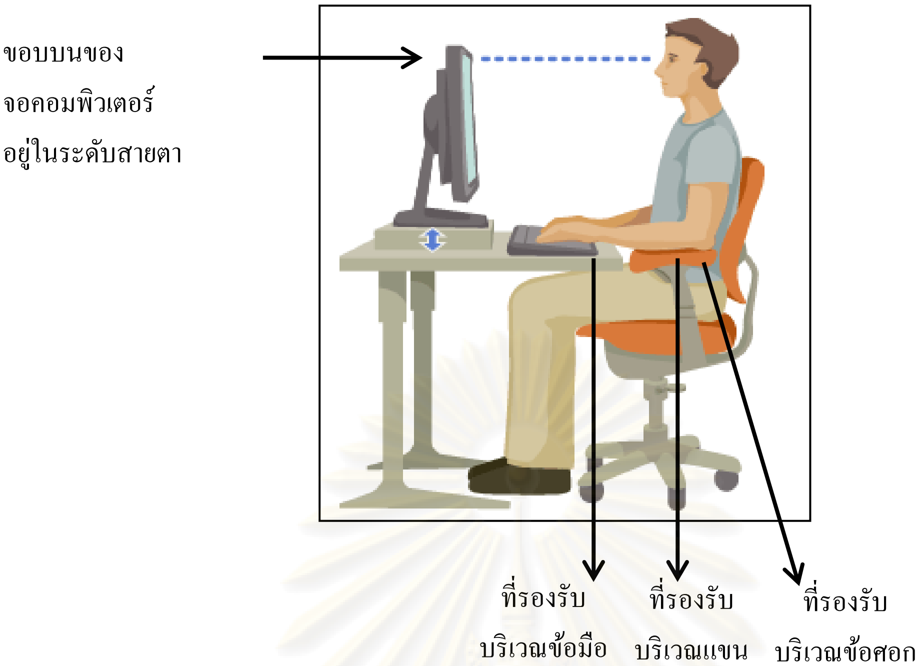
10. ขณะนั่งทำคอมพิวเตอร์ ส่วนมากท่านมักจะนั่งโดยมีที่พิงหรือไม่ (เช่น นั่งเก้าอี้ที่มีพนักพิง นั่งหลังพิงกำแพง)

☐ 1. มี ☐ 2. ไม่มี (ข้ามไปตอบข้อ 12)

11. ขณะนั่งมีที่พิงส่วนใดของร่างกายที่ได้รับการรองรับ **(สามารถตอบได้มากกว่า 1 ข้อ)**

☐ 1. คอ ☐ 2. หลังส่วนบน ☐ 3. หลังส่วนล่างและเอว

ภาพต่อไปนี้ใช้เป็นภาพประกอบในการพิจารณาในการตอบคำถามข้อ 12-13



12. ขณะนั่งใช้คอมพิวเตอร์ส่วนมาก ท่านมักจะมีที่รองรับบริเวณข้อศอก แขน และข้อมือหรือไม่

12.1 ข้อศอก ☐ 1. มี ☐ 2. ไม่มี

12.2 แขน ☐ 1. มี ☐ 2. ไม่มี

12.3 ข้อมือ ☐ 1. มี ☐ 2. ไม่มี

13. ขอบบนของจอคอมพิวเตอร์ของท่านมักจะอยู่ในระดับเดียวกับสายตาหรือไม่

☐ 1. อยู่ ☐ 2. ไม่อยู่

14. ระดับความสูงของอุปกรณ์คอมพิวเตอร์**ที่ท่านใช้อยู่เป็นประจำ**

14.1 ท่านคิดว่าระดับความสูงของ**แป้นพิมพ์**ในขณะใช้คอมพิวเตอร์อยู่ในระดับที่

☐ 1. พอดี ☐ 2. สูงเกินไป ☐ 3. ต่ำเกินไป

14.2 ท่านคิดว่าระดับความสูงของการวาง **mouse** ในขณะใช้คอมพิวเตอร์ อยู่ในระดับที่

☐ 1. พอดี ☐ 2. สูงเกินไป ☐ 3. ต่ำเกินไป

14.3 ท่านคิดว่าระดับความสูงของ **touch pad** ในขณะใช้คอมพิวเตอร์อยู่ในระดับที่

☐ 1. พอดี ☐ 2. สูงเกินไป ☐ 3. ต่ำเกินไป

15. เปอร์เซ็นต์การใช้อุปกรณ์**คอมพิวเตอร์ส่วนมากที่ท่านใช้**

15.1 ในขณะใช้คอมพิวเตอร์แบบตั้งโต๊ะ (PC)

เปอร์เซนต์ในการใช้ mouse ....% + แป้นพิมพ์...............% = 100%

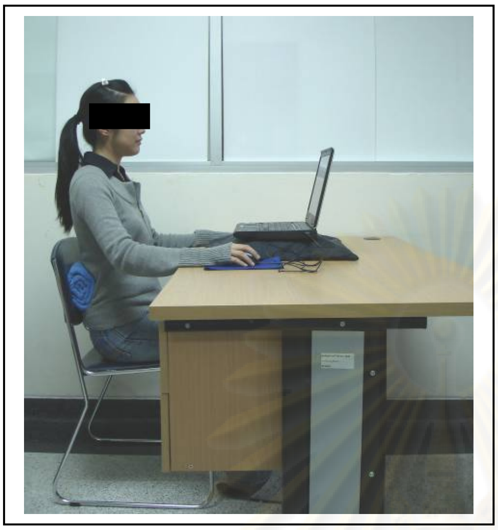
15.2 ในขณะใช้คอมพิวเตอร์แบบพกพา (Laptop/Notebook)

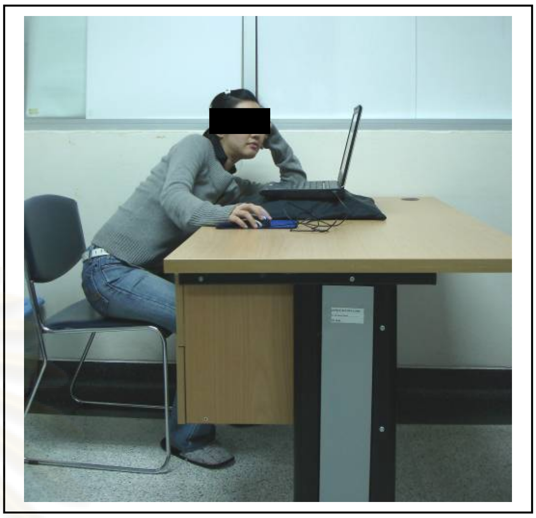
เปอร์เซนต์ในการใช้ mouse ......% + แป้นพิมพ์......%+ touch pad......% = 100%

16. ปกติท่านมักจะพิมพ์แบบสัมผัสหรือไม่ (พิมพ์แบบสัมผัส คือขณะพิมพ์งาน ตามองจอมอนิเตอร์ไม่ต้องมองแป้นพิมพ์)

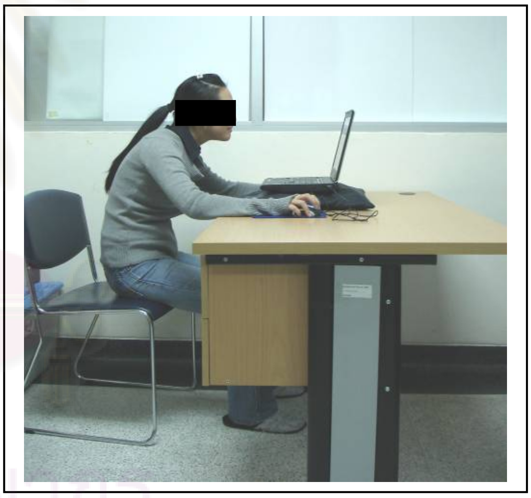
☐ 1. พิมพ์ ☐ 2. ไม่พิมพ์

17. ขณะใช้คอมพิวเตอร์ท่านคิดว่าท่านอยู่ในท่าทางแบบใดมากที่สุด

☐ 1.


☐ 2.


☐ 3.


☐ 4.


☐ 5.


ส่วนที่ 4 ข้อมูลเกี่ยวกับสภาพจิตใจ

ดัชนีชี้วัดสุขภาพจิตคนไทยฉบับย่อ (TMHI-15)

คำชี้แจง กรุณากาเครื่องหมาย ✓ ลงในช่องที่มีข้อความตรงกับตัวท่านมากที่สุด และขอความร่วมมือตอบคำถามทุกข้อ

คำถามต่อไปนี้จะถามถึงประสบการณ์ของท่าน**ในช่วง 1 เดือนที่ผ่านมา**จนถึงปัจจุบัน ให้ท่านสำรวจตัวท่านเอง และประเมินเหตุการณ์ อาการ ความคิดเห็น และความรู้สึกของท่านว่าอยู่ในระดับใด แล้วตอบลงในช่องคำตอบที่ เป็นจริงกับตัวท่านมากที่สุด โดยคำตอบจะมี 4 ตัวเลือกคือ

ไม่เลย หมายถึง ไม่เคยมีเหตุการณ์ อาการ ความรู้สึกหรือไม่เห็นด้วยกับเรื่องนั้นๆ

เล็กน้อย หมายถึง เคยมีเหตุการณ์ อาการ ความรู้สึกในเรื่องนั้นๆ เพียงเล็กน้อย หรือเห็นด้วยกับเรื่องนั้นๆ เพียงเล็กน้อย

มาก หมายถึง เคยมีเหตุการณ์ อาการ ความรู้สึกในเรื่องนั้นๆ มาก หรือเห็นด้วยกับเรื่อนั้นๆ มาก

มากที่สุด หมายถึง เคยมีเหตุการณ์ อาการ ความรู้สึกในเรื่องนั้นๆ มากที่สุด หรือเห็นด้วยกับเรื่องนั้นๆ มากที่สุด

ข้อ	คำถาม	ไม่เลย	เล็กน้อย	มาก	มากที่สุด	ส่วนของผู้วิจัย
1	ท่านรู้สึกพึงพอใจในชีวิต					M1 ☐
2	ท่านรู้สึกสบายใจ					M2 ☐
3	ท่านรู้สึกเบื่อหน่ายท้อแท้กับการดำเนินชีวิตประจำวัน					M3 ☐
4	ท่านรู้สึกผิดหวังในตัวเอง					M4 ☐
5	ท่านรู้สึกว่าชีวิตของท่านมีแต่ความทุกข์					M5 ☐
6	ท่านสามารถทำใจยอมรับได้สำหรับปัญหาที่ยากจะแก้ไข (เมื่อมีปัญหา)					M6 ☐
7	ท่านมั่นใจว่าจะสามารถควบคุมอารมณ์ได้เมื่อมีเหตุการณ์คับขันหรือร้ายแรงเกิดขึ้น					M7 ☐
8	ท่านมั่นใจที่จะเผชิญกับเหตุการณ์ร้ายแรงที่เกิดขึ้นในชีวิต					M8 ☐
9	ท่านรู้สึกเห็นอกเห็นใจเมื่อผู้อื่นมีทุกข์					M9 ☐
10	ท่านรู้สึกเป็นสุขในการช่วยเหลือผู้อื่นที่มีปัญหา					M10 ☐
11	ท่านให้ความช่วยเหลือแก่ผู้อื่นเมื่อมีโอกาส					M11 ☐
12	ท่านรู้สึกภูมิใจในตนเอง					M12 ☐
13	ท่านรู้สึกมั่นคงปลอดภัยเมื่ออยู่ในครอบครัว					M13 ☐
14	หากท่านป่วยหนัก ท่านเชื่อว่าครอบครัวจะดูแลท่านเป็นอย่างดี					M14 ☐
15	สมาชิกในครอบครัวมีความรักและผูกพันต่อกัน					M15 ☐

APPENDIX E

PARTICIPANT INFOMATION SHEET

แบบคำชี้แจงอาสาสมัคร (Patient or subject information sheet)

1. ชื่อโครงการ

การศึกษาอุบัติการณ์ในระยะ 1 ปีและปัจจัยเสี่ยงของการเกิดอาการทางระบบกระดูกและกล้ามเนื้อ บริเวณคอ/บ่า หลังส่วนบน และหลังส่วนล่างอันเนื่องมาจากการใช้คอมพิวเตอร์ ในนักศึกษาระดับอุดมศึกษมหาวิทยาลัยธรรมศาสตร์

(The 1-year incidence and risk factors for the development of musculoskeletal symptoms in the head/neck, upper back and low back due to computer use in Thammasat undergraduate students)

2. **ชื่อผู้รับผิดชอบโครงการ** นางสิริลักษณ์ กาญจโนมัย นักศึกษาปริญญาเอก สาขาชีวเวชศาสตร์ คณะบัณฑิตวิทยาลัย จุฬาลงกรณ์มหาวิทยาลัย

- สถานที่ติดต่อ: ภาควิชากายภาพบำบัด คณะสหเวชศาสตร์ มหาวิทยาลัยธรรมศาสตร์(ศูนย์รังสิต) อาคารปิยชาติ ชั้น 3

- หมายเลขโทรศัพท์ที่สามารถติดต่อได้ในกรณีฉุกเฉิน: มือถือ 087-0098885, ที่ทำงาน 029869213 ต่อ 7208

3. เหตุผลที่ต้องทำวิจัยและเหตุผลที่ต้องการศึกษาในคน รวมทั้งเหตุผลที่อาสาสมัครที่ได้รับเชิญเข้าร่วมโครงการ

การทำงานกับเครื่องคอมพิวเตอร์เป็นสิ่งที่แทบจะหลีกเลี่ยงไม่ได้ในโลกปัจจุบันนี้เพราะเครื่องคอมพิวเตอร์เป็นเครื่องมือที่สามารถทำให้บุคคลทำการติดต่อสื่อสารกันได้ทั่วโลก ได้รับข้อมูลข่าวสารได้โดยใช้เวลาไม่นาน มีประโยชน์ในหลายๆ ด้านและมีความสะดวกสบายในการใช้ จากคุณสมบัติที่กล่าวมาทำให้เครื่องคอมพิวเตอร์ถูกใช้กันอย่างแพร่หลายมากขึ้น ที่ผ่านมาการเกิดโรค/อาการทางระบบกระดูกและกล้ามเนื้อเนื่องมาจากการทำงานนั้นมักจะเกิดขึ้นในกลุ่มประชากรวัยผู้ใหญ่หรือวัยทำงาน แต่ปัจจุบันการอัตราการใช้เครื่องคอมพิวเตอร์มีแนวโน้มเพิ่มมากขึ้นในระดับอุดมศึกษา เพราะเครื่องคอมพิวเตอร์เป็นอุปกรณ์ที่จำเป็นในนักศึกษาระดับมหาวิทยาลัย เนื่องจากต้องใช้ในการเรียน ค้นคว้าข้อมูล ทำรายงาน และอื่นๆ ทำให้โรค/อาการทางระบบกระดูกและกล้ามเนื้อที่เกิดเนื่องจากการใช้คอมพิวเตอร์เพิ่มมากขึ้นอย่างรวดเร็วในกลุ่มนักศึกษา ซึ่งจากการทบทวนวรรณกรรมไม่พบว่ามีการศึกษาวิจัยติดตามผลการเกิดโรค/อาการทางระบบกระดูกและกล้ามเนื้อเนื่องจากการใช้คอมพิวเตอร์ในนักศึกษาในระยะยาว ทำให้ยังไม่พบหลักฐานเพียงพอในการสรุปถึงปัจจัยเสี่ยงที่ก่อให้เกิดโรค/อาการทางระบบกระดูกและกล้ามเนื้ออันเนื่องมาจากการใช้คอมพิวเตอร์ในนักศึกษา

ดังนั้นผู้วิจัยจึงมีความสนใจในการศึกษาถึงความชุก อุบัติการณ์ และปัจจัยเสี่ยงที่ก่อให้เกิดอาการทางระบบกระดูกและกล้ามเนื้ออันเนื่องมาจากการใช้เครื่องคอมพิวเตอร์ในกลุ่มวัยเด็กหรือวัยรุ่น ข้อมูลที่ได้น่าจะเป็นพื้นฐานที่เป็นประโยชน์ในการวางแผนเพื่อหาแนวทางการลดและป้องกันการเกิดโรค/อาการทางระบบกระดูกและกล้ามเนื้ออันเนื่องมาจากการการใช้คอมพิวเตอร์ในกลุ่มนักศึกษาเอง และคนวัยทำงานให้น้อยลง ซึ่งจะส่งผลให้คนเหล่านี้มีสุขภาพและคุณภาพชีวิตที่ดี เป็นกำลังสำคัญในการพัฒนาประเทศต่อไป

4. วัตถุประสงค์ของโครงการ

วัตถุประสงค์หลัก

หาความสัมพันธ์ระหว่างการใช้คอมพิวเตอร์มากกว่า 2 ชั่วโมงต่อวันกับอุบัติการณ์การเกิดโรคทางระบบกระดูกและกล้ามเนื้อ บริเวณคอ/บ่า หลังส่วนบน และหลังส่วนล่าง ภายในระยะติดตามผล 12 เดือน

5. ขั้นตอนและกระบวนการทำวิจัย

5.1 กลุ่มตัวอย่าง

นักศึกษามหาวิทยาลัยธรรมศาสตร์ อายุระหว่าง 18-25 ปี ทั้งเพศชายและหญิง ที่ใช้คอมพิวเตอร์แบบตั้งโต๊ะหรือแบบพกพา และรายงานว่าไม่มี"อาการปวดหรือเมื่อยหรือตึงหรือมีความรู้สึกที่ผิดปกติ เช่น ชาหรืออ่อนแรง" ในส่วนของคอ/บ่า หลังส่วนบน และหลังส่วนล่าง ติดต่อกันมากกว่า 24 ชั่วโมง ในระยะ 3 เดือนที่ผ่านมา ซึ่งคัดกรองโดยใช้แบบสอบถาม

5.2 วิธีการดำเนินการวิจัย

ในการศึกษานี้ จะใช้ทั้งแบบสอบถามและการตรวจประเมินร่างกายทางกายภาพบำบัดเป็นเครื่องมือในการเก็บข้อมูล ผู้วิจัยจะพัฒนาแบบคัดกรองอาการทางระบบกระดูกและกล้ามเนื้อรวมทั้งแบบสอบถามเพื่อใช้ในการเก็บข้อมูล โดยแบบสอบถามจะแบ่งออกเป็น 3 ส่วน คือ ข้อมูลส่วนตัว ข้อมูลเกี่ยวกับการใช้คอมพิวเตอร์ และข้อมูลด้านสภาพจิตใจ

เมื่อร่างแบบสอบถามเสร็จแล้ว จึงเป็นขั้นตอนของการปรับปรุงถ้อยคำภาษาที่ใช้ในแบบสอบถามเพื่อให้สื่อในสิ่งที่ผู้วิจัยต้องการสื่อให้ได้มากที่สุด เพื่อที่จะบรรลุวัตถุประสงค์ดังกล่าว ผู้วิจัยระดมประชากรตัวอย่างจากประชากรเป้าหมายจำนวน 20 คน และขอให้ประชากรตัวอย่างกลุ่มนี้ตอบแบบสอบถาม โดยในระหว่างการตอบแบบสอบถาม ผู้วิจัยทำการสัมภาษณ์ประชากรตัวอย่างถึงความเข้าใจเกี่ยวกับเนื้อหาทั้งหมดที่อยู่ในแบบสอบถามเพื่อทำการเปรียบเทียบว่า สิ่งที่ผู้ตอบแบบสอบถามเข้าใจและสิ่งที่ผู้วิจัยต้องการตรงกันหรือไม่ ผลการศึกษาในขั้นนี้จะถูกนำมาใช้ปรับปรุงการใช้ภาษาในแบบสอบถามให้มีความชัดเจนมากขึ้น พร้อมที่จะนำไปใช้ในการเก็บข้อมูลจริงต่อไป

การตรวจประเมินสมรรถภาพร่างกายทางกายภาพบำบัด ประกอบด้วย

- การวัดองศาการเคลื่อนไหวของคอในท่าก้มคอ เงยคอ เอียงคอ และหมุนคอ
- การวัดความตึงตัวของเส้นประสาทแขน
- การวัดความตึงตัวของเส้นประสาทขา
- การประเมินความทนทานของกล้ามเนื้อเงยคอและแอ่นหลัง

- การประเมินความทนทานของกล้ามเนื้อก้มคอและก้มหลัง
- การประเมินความยืดหยุ่นของหลัง ในท่าก้มหลังและแอ่นหลัง
- การวัดความยาวของกล้ามเนื้อส่วนอกและกล้ามเนื้อบ่า
- การวัดความยาวของกล้ามเนื้อขาด้านหน้า
- การวัดความยาวของกล้ามเนื้อขาด้านหลัง

โดยก่อนจะทำการเก็บข้อมูล จะทำการทดสอบความน่าเชื่อถือของการตรวจประเมินของนักกายภาพบำบัด ในกลุ่มตัวอย่าง จำนวน 30 คน

5.3 ขั้นตอนการเก็บข้อมูล

ผู้วิจัยติดต่อกับฝ่ายกิจการนักศึกษาของแต่ละคณะเพื่อสอบถามรายชื่อและตารางเรียนของนักศึกษาแต่ละคณะเพื่อสุ่มเลือกอาสาสมัครตามความสะดวกของอาสาสมัคร คัดเลือกประชากรโดยทำการสำรวจด้วยการส่งแบบคัดกรองผู้ที่มีอาการบาดเจ็บทางระบบกระดูกและกล้ามเนื้อในรอบ 3 เดือนที่ผ่านมาให้กับนักศึกษาแต่ละคณะ ผู้วิจัยคัดกรองแบบสอบถามเพื่อคัดอาสาสมัครที่ไม่ผ่านเกณฑ์ออก ผู้ที่ถูกคัดออกจากงานวิจัยเนื่องจากมีอาการทางระบบกระดูกและกล้ามเนื้อจากการใช้คอมพิวเตอร์นั้น ผู้วิจัยจะให้แผ่นพับคำแนะนำการปฏิบัติตัวที่ถูกต้องในขณะใช้คอมพิวเตอร์และการดูแลรักษาเบื้องต้นด้วยตนเอง และติดต่อนักศึกษาที่ผ่านเกณฑ์คือ เป็นนักศึกษามหาวิทยาลัยธรรมศาสตร์ อายุระหว่าง 18-25 ปี ทั้งเพศชายและหญิง ที่ใช้เครื่องคอมพิวเตอร์แบบตั้งโต๊ะหรือแบบพกพา และรายงานว่าไม่มี “อาการปวดหรือเมื่อยหรือตึงหรือมีความรู้สึกที่ผิดปกติ เช่น ชาหรืออ่อนแรง” ในส่วนของคอ/บ่า หลังส่วนบน และหลังส่วนล่าง อันเนื่องมาจากการใช้คอมพิวเตอร์ เพื่อเข้าร่วมการศึกษา ผู้วิจัยจะติดต่อและนัดหมายกับผู้ที่สนใจเข้าร่วมวิจัย เพื่อทำการเก็บข้อมูลโดยใช้แบบสอบถามที่พัฒนาขึ้นมา และรับการตรวจประเมินร่างกายทางกายภาพบำบัดโดยนักกายภาพบำบัดที่ไม่ใช่ผู้วิจัยเพื่อป้องกันการมีอคติ ผู้วิจัยจะนัดหมายให้ผู้เข้าร่วมงานวิจัยมาเก็บข้อมูลที่ภาควิชากายภาพบำบัด คณะสหเวชศาสตร์ มหาวิทยาลัยธรรมศาสตร์ และโทรศัพท์สอบถามผู้ที่เข้าร่วมงานวิจัยซึ่งยังไม่มีอาการทางระบบกระดูกและกล้ามเนื้อเกี่ยวกับอาการทางระบบกระดูกและกล้ามเนื้ออันเนื่องมาจากการใช้คอมพิวเตอร์ทุกๆ 3 เดือน ติดตามจนถึงเดือนที่ 12 ถ้าผู้เข้าร่วมงานวิจัยคนใดมีอาการทางระบบกระดูกและกล้ามเนื้ออันเนื่องมาจากการใช้คอมพิวเตอร์ ณ เวลาใดเวลาหนึ่งระหว่าง 12 เดือน ที่ติดตามไป ผู้วิจัยจะให้แผ่นพับคำแนะนำการปฏิบัติตัวที่ถูกต้องในขณะใช้คอมพิวเตอร์และการดูแลรักษาเบื้องต้นด้วยตนเอง ส่วนผู้ไม่มีอาการทางระบบกระดูกและกล้ามเนื้ออันเนื่องมาจากการใช้คอมพิวเตอร์จนกระทั่งถึงเดือนที่ 12 ผู้วิจัยจะนัดหมายกับผู้เข้าร่วมวิจัยเพื่อทำการเก็บข้อมูลเหมือนเดิมซ้ำอีกครั้งหนึ่ง

6. ประโยชน์ที่คาดว่าจะเกิดขึ้นจากการทำวิจัย

อาสาสมัครได้ตอบแบบสอบถามเกี่ยวกับปัจจัยเสี่ยงต่างๆ รวมทั้งการตรวจประเมินทางด้านกายภาพบำบัดในด้านปัจจัยสมรรถภาพทางร่างกายในส่วนของคอและหลัง ซึ่งปัจจัยดังกล่าวอาจจะก่อให้เกิดโรค/อาการทางระบบกระดูกและกล้ามเนื้ออันเนื่องมาจากการใช้คอมพิวเตอร์ในส่วนของคอ/บ่า

หลังส่วนบน และหลังส่วนล่างในนักศึกษา ซึ่งงานวิจัยนี้ทำให้ทราบขนาดของปัญหา และปัจจัยที่เกี่ยวข้องซึ่งอาจเป็นสาเหตุการเกิดอาการทางระบบกระดูกและกล้ามเนื้อในส่วนของคอ/บ่า หลังส่วนบน และหลังส่วนล่างในกลุ่มนักศึกษา ซึ่งจะนำไปสู่การวางแผนป้องกันการเกิดโรคทางระบบกระดูกและกล้ามเนื้ออันเนื่องมาจากการการใช้คอมพิวเตอร์ในกลุ่มนักศึกษาต่อไปในอนาคต

7. สิ่งที่อาสาสมัครจะต้องปฏิบัติและไม่ปฏิบัติระหว่างการศึกษา และระยะเวลาของการวิจัย

สิ่งที่ต้องปฏิบัติระหว่างการศึกษา คือให้อาสาสมัครดำเนินชีวิตประจำวันตามปกติและให้ตอบแบบสอบถามเกี่ยวกับอาการทางระบบกระดูกและกล้ามเนื้อในส่วนของคอ/บ่า หลังส่วนบน และหลังส่วนล่างทุกๆ 3 เดือนจากการสัมภาษณ์ทางโทรศัพท์ ซึ่งรวมระยะเวลาของการวิจัยคือ 12 เดือน

8. ความเสี่ยงหรืออันตรายที่จะเกิดขึ้นและหรือความไม่สะดวกสบายของอาสาสมัครที่อาจได้รับและมาตรการที่ผู้วิจัยเตรียมไว้ป้องกัน

อาสาสมัครจะต้องเดินทางมาที่อาคารปิยชาติ เพื่อทำการประเมินสมรรถภาพของร่างกายแต่ละครั้งใช้เวลาประมาณ 30 นาที เป็นจำนวน 2 ครั้ง ห่างกันเป็นระยะเวลา 12 เดือน

การตรวจประเมินสมรรถภาพของร่างกายทางกายภาพบำบัด อาสาสมัครต้องมีการเปลี่ยนชุด ซึ่งชุดที่สวมใส่เป็นชุดที่ปกปิดแต่จะเปิดเฉพาะบริเวณหลังส่วนล่างเพื่อทำเครื่องหมายบนปุ่มกระดูกเท่านั้น และการตรวจร่างกายจะกระทำอยู่ในสถานที่มิดชิด และในการตรวจประเมินไม่ได้กระทำเพียงลำพัง มีผู้ช่วยวิจัยร่วมการตรวจประเมินด้วย

การตรวจประเมินสมรรถภาพของร่างกายทางกายภาพบำบัดในการศึกษานี้ทั้งหมดเป็นท่าตรวจที่มีมาตรฐานและใช้กันอย่างแพร่หลายในทางคลินิค แต่ในอาสาสมัครบางคนอาจจะเกิดอาการไม่สบายหรือเจ็บระหว่างทำการตรวจร่างกายเนื่องจากอาจจะมีความไวต่อการตรวจประเมินในบางท่า มาตราการการแก้ไขคือผู้วิจัยจะให้อาสาสมัครพักจนกระทั่งอาการดีขึ้น ในการตรวจประเมินความทนทานของกล้ามเนื้อกลุ่มแอ่นหลังถ้าอาสาสมัครมีอาการเมื่อยหรือรู้สึกไม่สบาย สามารถหยุดการทดสอบได้ทันที ในการตรวจประเมินความยาวของกล้ามเนื้อบ่าและความยืดหยุ่นของหลังในท่าก้มและแอ่นหลัง ขณะทำอาจจะมีอาการตึงของกล้ามเนื้อแต่อาการที่เกิดขึ้นนั้นเป็นอาการปกติที่สามารถเกิดขึ้นได้และไม่เป็นอันตรายต่ออาสาสมัคร เนื่องจากการตรวจนั้นไม่ได้ให้อาสาสมัครกระทำเกินช่วงมุมการเคลื่อนไหวปกติ และอาสาสมัครสามารถหยุดการทดสอบได้ทันที เมื่อมีความรู้สึกตึงหรือความรู้สึกไม่สบายเกิดขึ้น มาตราการการแก้ไขคือเมื่ออาสาสมัครมีอาการตึงหรือความรู้สึกไม่สบายของกล้ามเนื้อก็ให้หยุดการเคลื่อนไหวได้ทันที

9. กรณีเกิดภาวะแทรกซ้อนที่เกี่ยวข้องกับการวิจัยผู้วิจัยจะให้การดูแลรักษาพยาบาลหรือชดเชยอาสาสมัครอย่างไร

ในกรณีที่อาสาสมัครเกิดอันตรายใดๆ ที่มีสาเหตุจากงานวิจัยระหว่างการประเมินสมรรถภาพของร่างกาย ผู้วิจัยจะให้การดูแลรักษา โดยไม่เสียค่าใช้จ่ายและจะได้รับการชดเชย ตลอดจนเงินทดแทนความพิการที่อาจเกิดขึ้นตามความเหมาะสม

10. การให้ค่าตอบแทนเป็นเงิน ควรระบุจำนวนและจำนวนครั้งที่ให้อาสาสมัคร

-

11. การรักษาความลับเกี่ยวกับอาสาสมัคร

ผู้วิจัยรับรองว่าจะเก็บข้อมูลเฉพาะเกี่ยวกับอาสาสมัครเป็นความลับและจะเปิดเผยได้เฉพาะในรูปที่เป็นสรุปผลการวิจัย การเปิดเผยข้อมูลเกี่ยวกับตัวอาสาสมัครต่อหน่วยงานต่างๆ ที่เกี่ยวข้องกระทำได้เฉพาะกรณีจำเป็นด้วยเหตุผลทางวิชาการเท่านั้นและจะต้องได้รับคำยินยอมจากอาสาสมัครเป็นลายลักษณ์อักษร

12. สิทธิของอาสาสมัครในการถอนตัวออกจากโครงการเมื่อไรก็ได้ โดยไม่กระทบต่อการรักษาพยาบาลของอาสาสมัครที่เป็นผู้ป่วย

อาสาสมัครมีสิทธิ์ที่จะบอกเลิกการเข้าร่วมการวิจัยนี้เมื่อใดก็ได้ ถ้าอาสาสมัครปรารถนาโดยไม่เสียสิทธิในการรักษาพยาบาลที่จะเกิดขึ้นตามมาในโอกาสต่อไป

13. แหล่งทุนวิจัย

ทุนวิจัยคณะสหเวชศาสตร์จุฬา

14. ชื่อ สถานที่ติดต่อ หมายเลขโทรศัพท์ที่อาสาสมัครสามารถติดต่อได้

นางสิริลักษณ์ กาญจโนมัย นักศึกษาปริญญาเอก สาขาชีวเวชศาสตร์ คณะบัณฑิตวิทยาลัย จุฬาลงกรณ์มหาวิทยาลัย

- สถานที่ติดต่อ: ภาควิชากายภาพบำบัด คณะสหเวชศาสตร์ มหาวิทยาลัยธรรมศาสตร์ (ศูนย์รังสิต) อาคารปิยชาติ ชั้น 3

- หมายเลขโทรศัพท์ที่สามารถติดต่อได้ในกรณีฉุกเฉิน: มือถือ 087-0098885, ที่ทำงาน 02-9869213 ต่อ 7208

15. โครงการวิจัยได้รับความเห็นชอบจากคณะอนุกรรมการจริยธรรมการวิจัยในคน มหาวิทยาลัยธรรมศาสตร์ ชุดที่ 2 โทรศัพท์ 0-2564-4440-79 ต่อ 1828-9

APPENDIX F

CONSENT FORM

ใบยินยอมของอาสาสมัคร

ใบยินยอมของอาสาสมัคร (Consent form)

โครงการวิจัยเรื่อง การศึกษาอุบัติการณ์ในระยะ 1 ปี และปัจจัยเสี่ยงของการเกิดโรคทางระบบกระดูกและกล้ามเนื้อ บริเวณคอ/บ่า หลังส่วนบน และหลังส่วนล่าง อันเนื่องมาจากการใช้คอมพิวเตอร์ในนักศึกษาระดับอุดมศึกษา มหาวิทยาลัยธรรมศาสตร์
(The 1-year incidence and risk factors of head/neck, upper back and lower back pain attributed to computer use in Thammasat undergraduate students)

วันที่ให้คำยินยอม วันที่ ....เดือน ....พ.ศ...........................

ก่อนที่จะลงนามในใบยินยอมให้ทำการวิจัยนี้ ข้าพเจ้าได้รับการอธิบายจากผู้วิจัยถึงวัตถุประสงค์ของการวิจัย วิธีการวิจัย อันตรายหรืออาการที่อาจเกิดขึ้นจากการวิจัยหรือจากยาที่ใช้ รวมทั้งประโยชน์ที่จะเกิดขึ้นจากการวิจัยอย่างละเอียด และมีความเข้าใจดีแล้ว ซึ่งผู้วิจัยได้ตอบคำถามต่างๆ ที่ข้าพเจ้าสงสัยด้วยความเต็มใจ ไม่ปิดบัง ซ่อนเร้น จนข้าพเจ้าพอใจ และเข้าร่วมโครงการนี้โดยสมัครใจ

ข้าพเจ้ามีสิทธิ์ที่จะบอกเลิกการเข้าร่วมการวิจัยนี้เมื่อใดก็ได้ ถ้าข้าพเจ้าปรารถนาโดยไม่เสียสิทธิในการรักษาพยาบาลที่จะเกิดขึ้นตามมาในโอกาสต่อไป

ผู้วิจัยรับรองว่าจะเก็บข้อมูล เฉพาะเกี่ยวกับตัวข้าพเจ้าเป็นความลับและจะเปิดเผยได้เฉพาะในรูปที่เป็นสรุปผลการวิจัย

การเปิดเผยข้อมูลเกี่ยวกับตัวข้าพเจ้าต่อหน่วยงานต่างๆ ที่เกี่ยวข้องกระทำได้เฉพาะกรณีจำเป็นด้วยเหตุผลทางวิชาการเท่านั้นและจะต้องได้รับคำยินยอมจากข้าพเจ้าเป็นลายลักษณ์อักษร

ในการวิจัยครั้งนี้ จะมีการตอบแบบสอบถามด้วยแบบสอบถามเกี่ยวกับข้อมูลส่วนตัว ข้อมูลเกี่ยวกับการใช้คอมพิวเตอร์ ข้อมูลเกี่ยวกับท่าทางของร่างกายขณะใช้คอมพิวเตอร์ ข้อมูลเกี่ยวกับสภาพทางจิตใจ ข้อมูลเกี่ยวกับลักษณะการบาดเจ็บทางระบบกระดูกและกล้ามเนื้อในรอบ 12 เดือนที่ผ่านมา และการตรวจร่างกาย ทางกายภาพบำบัดจำนวน 2 ครั้ง เว้นระยะห่างกันเป็นเวลา 12 เดือน

ผู้วิจัยรับรองว่าหากเกิดภาวะแทรกซ้อนใดๆ ที่มีสาเหตุจากการวิจัยดังกล่าว ข้าพเจ้าจะได้รับการรักษาพยาบาลโดยไม่คิดค่าใช้จ่าย และหรือจะมีการชดเชยค่าตอบแทน ตลอดจนเงินทดแทนความพิการที่อาจเกิดขึ้นตามความเหมาะสม

ข้าพเจ้ายินยอมให้ผู้กำกับดูแลการวิจัย ผู้ตรวจสอบ คณะกรรมการจริยธรรมการวิจัยในมนุษย์ และคณะกรรมการที่เกี่ยวข้องกับการควบคุมยา สามารถเข้าไปตรวจสอบบันทึกข้อมูลทางการแพทย์ของข้าพเจ้า เพื่อเป็นการยืนยันถึงขั้นตอนโครงการวิจัยทางคลินิก โดยไม่ล่วงละเมิดเอกสิทธิ์ ในการปิดบังข้อมูลของการสมัครตามกรอบที่กฎหมายและกฎระเบียบได้อนุญาตไว้

ข้าพเจ้าได้อ่านข้อความข้างต้นแล้ว และมีความเข้าใจดีทุกประการ และได้ลงนามในใบยินยอมนี้ด้วยความเต็มใจ

ข้าพเจ้าไม่สามารถอ่านหนังสือได้ ผู้วิจัยได้อ่านข้อความในใบยินยอมนี้ให้แก่ฟังจนเข้าใจดีแล้ว ข้าพเจ้าจึงลงนามในใบยินยอมนี้ด้วยความเต็มใจ

ข้าพเจ้าสามารถติดต่อได้ที่ ……………………………………………………………

……………………………………………………………………………………………

โดยบุคคลที่รับผิดชอบเรื่องนี้ คือ นางสิริลักษณ์ กาญจโนมัย ภาควิชากายภาพบำบัด คณะสหเวชศาสตร์ ในเวลาราชการโปรดติดต่อ เบอร์โทร 02-9869213 ต่อ 7208 นอกเวลาราชการโปรดติดต่อ 087-0098885, 02-1525140

ลงนาม…………………………………ผู้ยินยอม

(..)

ลงนาม…………………………………พยาน

(..)

ลงนาม…………………………………พยาน

(...)

การศึกษาวิจัยครั้งนี้ มีความจำเป็นอย่างยิ่งที่จะต้องให้ผู้เยาว์และหรือบุคคลไร้ความสามารถมีส่วนร่วมในการวิจัย ข้าพเจ้าได้อ่านข้อความข้างต้นแล้ว มีความเข้าใจในสิทธิและหน้าที่ของผู้เข้าร่วมโครงการวิจัยทุกประการและยินยอมให้ผู้เยาว์ และหรือ บุคคลไร้ความสามารถเข้าร่วมการวิจัยได้ จึงลงลายมือชื่อไว้เป็นหลักฐาน

ลงนาม…………………………………

(..)

ผู้ปกครอง ผู้แทนโดยชอบธรรม หรือ ผู้มีอำนาจกระทำการแทน

ลงนาม…………………………………พยาน

(..)

ลงนาม…………………………………พยาน

(...)

APPENDIX G

CROSS SECTIONAL STUDY

G I ABSTRACT

Background Although undergraduate students are future workers, little attention has been given to musculoskeletal symptoms in the spine among them.

Methods A cross-sectional survey was conducted using a descriptive questionnaire distributed to 3545 undergraduate students at a large public university in Thailand.

Results The 3-month prevalence of self-reported musculoskeletal symptoms in the spine attributed to computer use was 30.9%. Cervical symptoms (22.3%) were the most frequently reported body region followed by thoracic (11%) and lumbar symptoms (10.7%), respectively. Female, higher undergraduate year of the study, daily computer use for >3 hours and too-high keyboard's position are related to high musculoskeletal symptoms in the spine. Better-than-normal mental health status is associated with low prevalence of lumbar pain.

Conclusions Musculoskeletal symptoms in the spine attributed to computer use are common and some biopsychosocial factors were associated with the prevalence of musculoskeletal symptoms in the spine among undergraduate students.

G II Introduction

Musculoskeletal symptoms in the spine are common among office workers (1-2). Previous studies showed substantial increase in the prevalence of neck and back pain among office workers working for longer hours on a computer (3-4). Computer use is very common among undergraduate students (5). Undergraduate students involved in prolonged computer work were at risk of experiencing upper extremity musculoskeletal disorders (6-7). However, the effect of prolonged computer use on musculoskeletal symptoms in the spine among undergraduate students is unknown. Siivola et al (8) indicated that 15-18 year old high school students with neck and shoulder pain were likely to become adults with such symptoms. Conceivably, undergraduate students with musculoskeletal symptoms in the spine may develop to be unhealthy future workers. Recognition of factors associated with musculoskeletal symptoms in the spine among undergraduate students would provide an opportunity for the development of prevention and intervention strategies to minimize a number of unhealthy workers in the future.

Musculoskeletal symptoms are assumed to be of multi-factorial origin, indicating that individual, physical and psychosocial factors can contribute to their development and persistence (9). Female, older age and low physical exercise were related to a more frequent report of neck and back pain in adolescents and undergraduate students (6, 10-11). Apart from increased computer usage (12), a previous study showed that students who had high numbers of years of computer use were associated with high prevalence of upper extremity symptoms (7). Szeto et al (13) found that flexion angles of subjects' cervical and thoracic spine increased progressively while they used a notebook computer compared to a desktop computer. Thus, type of computer may be another risk factor of musculoskeletal symptoms, particularly in the neck and upper back. The role of psychosocial factors has recently gained much attention in the study of musculoskeletal pain in undergraduate students (14-15). In adolescents, high psychosomatic stress and depressive symptoms as well as poor mental health status and self-esteem have been found to be associated with musculoskeletal symptoms in the spine (16-17). It is most likely that a complex array of individual, physical and psychosocial factors is responsible for the development of musculoskeletal symptoms in undergraduate students.

The aims of this study were: (i) to examine the 3-month prevalence of self-reported musculoskeletal symptoms in the neck, upper back and low back regions attributed to computer use; and (ii) to determine the relationships between the prevalence of symptoms and certain individual, computer-use related and psychosocial factors in undergraduate students.

G III Material and methods

A cross-sectional survey was conducted with a convenience sample of 3545 undergraduate students aged between 18-25 years. All students were enrolled in Thammasat University, which is a large public university in Thailand with an average total number of

33000 students annually. A self-administered questionnaire was distributed to each student by hand. The researcher returned to collect the completed questionnaire after a few days. Subjects were excluded if they had had any known central/peripheral neurological or musculoskeletal disorders, which were confirmed by a physician, and had had a history of upper extremity, lower extremity or spinal surgery. The study was approved by the Thammasat University Human Ethics Committee.

The self-administered questionnaire consisted of four sections in order to gather data on individual, physical (computer-use related) and psychosocial factors as well as musculoskeletal symptoms in the neck, upper back and low back region during the previous 3 months.

Individual factors include gender (male or female), age, height, body weight, year of study (1^{st} to 5^{th} year), chronic diseases (yes or no), field of study (art/humanities or science) and frequency of weekly exercise sessions (regularly, occasionally or never).

Computer-use related factors include type of computer (notebook, laptop or both), years of computer use and average number of daily computer use. Respondents were asked whether during computer use their neck, upper back, low back and arm were supported, their feet were flat on the floor and their elbows, hips, knees and ankles were positioned at 90 degree flexion (yes or no). The questionnaire asked respondents to self-rate the appropriateness of positions of computer screen, keyboard and mouse/touch pad during computer use (suitable, too high or too low) and to specify the percentage time of computer use for study and entertainment as well as the percentage of duration using keyboard, mouse/touch pad and a habitual posture while using a computer.

Psychosocial factors The Thai Mental Health Indicator Questionnaire (TMHI-15) was used to collect psychological data. The test was developed by Apichai et al (18) for assessing mental health status in the Thai population. The questionnaire was found to possess a good reliability and validity. The test consists of 15 questions assessing general well being, confidence in coping, kindness and altruism, self-esteem and supporting factors. Each question was rated by the subject according to four levels (0 = completely disagree, 1 = somewhat disagree, 2 = somewhat agree, 3 = completely agree). Respondents were asked whether the statements applied to them during the preceding 1 month. The total score of the test ranged from 0 to 45. The mental health score was scaled into three groups (less than 27 = worse-than-normal, 28-34 = normal, 35-45 = better-than-normal).

Musculoskeletal symptoms during the previous 3 months was measured by the standardized Nordic questionnaire (19). Respondents who reported symptoms were asked to specify what they thought were the causes of symptoms (e.g., due to sports, a hobby, housework, computer use or other causes). In this study, students were identified as cases if they reported musculoskeletal symptoms in the spine in the previous 3 months and specified that the cause of such symptoms was partly or solely computer-related.

Statistical analyses

The percentage of missing data in all factors ranged from 0.7% to 22.7%. To retain the statistical power of the database, missing data were handled by using the 'hot-deck imputation' procedure. A respondent was selected at random from the total sample of the study and the value for that person was assigned to the case in which this information was missing. This procedure was conducted repeatedly for each missing value until the dataset was complete (20).

Chi-square analysis was carried out first to determine significant differences in the prevalence of self-reported musculoskeletal symptoms in each body part (i.e. the cervical, thoracic and lumbar regions) with various biopsychosocial characteristics. Chi-square analysis was performed using 2x2 contingency tables. The odds ratios (OR) and their 95% confidence intervals (95% CI) were calculated.

Separated multivariable logistic regression models were used to assess the associations between the prevalence in each spinal region and biopsychosocial factors. Backward selection procedures were used in the statistical modeling. Any factors with a p value <0.05 in the univariate analysis were eligible for addition to the modeling procedures. However, we included gender and year of study in all multivariate analysis in order to adjust the bias of gender and year of study. In the final modeling, the statistically significant level of each determining factor was adjusted using the Bonferroni correction procedure. According to the procedure, a p value of 0.05 is divided by the number of factors added to the modeling procedure, and the new statistically significant level is then set as a p value less than this obtained value. Adjusted ORs and 95% CI are presented for the final models. All statistical analyses were performed using the SPSS statistical software, version 17.0 (SPSS Inc, Chicago, IL, USA).

G IV Results

A total of 2614 students responded to the questionnaire for a response rate of 73.7%. Of these, 103 were excluded because they did not meet the inclusion criteria, leaving a study population of 2511. Table G.1 presents the demographic characteristics of the respondents.

There were 776 (30.9%) students who reported musculoskeletal symptoms in the spine during the preceding three months, which they partly or solely attributed to computer use. The sites of the symptoms, in order of prevalence, were the neck (22.3%), upper back (11%) and low back regions (10.7%). Twenty-nine percent of students who reported musculoskeletal symptoms in the spine experienced musculoskeletal symptoms in more than 1 body region.

Neck region

When multivariate logistic regression was used and the Bonferroni correction procedure was applied (with the significance level set at P<0.0028), gender, hours of daily computer use and keyboard height were correlated with complaints of neck symptoms (Table G.2). Female students had a higher risk for developing neck pain than their male counterparts (adjusted OR = 1.43, 95%CI = 1.14-1.80).

The average hours of computer use per day was scaled into two classes (1 = ≤3 hours per day, 2 = >3 hours per day). Students who reportedly used the computer >3 hours per day were at greater risk of experiencing cervical symptoms compared to those who used the computer ≤3 hours per day (adjusted OR = 1.59, 95%CI = 1.31-1.93).

Regarding keyboard height, self-rated appropriateness of the keyboard height during computer use was categorized into three levels (1 = suitable, 2 = too high, 3 = too low). Students reporting that the keyboard was too high were at greater risk of experiencing cervical symptoms than those reporting the keyboard was placed at a suitable height. (adjusted OR = 1.80, 95%CI = 1.41-2.30).

Upper back region

When multivariate logistic regression was used and the Bonferroni correction procedure was applied (with the significance level set at P<0.0038), the results showed that year of study and keyboard height were significantly correlated with complaints of upper back symptoms (Table G.3). The year of study was divided into 5 levels (1st year to 5th year). The prevalence of thoracic symptoms was significantly higher in the 4th year students than the 1st year students (adjusted OR = 2.81, 95%CI = 1.67-4.72). Similar to the neck region, students reporting that the keyboard was too high were at greater risk of experiencing upper back symptoms than those reporting that the keyboard was placed in suitable height. (adjusted OR = 1.63, 95%CI 1.19-2.23).

Low back region

When multivariate logistic regression was used and the Bonferroni correction procedure was applied (with the significance level set at P<0.0031), the results revealed that year of study, hours of daily computer use and mental health status were strongly associated with complaints of low back symptoms (Table G.4). The 3^{rd} year (adjusted OR = 1.9, 95%CI 1.32-2.75) and 4^{th} year students (adjusted OR = 3.08, 95%CI 1.81-5.25) had an elevated risk for lumbar symptoms compared to the 1^{st} year students. Mental health status, measured by Thai Mental Health Indicator, was scaled into three categories (1 = normal, 2 = better-than-normal, 3 = worse-than-normal). Better-than-normal mental health status was associated with decreased risk of experiencing lumbar symptoms compared to normal mental health status (adjusted OR = 0.63, 95%CI 0.46-0.86).

G V Discussion

The present study showed that musculoskeletal symptoms in the spine attributed to computer use among undergraduate students were quite common. The body region with the highest 3-month prevalence of symptoms was the neck region (22.3%). The 3-month prevalence of upper back and low back pain was nearly identical (11% and 10.7%, respectively). Schlossberg et al (7) found that approximately 26% of engineering graduate students reported shoulder and neck pain attributed to computer use.

The analysis of the relationships between the prevalence of musculoskeletal symptoms in the spine and certain biopsychosocial factors showed that gender, years of study, duration of daily computer use, keyboard height and mental health status were significantly correlated to spinal complaint. Many of these factors were related to musculoskeletal symptoms in more than one body region.

Individual factors

In the present study, we found that females were at higher risk for experiencing neck symptoms than males. The finding was consistent with previous studies indicating that female students had higher prevalence of musculoskeletal symptoms in the neck and upper extremities than male counterparts (6-7, 14, 21). One explanation may relate to gender differences in anthropometrics. Evidence suggests that women work in awkward postures and using higher relative muscle force than men during computer use (22). In our study, higher percentage of women (81%) reported working in poor postures compared to men (74%). Wahlstrom et al (23) studied the difference between work methods and gender in computer mouse use and found that women had higher muscular activity in the right and left trapezius muscles and had the highest ratings of perceived exertion in the neck and shoulder than men when operating a computer mouse during a text selection and deletion task. An alternative hypothesis is that, in many cultures including Thai culture, it is more acceptable for women to complain of discomfort or pain than men (24).

Year of study was found to have a strong effect on the prevalence of upper back and low back pain. The risk of experiencing thoracic symptoms was 2.8-fold for the 4^{th} year students in comparison with the 1^{st} year students, while the risk of experiencing low back symptoms was 1.9 to 3.1-fold for the 3^{rd} and 4^{th} year students in comparison with the 1^{st} year students. The finding is in line with previous studies (7). Schlossberg et al (7) reported no significant relationship between upper extremity pain and years of study.

Since computer work requires a sitting posture and students generally lead sedentary lifestyles, the association between year of study and musculoskeletal symptoms in the spine may relate to repetitive, prolonged sitting in poor posture. Previous studies reported a positive relationship between sitting duration and self-reported neck, upper limb and back pain (4, 25). Computer work usually results in poor sitting posture for a long period of time (26). Sitting increases the thoracic kyphotic curve and decreases the lumbar lordotic curve (27) which, in turn, leads to the compression of the anterior annulus and the nucleus pulposus of intervertebral discs as well as stretching of the posterior annulus of intervertebral discs, joint capsules and posterior ligaments and muscles (26). According to the tissue strain concept, external loads applied to tendons during repetitive work will elongate the tendon and create micro-tears in the tissue. Repetitive computer use may lead to inadequate time for complete recovery. Consequently, a residual strain develops in the tendons and creates a chronic inflammatory response in the tendon (28). Lack of movement during sitting also leads to the reduction of fluid exchange in the intervertebral discs and poor blood supply to muscle (29). Evidence suggests that sustained trunk flexion reduces the ability of the spine to resist forces acting upon it (30). Prolonged sitting also induces the shortening of some muscles, such as the abdominal and hamstring muscles, as well as lengthening of other muscles such as back muscles, which result in altered biomechanical loading of the spine during movement (31). The adverse effect of prolonged sitting accumulated over years may predispose the spine to injury during forceful loading.

The more pronounced effect of year of study on the lumbar spine may be due to slouched posture induced by prolonged sitting. Slouched sitting was found to associate with reduced trunk muscle activity, leading to a transition of load from active to passive stabilizing structures (32). Thus, the lumbar may endure the greatest mechanical stress during prolonged sitting compared to the thoracic regions while in prolonged sitting.

Computer-use related factors

Using a computer for >3 hours per day increased the risk of experiencing neck and low back symptoms. The selection of 3 hours per days as a cutoff point was because previous studies showed that computer use about 1 to 3 hours per day was associated with upper extremities and low back pain in undergraduate students (6, 12). The findings are consistent with previous studies showing that computer usage for >3 hours per day was associated with upper extremity symptoms in undergraduate students (6-7, 12, 14, 21). Hakala et al (10) found that adolescents who used a computer for >5 hours per day reported greater musculoskeletal discomfort in the low back region than those who used no computer at all. One possible interpretation of the findings may relate to prolonged sitting posture. The adverse effect of prolonged sitting on the lumbar spine as mentioned above may lead to the increased risk of lumbar pain. Intensive computer work causes continuous contraction of the neck and shoulder muscles, which consequently may lead to an accumulation of musculoskeletal overload and/or insufficient time for the natural healing process of injured structures, finally resulting in neck symptoms (29).

Self-rated perception of keyboard position as too high while using a computer increased the risk of experiencing neck and upper back pain. Evidence for the effect of keyboard height on musculoskeletal symptoms is far from conclusive (33-34). Faucett et al (33) found that higher keyboard height (with respect to the elbow height) was associated with increased risk of neck, upper back and upper extremities discomfort whereas Hunting et al (34) showed that lowering keyboard height to below elbow height was associated with elevated risk of neck, shoulder and arm discomfort. However, Mekhora et al (35) who investigated the long-term effects of ergonomic intervention on neck and shoulder discomfort among computer users with symptoms of tension neck syndrome found that neck and shoulder discomfort significantly declined when the keyboard level was adjusted to suit the individual. The authors hypothesized that adjustment of keyboard level would reduce the need to reach the hand forward and backward or to elevate the shoulder. Therefore, less muscle activity would be present after the adjustment. Further research is required before the effect of keyboard height on musculoskeletal symptoms can be conclusively determined.

Psychosocial factors

Students who had better-than-normal mental health status were at less risk of experiencing low back symptoms than those having normal mental health status. The findings support the current view that a large index number within the psychosocial dimensions contributes to the development of musculoskeletal symptoms (36-37). Smith et al (36) reported that high mental pressure was a strong risk factor for low back symptoms among medical students. Diepenmatt et al (37) showed that stress was associated with a higher prevalence of neck/shoulder and low back pain among adolescents.

The precise mechanisms through which psychosocial factors are linked to musculoskeletal symptoms are not yet fully understood. However, a number of hypotheses have been proposed to explain the association between psychosocial factors and the development of musculoskeletal symptoms (4, 38-39). It has been suggested that adverse psychosocial factors cause mental stress, which may play an intermediate role. Evidence indicates that mental stress increases muscle activity (40) and the force applied to performing physical activity (41), which compounds physical load to body structures and consequently increases the risk of musculoskeletal symptoms (38-39). Another hypothesis focuses on mental stress induced by psychosocial factors having direct effect on the occurrence of musculoskeletal pain. However, the pathomechanism of such hypothesis is still unclear (38).

There are a number of methodological limitations of this study that are noteworthy. First, in this study, many variables, including computer-use related variable and musculoskeletal symptoms, and exclusion criteria were determined based only upon subjective information, which may lead to inaccuracy. Future studies should consider the inclusion of information from objective examination in order to increase the accuracy of information. Second, information regarding frequency and severity of pain was not collected in this study. Further study should gather this information in order to enhance understanding regarding the relationship between risk factors and musculoskeletal symptom in undergraduate students. Third, subjects in this study were recruited only from one university. Thus, generalization of the results from this study to a whole undergraduate student population may be limited. Fourth, the cross-sectional study design only allows the association between exposure and outcome to be examined. It is difficult to establish the causal relationship between exposure and outcome. Therefore, a prospective study design is required to validate the findings of this study.

G VI Conclusion

The current study found that self-reported musculoskeletal symptoms in the spine attributed to computer use are common among undergraduate students with a high proportion experiencing neck symptoms. Female, higher year of study, daily computer use for >3 hours and too-high keyboard position are significantly related to high musculoskeletal symptoms in the spine. Better-than-normal mental health status is significantly associated with low prevalence of low back symptoms. Musculoskeletal disorders are one of the major health problems of office workers. The findings of the present study confirm that prolonged computer use is a significant risk factor for adverse musculoskeletal symptoms in the spine among undergraduate students.

G VII References

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Table G.1 Characteristics of respondents (n=2,511)

Characteristics	n	%	Mean	SD
Gender				
-Male	764	30.4		
-Female	1747	69.6		
Age (years)			20.3	1.2
Year of study				
-Year 1	711	28.3		
-Year 2	1083	43.1		
-Year 3	597	23.8		
-Year 4	112	4.5		
-Year 5	8	0.3		
Field of the study				
- Art/Humanities	799	31.8		
- Science	1712	68.2		
Hours of daily computer use			3.4	2.4

Table G.2 Prevalence and adjusted odds ratio (OR_{adj}) with 95% confidence intervals (95%CI) of neck symptoms with respect to factors in the final modeling (n=2,511)

Factors	N	Prevalence n (%)	OR_{adj}	95%CI	*P*
Gender					
- Male	764	133 (17.4)	1.00		
- Female	1747	427 (24.4)	1.43	1.14-1.80	0.002*
Year of study					
- 1st year	711	125 (17.6)	1.00		
- 2nd year	1083	252 (23.3)	1.38	1.08-1.77	0.010
- 3rd year	597	148 (24.8)	1.33	1.01-1.75	0.044
- 4th year	112	33 (29.5)	1.62	1.01-2.58	0.044
- 5th year	8	2 (25)	1.32	0.25-7.01	0.747
Frequency of weekly exercise sessions					
- Never	414	103 (24.9)	1.00		
- Occasionally	450	66 (14.7)	0.67	0.48-1.01	0.053
- Regularly	1647	391 (23.7)	1.11	0.85-1.44	0.439
Hours of daily computer use					
- ≤3 hours/day	1397	263 (18.8)	1.00		
- >3 hours/day	1114	297 (26.7)	1.59	1.31-1.92	<0.001*
Hip is positioned at 90 degree angle					
- Yes	876	162 (18.5)	1.00		
- No	1635	398 (24.3)	1.24	1.01-1.54	0.044
Elbow is supported					
- Yes	619	109 (17.6)	1.00		
- No	1892	451 (23.8)	1.33	1.05-1.69	0.020

Factors	N	Prevalence n (%)	OR_{adj}	95%CI	*P*
Computer screen is positioned at a horizontal level with the eyes	1183	223 (18.9)	1.00		
- Yes	1328	337 (25.4)	1.28	1.04-1.56	0.018
- No					
Keyboard height					
- Suitable	1743	328 (18.8)	1.00		
- Too high	431	137 (31.8)	1.80	1.41-2.30	<0.001*
- Too low	337	95 (28.2)	1.44	1.09-1.91	0.010

* The level of statistical significance after the Bonferroni correction procedure was set at <0.0028

Table G.3 Prevalence and adjusted odds ratio (OR_{adj}) with 95% confidence intervals (95%CI) of upper back symptoms with respect to factors in the final modeling (n=2,511)

Factors	**N**	**Prevalence n (%)**	**OR_{adj}**	**95%CI**	***P***
Year of study					
- 1st year	711	61 (8.6)	1.00		
- 2nd year	1083	107 (9.9)	1.07	0.76-1.49	0.707
- 3rd year	597	78 (13.1)	1.34	0.93-1.92	0.114
- 4th year	112	28 (25)	2.81	1.67-4.72	<0.001*
- 5th year	8	1 (12.5)	1.29	0.15-11.14	0.818
Type of computer					
- PC	855	76 (8.9)	1.00		
- Laptop	1631	192 (11.8)	1.23	0.92-1.64	0.161
- Both	25	7 (28)	3.85	1.51-9.87	0.005
Hours of daily computer use					
- ≤3 hours/day	1397	127 (9.1)	1.00		
- >3 hours/day	1114	148 (13.3)	1.43	1.10-1.85	0.007
Hip is positioned at 90 degree angle					
- Yes	876	73 (8.3)	1.00		
- No	1635	202 (12.4)	1.30	0.97-1.74	0.079
Elbow is supported					
- Yes	619	49 (7.9)	1.00		
- No	1892	226 (11.9)	1.47	1.05-2.05	0.023
Keyboard height					
- Suitable	1743	158 (9.1)	1.00		
- Too high	431	68 (15.8)	1.63	1.19-2.23	0.003*
- Too low	337	49 (14.5)	1.51	1.06-2.16	0.023

Factors	**N**	**Prevalence n (%)**	**OR$_{adj}$**	**95%CI**	***P***
A Habitual posture					
- Posture 1	532	39 (7.3)	1.00		
- Posture 2	276	25 (9.1)	0.97	0.56-1.67	0.910
- Posture 3	800	103 (12.9)	1.63	1.09-2.42	0.017
- Posture 4	692	85 (12.3)	1.47	0.97-2.23	0.068
- Posture 5	159	16 (10.1)	1.23	0.64-2.27	0.536
- Posture 6	52	7 (13.5)	1.71	0.71-4.12	0.234

* The level of statistical significance after the Bonferroni correction procedure was set at <0.0038

Table G.4 Prevalence and adjusted odds ratio (OR_{adj}) with 95% confidence intervals (95%CI) of low back symptoms with respect to factors in the final modeling (n= 2,511)

Factors	**N**	**Prevalence n (%)**	**OR_{adj}**	**95%CI**	***P***
Year of study					
- 1^{st} year	711	53 (7.5)	1.00		
- 2^{nd} year	1083	106 (9.8)	1.37	0.96-1.94	0.079
- 3^{rd} year	597	83 (13.9)	1.90	1.32-2.75	0.001*
- 4^{th} year	112	26 (23.2)	3.08	1.81-5.25	< 0.001*
- 5^{th} year	8	0 (0)	0	0	0.999
Hours of daily computer					
use	1397	118 (8.4)	1.00		
- ≤3 hours/day	1114	150 (13.5)	1.49	1.15-1.94	0.003*
- >3 hours/day					
Feet are flat on the floor					
- Yes	986	81 (8.2)	1.00		
- No	1525	187 (12.3)	1.41	1.07-1.87	0.016
Low back is supported					
- Yes	1213	109 (9)	1		
- No	1298	159 (12.9)	1.30	1.00-1.69	0.053
Mouse height					
- Suitable	1811	169 (9.35)	1.00		
- Too high	451	65 (14.4)	1.24	0.83-1.85	0.301
- Too low	249	34 (13.7)	1.95	1.17-3.25	0.010
Touch pad height					
- Suitable	1842	182 (9.9)	1.00		
- Too high	416	64 (15.4)	1.29	0.86-1.92	0.223
- Too low	253	22 (8.7)	0.49	0.27-0.88	0.018

Factors	N	Prevalence n (%)	OR_{adj}	95%CI	*P*
Mental health status					
- Normal	1408	169 (12)	1.00		
- Better-than-normal	774	61 (7.9)	0.63	0.46-0.86	0.003*
- Worse-than-normal	329	38 (11.6)	0.97	0.66-1.42	0.867

* The level of statistical significance after the Bonferroni correction procedure was set at <0.003

APPENDIX H

TABLE OF ANNUAL INCIDENCE FOR DEVELOPMENT AND PERSISTENCE OF SPINAL SYMPTOM AND CRUDE ODDS RATIO WITH 95% CONFIDENCE INTERVAL

Table H.1 Incidence of developing neck symptoms in undergraduate student using desktop computer and crude odd ratio (OR) with 95% confidence intervals (95% CI) (n=207)

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Individual factors						
Gender						
- Male	59	16	(27.1)	1.00		
- Female	148	71	(48.0)	2.48	1.28-4.79	0.008*
Age						
- 18-20	191	79	(41.4)	1.00		
- 21-25	16	8	(50.0)	1.42	0.51-3.94	0.600
BMI						
- 18.5-24.9	134	55	(41.0)	1.00		
- <18.5	58	26	(44.8)	1.17	0.63-2.17	0.626
- ≥25	15	6	(40.0)	0.96	0.32-2.85	0.938
Year of study						
- 1st year	96	36	(37.5)	1.00		
- 2nd year	80	35	(43.8)	1.30	0.71-2.37	0.400
- 3rd year	29	15	(51.7)	1.79	0.77-4.13	0.175*
- 4th year	0	0	(0.00)	0.00	-	-
- 5th year	2	1	(50.0)	1.67	0.10-27.48	0.721
Field of study						
- Art/Humanities	68	26	(38.2)	1.00		
- Science/Health science	139	61	(43.9)	1.26	0.70-2.29	0.458
Frequency of weekly exercise sessions						
- Regularly	39	11	(28.2)	1.00		
- Occasionally	145	62	(42.8)	1.90	0.88-4.11	0.102
- Never exercise	23	14	(60.9)	3.96	0.63-2.32	0.013*

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Computer use related factors						
Year of computer use						
- <4	18	7	(38.9)	1.00		
- 4-7	84	40	(47.6)	1.43	0.51-4.04	0.501
- 8-10	86	34	(39.5)	1.02	0.36-2.91	0.959
- >10	19	6	(31.6)	0.73	0.19-2.81	0.642
Hours of daily computer use						
- ≤3	138	60	(43.5)	1.00		
- >3	69	27	(39.1)	0.84	0.46-1.51	0.645
Percentage time of computer use for study						
- ≤70	194	81	(41.8)	1.00		
- >70	13	6	(46.2)	1.20	0.39-3.69	0.778
Percentage time of computer use for entertainment						
- ≤70	171	75	(43.9)	1.00		
- >70	36	12	(33.3)	0.64	0.30-1.36	0.270
Feet are flat on the floor						
- Yes	107	48	(44.9)	1.00		
- No	100	39	(39.0)	0.79	0.45-1.37	0.402
Hip are positioned at 90 degree angle						
- Yes	90	36	(40.0)	1.00		
- No	117	51	(43.6)	1.16	0.66-2.03	0.671
Knee are positioned at 90 degree angle						
- Yes	57	18	(31.6)	1.00		
- No	150	69	(46.0)	1.85	0.97-3.52	0.082*
Ankles are positioned at 90 degree angle						
- Yes	74	25	(33.8)	1.00		
- No	133	62	(46.6)	1.71	0.95-3.09	0.080*

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Elbows are positioned at 90 degree angle						
- Yes	64	22	(34.4)	1.00		
- No	143	65	(45.5)	1.59	0.86-2.93	0.170*
Neck is supported						
- Yes	9	2	(22.2)	1.00		
- No	198	85	(42.9)	2.63	0.53-12.99	0.308
Upper back is supported						
- Yes	131	53	(40.5)	1.00		
- No	76	34	(44.7)	1.19	0.67-2.11	0.562
Low back is supported						
- Yes	118	53	(44.9)	1.00		
- No	89	34	(38.2)	0.76	0.43-1.33	0.394
Elbows are supported						
- Yes	65	26	(40.0)	1.00		
- No	142	61	(43.0)	1.13	0.62-2.05	0.762
Forearms are supported						
- Yes	84	33	(39.3)	1.00		
- No	123	54	(43.9)	1.21	0.69-2.13	0.567
Wrists are supported						
- Yes	139	59	(42.4)	1.00		
- No	68	28	(41.2)	0.95	0.53-1.71	0.882
Computer screen is positioned at a level horizontal with the eyes						
- Yes	100	37	(37.0)	1.00		
- No	107	50	(46.7)	1.49	0.86-2.60	0.162*
Keyboard height						
- Suitable	162	70	(43.2)	1.00		
- Too high	21	12	(57.1)	1.75	0.70-4.39	0.231
- Too low	24	5	(20.8)	0.35	0.12-0.97	0.044*
Mouse height						
- Suitable	154	65	(42.2)	1.00		
- Too high	38	19	(50.0)	1.37	0.67-2.79	0.387
- Too low	15	3	(20.0)	0.34	0.93-1.21	0.107*

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Duration of keyboard use during desktop						
- ≤70%	201	85	(42.3)	1.00		
- >70%	6	2	(33.3)	0.68	0.12-3.81	1.000
Duration of mouse use during desktop						
- ≤70%	167	73	(43.7)	1.00		
- >70%	40	14	(35.0)	0.69	0.34-1.42	0.374
Duration of keyboard use during laptop						
- ≤50%	176	75	(42.6)	1.00		
- >50%	31	12	(38.7)	0.85	0.39-1.86	0.844
Duration of mouse use during laptop						
- ≤50%	173	73	(42.2)	1.00		
- >50%	34	14	(41.2)	0.96	0.45-2.02	1.000
Duration of touchpad use during laptop						
- ≤50%	190	81	(42.6)	1.00		
- >50%	17	6	(35.3)	0.73	0.26-2.07	0.617
Touch typing						
- Yes	42	14	(33.3)	1.00		
- No	165	73	(44.2)	1.59	0.78-3.23	0.224
Posture						
- Posture 1	51	25	(49.0)	1.00		
- Posture 2	14	6	(42.8)	0.74	0.17-1.14	0.676
- Posture 3	68	25	(36.8)	0.61	0.29-1.27	0.181*
- Posture 4	63	30	(47.6)	0.95	0.45-1.98	0.882
- Posture 5	9	4	(44.4)	0.83	0.20-3.46	0.800
- Posture 6	2	0	(0)	0.00	0	0.999
Psychosocial factors						
Mental health status						
- Normal	117	54	(46.2)	1.00		
- Better than normal	69	28	(40.6)	0.80	0.44-1.46	0.460
- Worse than normal	21	5	(23..8)	0.37	0.34-1.20	0.064*

Factors	N	Incidence n (%)	OR	95%CI	*P*
Clinical factors					
Neck flexion					
- >52 degrees	100	43 (43.0)	1.00		
- ≤52 degrees	107	44 (41.1)	0.93	0.53-1.61	0.888
Neck extension					
- >75 degrees	119	56 (47.1)	1.00		
- ≤75 degrees	88	31 (35.2)	0.61	0.35-1.08	0.207
Neck Rt. Lateral flexion					
- >44 degrees	103	45 (43.7)	1.00		
- ≤44 degrees	104	42 (40.4)	0.87	0.50-1.52	0.674
Neck Lt. lateral flexion					
- >44 degrees	91	42 (46.2)	1.00		
- ≤44 degrees	116	45 (38.8)	0.74	0.42-1.29	0.322
Neck Rt. Rotation					
- >70 degrees	99	41 (41.4)	1.00		
- ≤70 degrees	108	46 (42.6)	1.05	0.60-1.82	0.889
Neck Lt. Rotation					
- >71 degrees	102	44 (43.1)	1.00		
- ≤71 degrees	105	43 (41.0)	0.91	0.53-1.59	0.779
Neck flexor muscle endurance					
- >37 sec	86	28 (32.6)	1.00		
- ≤37 sec	121	59 (48.8)	1.97	1.11-3.50	0.023*
Neck extensor muscle endurance					
- >522 sec	161	64 (39.8)	1.00		
- ≤522 sec	46	23 (50.0)	1.52	0.79-2.93	0.238
Rt. Elbow angle from ULTT					
- >160 degrees	101	38 (37.6)	1.00		
- ≤160 degrees	106	49 (46.2)	1.43	0.82-2.48	0.260
Lt. Elbow angle from ULTT					
->158 degrees	114	46 (40.4)	1.00		
-≤158 degrees	93	41 (44.1)	1.17	0.67-2.03	0.671

* Statistical significance at $p \leq 0.2$

Table H.2 Incidence of persistent neck symptoms in undergraduate student using desktop computer and crude odd ratio (OR) with 95% confidence intervals (95% CI) (n=207)

Factors	**N**	**Incidence**	**n (%)**	**OR**	**95%CI**	***P***
Individual factors						
Gender						
- Male	59	4	(6.8)	1.00		
- Female	148	29	(19.6)	3.35	1.12-10.0	0.022*
Age						
- 18-20	191	30	(15.7)	1.00		
- 21-25	16	3	(18.8)	1.24	0.33-4.61	0.725
BMI						
- 18.5-24.9	134	21	(15.7)	1.00		
- <18.5	58	9	(15.5)	0.99	0.42-2.31	0.978
- ≥25	15	3	(20.0)	1.35	0.35-5.18	0.666
Year of study						
- 1styear	96	13	(13.5)	1.00		
- 2ndyear	80	14	(17.5)	1.35	0.60-3.08	0.469
- 3rdyear	29	5	(17.2)	1.33	0.43-4.11	0.620
- 4thyear	0	0	(0.00)	0.00	-	-
- 5thyear	2	1	(50.0)	6.39	0.38-108.4	0.200
Field of study						
- Art/Humanities	68	8	(11.8)	1.00		
- Science/Health science	139	25	(18.0)	1.65	0.70-3.87	0.314
Frequency of weekly exercise sessions						
- Regularly	39	4	(10.3)	1.00		
- Occasionally	145	24	(16.6)	1.74	0.56-5.34	0.336
- Never exercise	23	5	(21.7)	2.43	0.58-10.18	0.224
Computer use related factors						
Year of computer use						
- <4	18	1	(5.6)	1.00		
- 4-7	84	16	(19.0)	4.00	0.50-32.31	0.193*
- 8-10	86	13	(15.1)	3.03	0.37-24.76	0.302
- >10	19	3	(15.8)	3.19	0.30-33.89	0.336

Factors	**N**	**Incidence**	**n (%)**	**OR**	**95%CI**	***P***
Hours of daily computer use						
- ≤3	138	19	(13.8)	1.00		
- >3	69	14	(20.3)	1.59	0.75-3.41	0.233
Percentage time of computer use for study						
- ≤70	194	31	(16.0)	1.00		
- >70	13	2	(15.4)	0.96	0.20-4.53	1.000
Percentage time of computer use for entertainment						
- ≤70	171	31	(18.1)	1.00		
- >70	36	2	(5.6)	0.27	0.06-1.17	0.078*
Feet are flat on the floor						
- Yes	107	14	(13.1)	1.00		
- No	100	19	(19.0)	1.56	0.74-3.31	0.261
Hip are positioned at 90 degree angle						
- Yes	90	16	(17.8)	1.00		
- No	117	17	(14.5)	0.79	0.37-1.66	0.569
Knee are positioned at 90 degree angle						
- Yes	57	7	(12.3)	1.00		
- No	150	26	(17.3)	1.50	0.61-3.67	0.524
Ankles are positioned at 90 degree angle						
- Yes	74	8	(10.8)	1.00		
- No	133	25	(18.8)	1.91	0.81-4.48	0.166*
Elbows are positioned at 90 degree angle						
- Yes	64	8	(12.5)	1.00		
- No	143	25	(17.5)	1.48	0.63-3.50	0.417
Neck is supported						
- Yes	9	1	(11.1)	1.00		
- No	198	32	(16.2)	1.54	0.19-12.76	1.000

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Upper back is supported						
- Yes	131	17	(13.0)	1.00		
- No	76	16	(21.1)	1.79	0.84-3.79	0.167*
Low back is supported						
- Yes	118	20	(16.9)	1.00		
- No	89	13	(14.6)	0.84	0.39-1.79	0.704
Elbows are supported						
- Yes	65	7	(10.8)	1.00		
- No	142	26	(18.3)	1.86	0.76-4.53	0.220
Forearms are supported						
- Yes	84	9	(10.7)	1.00		
- No	123	24	(19.5)	2.02	0.87-4.60	0.120*
Wrists are supported						
- Yes	139	21	(15.1)	1.00		
- No	68	12	(17.6)	1.20	0.55-2.62	0.688
Computer screen is positioned at a level horizontal with the eyes						
- Yes	100	14	(14.0)	1.00		
- No	107	19	(17.8)	1.33	0.63-2.81	0.569
Keyboard height						
- Suitable	162	26	(16.0)	1.00		
- Too high	21	6	(28.6)	2.09	0.74-5.89	0.162*
- Too low	24	1	(4.2)	0.23	0.03-1.76	0.156*
Mouse height						
- Suitable	154	23	(14.9)	1.00		
- Too high	38	9	(23.7)	1.76	0.74-4.22	0.199*
- Too low	15	1	(6.7)	0.47	0.05-3.24	0.396
Duration of keyboard use during desktop						
- ≤70%	201	33	(16.4)	1.00		
- >70%	6	0	(0)	0.97	0.94-0.99	0.592
Duration of mouse use during desktop						
- ≤70%	167	28	(16.8)	1.00		
- >70%	40	5	(12.5)	0.71	0.26-1.97	0.634

Factors	N	Incidence n (%)	OR	95%CI	*P*
Duration of keyboard use during laptop					
- ≤50%	176	25 (14.2)	1.00		
- >50%	31	8 (25.8)	2.10	0.85-5.21	0.114*
Duration of mouse use during laptop					
- ≤50%	173	28 (16.2)	1.00		
- >50%	34	5 (14.7)	0.89	0.32-2.51	1.000
Duration of touchpad use during laptop					
- ≤50%	190	31 (16.3)	1.00		
- >50%	17	2 (11.8)	0.68	0.15-3.14	1.000
Touch typing					
- Yes	42	2 (4.8)	1.00		
- No	165	31 (18.8)	4.63	1.06-20.18	0.032*
Posture					
- Posture 1	51	7 (13.7)	1.00		
- Posture 2	14	2 (14.3)	1.05	0.19-5.71	0.957
- Posture 3	68	10 (14.7)	1.08	0.38-3.07	0.880
- Posture 4	63	12 (19.0)	1.48	0.54-4.08	0.450
- Posture 5	9	2 (22.2)	1.80	0.31-10.46	0.515
- Posture 6	2	0 (0.0)	0	0	0.999
Psychosocial factors					
Mental health status					
- Normal	117	19 (16.2)	1.00		
- Better than normal	69	13 (18.8)	1.18	0.55-2.61	0.650
- Worse than normal	21	1 (4.8)	0.26	0.03-2.04	0.199*
Clinical factors					
Neck flexion					
- >52 degrees	100	21 (21.0)	1.00		
- ≤52 degrees	107	16 (16.8)	0.78	0.22-1.03	0.306
Neck extension					
- >75 degrees	119	19 (16.0)	1.00		
- ≤75 degrees	88	14 (15.9)	0.97	0.47-2.11	1.000

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Neck Rt. Lateral flexion						
- >44 degrees	103	20	(19.4)	1.00		
- ≤44 degrees	104	13	(12.5)	0.59	0.28-1.27	0.189*
Neck Lt. lateral flexion						
- >44 degrees	91	19	(20.9)	1.00		
- ≤44 degrees	116	14	(12.1)	0.52	0.25-1.11	0.125*
Neck Rt. Rotation						
- >70 degrees	99	15	(15.2)	1.00		
- ≤70 degrees	108	18	(16.7)	1.12	0.53-2.37	0.850
Neck Lt. Rotation						
- >71 degrees	102	19	(18.6)	1.00		
- ≤71 degrees	105	14	(13.3)	0.67	0.32-1.43	0.345
Neck flexor muscle endurance						
- >37 sec	86	10	(11.6)	1.00		
- ≤37 sec	121	23	(19.0)	1.78	0.80-3.97	0.180*
Neck extensor muscle endurance						
- >522 sec	161	21	(13.0)	1.00		
- ≤522 sec	46	12	(26.1)	2.35	1.06-5.25	0.041*
Rt. Elbow angle from ULTT						
- >160 degrees	101	13	(12.9)	1.00		
- ≤160 degrees	106	20	(18.9)	1.57	0.73-3.36	0.260
Lt. Elbow angle from ULTT						
->158 degrees	114	16	(14.0)	1.00		
-≤158 degrees	93	17	(18.3)	1.37	0.65-2.89	0.448

* Statistical significance at $p \leq 0.2$

Table H.3 Incidence of developing neck symptoms in undergraduate student using notebook computer and crude odd ratio (OR) with 95% confidence intervals (95% CI) (n=317)

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Individual factors						
Gender						
- Male	79	43	(54.4)	1.00		
- Female	238	109	(45.8)	0.71	0.42-1.18	0.196*
Age						
- 18-20	282	136	(48.2)	1.00		
- 21-25	35	16	(45.7)	0.90	0.45-1.83	0.858
BMI						
- 18.5-24.9	214	103	(48.1)	1.00		
- <18.5	75	39	(52.0)	1.17	0.69-1.98	0.564
- ≥25	28	10	(35.7)	0.60	0.26-1.36	0.219
Year of study						
- 1styear	87	39	(44.8)	1.00		
- 2ndyear	167	85	(50.9)	1.28	0.76-2.15	0.359
- 3rdyear	62	28	(45.2)	1.01	0.53-1.95	0.968
- 4thyear	0	0	(0.0)	0.00	-	-
- 5thyear	1	0	(0.0)	0.00	-	-
Field of study						
- Art/Humanities	107	54	(50.5)	1.00		
- Science/Health science	210	98	(46.7)	0.86	0.54-1.37	0.553
Frequency of weekly exercise sessions						
- Regularly	60	27	(45.0)	1.00		
- Occasionally	223	104	(46.6)	0.94	0.30-0.97	0.883
- Never exercise	34	11	(32.4)	0.50	0.12-0.72	0.468
Computer use related factors						
Year of computer use						
- <4	74	34	(45.9)	1.00		
- 4-7	99	45	(45.5)	0.98	0.54-1.80	0.949
- 8-10	116	56	(48.3	1.10	0.61-1.97	0.754
- >10	28	17	(60.7)	1.82	0.75-4.41	0.186*

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Hours of daily computer use						
- ≤3	199	89	(44.7)	1.00		
- >3	118	63	(53.4)	1.42	0.90-2.24	0.163*
Percentage time of computer use for study						
- ≤70	296	142	(48.0)	1.00		
- >70	21	10	(47.6)	0.99	0.41-2.39	1.000
Percentage time of computer use for entertainment						
- ≤70	255	122	(47.8)	1.00		
- >70	62	30	(48.4)	1.02	0.59-1.78	1.000
Feet are flat on the floor						
- Yes	115	51	(44.3)	1.00		
- No	202	101	(50.0)	1.26	0.79-1.99	0.351
Hip are positioned at 90 degree angle						
- Yes	106	52	(49.1)	1.00		
- No	211	100	(47.4)	0.94	0.59-1.49	0.812
Knee are positioned at 90 degree angle						
- Yes	73	32	(43.8)	1.00		
- No	244	120	(49.2)	1.24	0.73-2.10	0.505
Ankles are positioned at 90 degree angle						
- Yes	83	38	(45.8)	1.00		
- No	234	114	(48.7)	1.13	0.68-1.86	0.702
Elbows are positioned at 90 degree angle						
- Yes	68	27	(39.7)	1.00		
- No	249	125	(50.2)	1.53	0.89-2.54	0.134*
Neck is supported						
- Yes	8	5	(62.5)	1.00		
- No	309	147	(47.6)	0.54	0.13-2.32	0.487

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Upper back is supported						
- Yes	144	62	(43.1)	1.00		
- No	173	90	(52.0)	1.43	0.92-2.24	0.116*
Low back is supported						
- Yes	144	73	(50.7)	1.00		
- No	173	79	(45.7)	0.82	0.53-1.27	0.429
Elbows are supported						
- Yes	64	24	(37.5)	1.00		
- No	253	128	(50.6)	1.71	0.97-3.00	0.069*
Forearms are supported						
- Yes	103	47	(45.6)	1.00		
- No	214	105	(49.1)	1.15	0.72-1.84	0.631
Wrists are supported						
- Yes	200	98	(49.0)	1.00		
- No	117	54	(46.2)	0.89	0.57-1.41	0.643
Computer screen is positioned at a level horizontal with the eyes						
- Yes	121	48	(39.7)	1.00		
- No	196	104	(53.1)	1.72	1.09-2.72	0.021*
Keyboard height						
- Suitable	208	92	(44.2)	1.00		
- Too high	64	38	(59.4)	1.84	1.04-3.26	0.035*
- Too low	45	22	(48.9)	1.21	0.63-2.30	0.569
Mouse height						
- Suitable	228	107	(46.9)	1.00		
- Too high	55	31	(56.4)	1.46	0.81-2.64	0.210
- Too low	34	14	(41.2)	0.79	0.38-1.64	0.531
Duration of keyboard use during desktop						
- ≤70%	311	149	(47.9)	1.00		
- >70%	6	3	(50.0)	1.09	0.22-5.47	1.000

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Duration of mouse use during desktop						
- ≤70%	260	128	(49.2)	1.00		
- >70%	57	24	(42.1)	0.75	0.42-1.34	0.381
Duration of keyboard use during laptop						
- ≤50%	260	126	(48.5)	1.00		
- >50%	57	26	(45.6)	0.89	0.50-1.59	0.770
Duration of mouse use during laptop						
- ≤50%	241	118	(49.0)	1.00		
- >50%	76	34	(44.7)	0.84	0.50-1.42	0.599
Duration of touchpad use during laptop						
- ≤50%	267	126	(47.2)	1.00		
- >50%	50	26	(52.0)	1.21	0.66-2.22	0.542
Touch typing						
- Yes	61	30	(49.2)	1.00		
- No	256	122	(47.7)	0.94	0.54-1.65	0.887
Posture						
- Posture 1	45	22	(48.9)	1.00		
- Posture 2	35	19	(54.3)	1.24	0.51-3.01	0.632
- Posture 3	92	41	(44.6)	0.84	0.41-1.71	0.634
- Posture 4	115	53	(46.4)	0.89	0.45-1.78	0.750
- Posture 5	25	13	(52.0)	1.13	0.43-3.01	0.803
- Posture 6	5	4	(80.0)	4.18	0.43-40.39	0.216
Psychosocial factors						
Mental health status						
- Normal	157	79	(50.3)	1.00		
- Better than normal	133	60	(45.1)	0.81	0.51-1.29	0.377
- Worse than normal	27	13	(48.1)	0.92	0.41-2.08	0.835
Clinical factors						
Neck flexion						
- >52 degrees	154	75	(48.7)	1.00		
- ≤52 degrees	163	77	(47.2)	0.94	0.61-1.47	0.823

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Neck extension						
- >75 degrees	168	81	(48.2)	1.00		
- ≤75 degrees	149	71	(47.7)	0.98	0.63-1.52	1.000
Neck Rt. Lateral flexion						
- >44 degrees	157	70	(44.6)	1.00		
- ≤44 degrees	160	82	(51.3)	1.31	0.84-2.03	0.261
Neck Lt. lateral flexion						
- >44 degrees	138	62	(44.9)	1.00		
- ≤44 degrees	179	90	(50.3)	1.24	0.79-1.94	0.336
Neck Rt. Rotation						
- >70 degrees	141	70	(49.6)	1.00		
- ≤70 degrees	176	82	(46.6)	0.89	0.57-1.38	0.651
Neck Lt. Rotation						
- >71 degrees	146	64	(43.8)	1.00		
- ≤71 degree	171	88	(51.5)	1.36	0.87-2.12	0.209
Neck flexor muscle endurance						
- >37 sec	116	58	(50.0)	1.00		
- ≤37 sec	201	94	(46.8)	0.88	0.56-1.39	0.641
Neck extensor muscle endurance						
- >522 sec	231	107	(46.3)	1.00		
- ≤522 sec	86	45	(52.3)	1.27	0.76-2.01	0.377
Rt. Elbow angle from ULTT						
- >160 degrees	157	72	(45.9)	1.00		
- ≤160 degrees	160	80	(50.0)	1.18	0.76-1.84	0.501
Lt. Elbow angle from ULTT						
->158 degrees	158	75	(47.5)	1.00		
-≤158 degrees	159	77	(48.4)	1.04	0.67-1.62	0.911

* Statistical significance at $p \leq 0.2$

Table H.4 Incidence of persistent neck symptoms in undergraduate student using notebook computer and crude odd ratio (OR) with 95% confidence intervals (95% CI) (n=317)

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Individual factors						
Gender						
- Male	79	11	(13.9)	1.00		
- Female	238	35	(14.7)	1.07	0.51-2.21	1.000
Age						
- 18-20	282	42	(14.9)	1.00		
- 21-25	35	4	(11.4)	0.74	0.25-2.20	0.800
BMI						
- 18.5-24.9	214	32	(15.0)	1.00		
- <18.5	75	13	(17.3)	1.19	0.59-2.42	0.625
- ≥25	28	1	(3.6)	0.21	0.03-1.61	0.133*
Year of study						
- 1styear	87	8	(9.2)	1.00		
- 2ndyear	167	33	(19.8)	2.43	1.07-5.53	0.034*
- 3rdyear	62	5	(8.1)	0.87	0.27-2.79	0.810
- 4thyear	0	0	(0.0)	0.00	-	-
- 5thyear	1	0	(0.0)	0.00	-	-
Field of study						
- Art/Humanities	107	15	(14.0)	1.00		
- Science/Health science	210	31	(14.8)	1.06	0.55-2.07	1.000
Frequency of weekly exercise sessions						
- Regularly	60	10	(16.7)	1.00		
- Occasionally	223	34	(15.2)	0.90	0.42-1.94	0.788
- Never exercise	34	2	(5.9)	0.31	0.06-1.72	0.149*
Computer use related factors						
Year of computer use						
- <4	74	8	(10.8)	1.00		
- 4-7	99	11	(11.1)	1.03	0.39-2.71	0.950
- 8-10	116	21	(18.1)	1.82	0.76-4.37	0.177*
- >10	28	6	(21.4)	2.25	0.70-7.20	0.172*

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Hours of daily computer use						
- ≤3	199	29	(14.6)	1.00		
- >3	118	17	(14.4)	0.90	0.52-1.89	1.000
Percentage time of computer use for study						
- ≤70	296	42	(14.2)	1.00		
- >70	21	4	(19.0)	1.42	0.47-4.44	0.523
Percentage time of computer use for entertainment						
- ≤70	255	39	(15.3)	1.00		
- >70	62	7	(11.3)	0.71	0.30-1.66	1.547
Feet are flat on the floor						
- Yes	115	17	(14.8)	1.00		
- No	202	29	(14.4)	0.97	0.51-1.85	1.000
Hip are positioned at 90 degree angle						
- Yes	106	18	(17.0)	1.00		
- No	211	28	(13.3)	0.75	0.39-1.43	0.400
Knee are positioned at 90 degree angle						
- Yes	73	12	(16.4)	1.00		
- No	244	34	(13.9)	0.82	0.40-1.69	0.575
Ankles are positioned at 90 degree angle						
- Yes	83	10	(12.0)	1.00		
- No	234	36	(15.4)	1.33	0.63-2.81	0.587
Elbows are positioned at 90 degree angle						
- Yes	68	8	(11.8)	1.00		
- No	249	38	(15.3)	1.35	0.60-3.05	0.563
Neck is supported						
- Yes	8	2	(25.0)	1.00		
- No	309	44	(14.2)	0.50	0.09-2.54	0.327

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Upper back is supported						
- Yes	144	23	(16.0)	1.00		
- No	173	23	(13.3)	0.81	0.43-1.51	0.525
Low back is supported						
- Yes	144	21	(14.6)	1.00		
- No	173	25	(14.5)	0.98	0.53-1.85	1.000
Elbows are supported						
- Yes	64	6	(9.4)	1.00		
- No	253	40	(15.8)	1.82	0.73-4.49	0.236
Forearms are supported						
- Yes	103	17	(16.5)	1.00		
- No	214	29	(13.6)	0.79	0.41-1.52	0.499
Wrists are supported						
- Yes	200	33	(16.5)	1.00		
- No	117	13	(11.1)	0.63	0.32-1.26	0.247
Computer screen is positioned at a level horizontal with the eyes						
- Yes	121	13	(10.7)	1.00		
- No	196	33	(16.8)	1.68	0.85-3.34	0.144*
Keyboard height						
- Suitable	208	26	(12.5)	1.00		
- Too high	64	16	(25.0)	2.33	1.16-4.70	0.018*
- Too low	45	4	(8.9)	0.68	0.23-2.06	0.499
Mouse height						
- Suitable	228	32	(14.0)	1.00		
- Too high	55	12	(21.8)	1.71	0.82-3.59	0.156*
- Too low	34	2	(5.9)	0.38	0.09-1.68	0.202
Duration of keyboard use during desktop						
- ≤70%	311	44	(14.1)	1.00		
- >70%	6	2	(33.3)	3.03	0.54-17.06	0.211

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Duration of mouse use during desktop						
- ≤70%	260	38	(14.6)	1.00		
- >70%	57	8	(14.0)	0.95	0.42-2.17	1.000
Duration of keyboard use during laptop						
- ≤50%	260	38	(14.6)	1.00		
- >50%	57	8	(14.0)	0.95	0.42-2.17	1.000
Duration of mouse use during laptop						
- ≤50%	241	32	(13.3)	1.00		
- >50%	76	14	(18.4)	1.48	0.74-2.94	0.267
Duration of touchpad use during laptop						
- ≤50%	267	41	(15.4)	1.00		
- >50%	50	5	(10.1)	0.61	0.23-1.64	0.388
Touch typing						
- Yes	61	11	(18.0)	1.00		
- No	256	35	(13.7)	0.72	0.34-1.51	0.419
Posture						
- Posture 1	45	8	(17.8)	1.00		
- Posture 2	35	4	(11.4)	0.60	0.16-2.17	0.433
- Posture 3	92	14	(15.2)	0.83	0.32-2.15	0.702
- Posture 4	115	16	(13.9)	0.75	0.30-1.89	0.750
- Posture 5	25	1	(4.0)	1.19	0.02-1.64	0.539
- Posture 6	5	3	(60.0)	6.94	0.99-48.55	0.132*
Psychosocial factors						
Mental health status						
- Normal	157	21	(13.4)	1.00		
- Better than normal	133	20	(15.0)	1.15	0.59-2.22	0.686
- Worse than normal	27	5	(18.5)	1.47	0.50-4.31	0.481
Clinical factors						
Neck flexion						
- >52 degrees	154	21	(13.6)	1.00		
- ≤52 degrees	163	25	(15.3)	1.15	0.61-2.14	0.750

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Neck extension						
- >75 degrees	168	25	(14.9)	1.00		
- ≤75 degrees	149	21	(14.1)	0.94	0.50-1.76	0.874
Neck Rt. Lateral flexion						
- >44 degrees	157	23	(14.6)	1.00		
- ≤44 degrees	160	23	(14.4)	0.98	0.52-1.83	1.000
Neck Lt. lateral flexion						
- >44 degrees	138	17	(12.3)	1.00		
- ≤44 degrees	179	29	(16.2)	1.38	0.72-2.62	0.422
Neck Rt. Rotation						
- >70 degrees	141	17	(12.1)	1.00		
- ≤70 degrees	176	29	(16.5	1.44	0.76-2.74	0.336
Neck Lt. Rotation						
- >71 degrees	146	14	(9.6)	1.00		
- ≤71 degree	171	25	(14.6)	2.07	1.11-4.25	0.386
Neck flexor muscle endurance						
- >37 sec	116	14	(12.1)	1.00		
- ≤37 sec	201	32	(15.9)	1.38	0.70-2.71	0.406
Neck extensor muscle endurance						
- >522 sec	231	34	(14.7)	1.00		
- ≤522 sec	86	12	(14.0)	0.94	0.46-1.91	1.000
Rt. Elbow angle from ULTT						
- >160 degrees	157	25	(15.9)	1.00		
- ≤160 degrees	160	21	(13.1)	0.80	0.43-1.49	0.526
Lt. Elbow angle from ULTT						
->158 degrees	158	24	(15.2)	1.00		
-≤158 degrees	159	22	(13.8)	0.90	0.48-1.68	0.752

* Statistical significance at $p \leq 0.2$

Table H.5 Incidence of developing upper back symptoms in undergraduate student using desktop computer and crude odd ratio (OR) with 95% confidence intervals (95% CI) (n=207)

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Individual factors						
Gender						
- Male	59	7	(11.9)	1.00		
- Female	148	41	(27.7)	2.85	1.20-6.78	0.017*
Age						
- 18-20	191	42	(22.0)	1.00		
- 21-25	16	6	(37.5)	2.13	0.73-6.20	0.213
BMI						
- 18.5-24.9	134	30	(22.4)	1.00		
- <18.5	58	14	(24.1)	1.10	0.53-2.28	0.791
- ≥25	15	4	(26.7)	1.26	0.37-4.25	0.709
Year of study						
- 1st year	96	18	(18.8)	1.00		
- 2nd year	80	24	(30.0)	1.86	0.92-3.74	0.083*
- 3rd year	29	6	(20.7)	1.13	0.40-3.18	0.816
- 4th year	0	0	(0.0)	0.00	-	-
- 5th year	2	0	(0.0)	0.00	0	0.999
Field of study						
- Art/Humanities	68	18	(26.5)	1.00		
- Science/Health science	139	30	(21.6)	0.77	0.39-1.50	0.484
Frequency of weekly exercise sessions						
- Regularly	39	8	(20.5)	1.00		
- Occasionally	145	33	(22.8)	1.14	0.48-2.72	0.765
- Never exercise	23	7	(30.4)	1.70	0.52-5.52	0.381
Computer use related factors						
Year of computer use						
- <4	18	4	(22.2)	1.00		
- 4-7	84	19	(22.6)	1.02	0.30-3.48	0.971
- 8-10	86	22	(25.6)	1.20	0.36-4.04	0.765
- >10	19	3	(15.8)	0.66	0.13-3.45	0.619

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Hours of daily computer use						
- ≤3	138	37	(26.8)	1.00		
- >3	69	11	(15.9)	0.52	0.24-1.09	0.205
Percentage time of computer use for study						
- ≤70	194	43	(22.2)	1.00		
- >70	13	5	(38.5)	2.20	0.68-7.05	0.185*
Percentage time of computer use for entertainment						
- ≤70	171	42	(24.6)	1.00		
- >70	36	6	(16.7)	0.61	0.24-1.58	0.388
Feet are flat on the floor						
- Yes	107	22	(20.6)	1.00		
- No	100	26	(26.0)	1.36	0.71-2.59	0.411
Hip are positioned at 90 degree angle						
- Yes	90	23	(25.6)	1.00		
- No	117	25	(21.4)	0.79	0.41-1.51	0.509
Knee are positioned at 90 degree angle						
- Yes	57	9	(15.8)	1.00		
- No	150	39	(26.0)	1.87	0.84-4.17	0.142*
Ankles are positioned at 90 degree angle						
- Yes	74	15	(20.3)	1.00		
- No	133	33	(24.8)	1.30	0.65-2.59	0.496
Elbows are positioned at 90 degree angle						
- Yes	64	10	(15.6)	1.00		
- No	143	38	(26.6)	1.95	0.91-4.22	0.109*
Neck is supported						
- Yes	9	2	(22.2)	1.00		
- No	198	46	(23.2)	1.06	0.21-5.28	1.000

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Upper back is supported						
- Yes	131	28	(21.4)	1.00		
- No	76	20	(26.3)	1.31	0.68-2.54	0.495
Low back is supported						
- Yes	118	28	(23.7)	1.00		
- No	89	20	(22.5)	0.93	0.48-1.79	0.869
Elbows are supported						
- Yes	65	15	(23.1)	1.00		
- No	142	33	(23.2)	1.01	0.53-2.02	1.000
Forearms are supported						
- Yes	84	14	(16.7)	1.00		
- No	123	34	(27.6)	1.91	0.95-3.83	0.093*
Wrists are supported						
- Yes	139	28	(20.1)	1.00		
- No	68	20	(29.4)	1.65	0.85-3.22	0.161*
Computer screen is positioned at a level horizontal with the eyes						
- Yes	100	20	(20.0)	1.00		
- No	107	28	(26.2)	1.42	0.74-2.72	0.325
Keyboard height						
- Suitable	162	32	(19.8)	1.00		
- Too high	21	11	(52.4)	4.47	1.75-11.44	0.002*
- Too low	24	5	(20.8)	1.07	0.37-3.08	0.902
Mouse height						
- Suitable	154	29	(18.8)	1.00		
- Too high	38	16	(42.1)	3.14	1.47-6.70	0.003*
- Too low	15	3	(20.0)	1.08	0.29-4.07	0.912
Duration of keyboard use during desktop						
- ≤70%	201	46	(22.9)	1.00		
- >70%	6	2	(33.3)	1.69	0.30-9.49	0.624

Factors	N	Incidence	n (%)	OR	95%CI	***P***
Duration of mouse use during desktop						
- ≤70%	167	36	(21.6)	1.00		
- >70%	40	12	(30.0)	1.56	0.72-3.37	0.297
Duration of keyboard use during laptop						
- ≤50%	176	39	(22.2)	1.00		
- >50%	31	9	(29.0)	1.44	0.61-3.37	0.488
Duration of mouse use during laptop						
- ≤50%	173	44	(25.4)	1.00		
- >50%	34	4	(11.8)	0.39	0.13-1.17	0.118*
Duration of touchpad use during laptop						
- ≤50%	190	45	(23.7)	1.00		
- >50%	17	3	(17.6)	0.69	0.19-2.51	0.767
Touch typing						
- Yes	42	10	(23.8)	1.00		
- No	165	38	(23.0)	0.96	0.43-2.13	1.000
Posture						
- Posture 1	51	9	(17.6)	1.00		
- Posture 2	14	4	(28.6)	1.88	0.48-7.31	0.370
- Posture 3	68	16	(23.5)	1.44	0.58-3.58	0.437
- Posture 4	63	16	(25.4)	1.59	0.64-3.97	0.322
- Posture 5	9	3	(33.3)	2.33	0.49-11.12	0.288
- Posture 6	2	0	(0.00)	0.00	0	0.999
Psychosocial factors						
Mental health status						
- Normal	117	27	(23.1)	1.00		
- Better than normal	69	13	(18.8)	0.77	0.37-1.62	0.498
- Worse than normal	21	6	(28.6)	1.57	0.77-5.47	0.551
Clinical factors						
Neck flexion						
- >52 degrees	100	29	(29.0)	1.00		
- ≤52 degrees	107	19	(17.8)	0.53	0.27-1.02	0.070*

Factors	**N**	**Incidence**	**n (%)**	**OR**	**95%CI**	***P***
Neck extension						
- >75 degrees	119	29	(24.4)	1.00		
- ≤75 degrees	88	19	(21.6)	0.86	0.44-1.65	0.740
Neck Rt. Lateral flexion						
- >44 degrees	103	23	(22.3)	1.00		
- ≤44 degrees	104	25	(24.0)	1.10	0.58-2.10	0.869
Neck Lt. lateral flexion						
- >44 degrees	91	22	(24.2)	1.00		
- ≤44 degrees	116	26	(22.4)	0.91	0.47-1.73	0.868
Neck Rt. Rotation						
- >70 degrees	99	19	(19.2)	1.00		
- ≤70 degrees	108	29	(26.9)	1.55	0.80-2.98	0.248
Neck Lt. Rotation						
- >71 degrees	102	23	(22.5)	1.00		
- ≤71 degrees	105	25	(23.8)	1.07	0.56-2.05	0.870
Neck flexor muscle endurance						
- >37 sec	86	14	(16.3)	1.00		
- ≤37 sec	121	34	(28.1)	2.01	1.00-4.03	0.065*
Neck extensor muscle endurance						
- >522 sec	161	35	(21.7)	1.00		
- ≤522 sec	46	13	(28.3)	1.42	0.68-2.98	0.428
Rt. Elbow angle from ULTT						
- >160 degrees	101	24	(23.8)	1.00		
- ≤160 degrees	106	24	(22.6)	0.94	0.49-1.79	0.870
Lt. Elbow angle from ULTT						
->158 degrees	114	28	(24.6)	1.00		
-≤158 degrees	93	20	(21.5)	0.84	0.44-1.62	0.624

* Statistical significance at $p \leq 0.2$

Table H.6 Incidence of persistent upper back symptoms in undergraduate student using desktop computer and crude odd ratio (OR) with 95% confidence intervals (95% CI) (n=207)

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Individual factors						
Gender						
- Male	59	1	(1.7)	1.00		
- Female	148	11	(7.4)	4.66	0.59-36.91	0.185*
Age						
- 18-20	191	10	(5.2)	1.00		
- 21-25	16	2	(12.5)	2.59	0.52-12.97	0.234
BMI						
- 18.5-24.9	134	8	(6.0)	1.00		
- <18.5	58	3	(5.2)	0.86	0.22-3.36	0.827
- ≥25	15	1	(6.7)	1.13	0.13-9.68	0.915
Year of study						
- 1styear	96	3	(3.1)	1.00		
- 2ndyear	80	9	(11.3)	3.93	1.03-15.05	0.046*
- 3rdyear	29	0	(0.0)	0.00	0	0.998
- 4thyear	0	0	(0.0)	0.00	-	-
- 5thyear	2	0	(0.0)	0.00	0	0.999
Field of study						
- Art/Humanities	68	4	(5.9)	1.00		
- Science/Health science	139	8	(5.8)	0.98	0.28-3.37	1.000
Frequency of weekly exercise sessions						
- Regularly	39	1	(2.6)	1.00		
- Occasionally	145	8	(5.5)	2.22	0.27-18.30	0.459
- Never exercise	23	3	(13.0)	5.70	0.56-58.41	0.143*
Computer use related factors						
Year of computer use						
- <4	18	1	(5.6)	1.00		
- 4-7	84	6	(7.1)	1.31	0.15-11.50	0.809
- 8-10	86	5	(5.8)	1.05	0.12-9.56	0.966
- >10	19	0	(0.0)	0.00	0	0.998

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Hours of daily computer use						
- ≤3	138	10	(7.2)	1.00		
- >3	69	2	(2.9)	0.38	0.08-1.79	0.344
Percentage time of computer use for study						
- ≤70	194	9	(4.6)	1.00		
- >70	13	3	(23.1)	6.17	1.44-27.38	0.031*
Percentage time of computer use for entertainment						
- ≤70	171	11	(6.4)	1.00		
- >70	36	1	(2.8)	0.42	0.05-3.33	0.696
Feet are flat on the floor						
- Yes	107	7	(6.5)	1.00		
- No	100	5	(5.0)	0.75	0.23-2.45	0.769
Hip are positioned at 90 degree angle						
- Yes	90	5	(5.6)	1.00		
- No	117	7	(6.0)	1.08	0.33-3.53	1.000
Knee are positioned at 90 degree angle						
- Yes	57	2	(3.5)	1.00		
- No	150	10	(6.7)	1.96	0.42-9.25	0.518
Ankles are positioned at 90 degree angle						
- Yes	74	5	(6.8)	1.00		
- No	133	7	(5.3)	0.77	0.24-2.51	0.759
Elbows are positioned at 90 degree angle						
- Yes	64	2	(3.1)	1.00		
- No	143	10	(7.0)	2.33	0.50-10.96	0.350
Neck is supported						
- Yes	9	1	(11.1)	1.00		
- No	198	11	(5.6)	0.47	0.05-4.11	0.422

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Upper back is supported						
- Yes	131	7	(5.3)	1.00		
- No	76	5	(6.6)	1.25	0.38-4.08	0.762
Low back is supported						
- Yes	118	8	(6.8)	1.00		
- No	89	4	(4.5)	0.65	0.19-2.22	0.561
Elbows are supported						
- Yes	65	1	(1.5)	1.00		
- No	142	11	(7.7)	5.37	0.68-42.54	0.109*
Forearms are supported						
- Yes	84	2	(2.4)	1.00		
- No	123	10	(8.1)	3.63	0.77-17.0	0.128*
Wrists are supported						
- Yes	139	9	(6.5)	1.00		
- No	68	3	(4.4)	0.67	0.16-2.55	0.754
Computer screen is positioned at a level horizontal with the eyes						
- Yes	100	5	(5.0)	1.00		
- No	107	7	(6.5)	1.33	0.41-4.34	0.769
Keyboard height						
- Suitable	162	9	(5.6)	1.00		
- Too high	21	3	(14.3)	2.83	0.70-11.43	0.143*
- Too low	24	0	(0.0)	0.00	0	0.998
Mouse height						
- Suitable	154	5	(3.2)	1.00		
- Too high	38	6	(15.8)	5.59	1.61-19.44	0.007*
- Too low	15	1	(6.7)	2.13	0.23-19.52	0.504
Duration of keyboard use during desktop						
- ≤70%	201	11	(5.5)	1.00		
- >70%	6	1	(16.7)	3.46	0.37-32.17	0.304

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Duration of mouse use during desktop						
- ≤70%	167	11	(6.6)	1.00		
- >70%	40	1	(2.5)	0.36	0.05-2.90	0.468
Duration of keyboard use during laptop						
- ≤50%	176	10	(5.7)	1.00		
- >50%	31	2	(6.5)	1.15	0.24-5.50	0.697
Duration of mouse use during laptop						
- ≤50%	173	11	(6.4)	1.00		
- >50%	34	1	(2.9)	0.45	0.06-3.58	0.695
Duration of touchpad use during laptop						
- ≤50%	190	10	(5.3)	1.00		
- >50%	17	2	(11.8)	2.40	0.48-11.97	0.257
Touch typing						
- Yes	42	3	(7.1)	1.00		
- No	165	9	(5.5)	0.75	0.19-2.90	0.712
Posture						
- Posture 1	51	3	(5.9)	1.00		
- Posture 2	14	1	(7.1)	1.23	0.12-12.84	0.862
- Posture 3	68	1	(1.5)	0.24	0.02-2.37	0.221
- Posture 4	63	6	(9.5)	1.68	0.40-7.10	0.477
- Posture 5	9	1	(11.1)	2.00	0.18-21.69	0.569
- Posture 6	2	0	(0.00)	0.00	0	0.999
Psychosocial factors						
Mental health status						
- Normal	117	5	(4.3)	1.00		
- Better than normal	69	4	(5.8)	1.38	0.36-5.32	0.641
- Worse than normal	21	2	(9.5)	2.73	0.82-16.99	0.488
Clinical factors						
Neck flexion						
- >52 degrees	100	6	(6.0)	1.00		
- ≤52 degrees	107	6	(5.6)	0.93	0.29-2.99	1.000

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Neck extension						
- >75 degrees	119	4	(3.4)	1.00		
- ≤75 degrees	88	8	(9.1)	2.88	0.84-9.87	0.130*
Neck Rt. Lateral flexion						
- >44 degrees	103	6	(5.8)	1.00		
- ≤44 degrees	104	6	(5.8)	0.99	0.31-3.18	1.000
Neck Lt. lateral flexion						
- >44 degrees	91	6	(6.6)	1.00		
- ≤44 degrees	116	6	(5.2)	0.77	0.24-2.48	0.768
Neck Rt. Rotation						
- >70 degrees	99	3	(3.0)	1.00		
- ≤70 degrees	108	9	(8.3)	2.91	0.76-11.07	0.139*
Neck Lt. Rotation						
- >71 degrees	102	5	(4.9)	1.00		
- ≤71 degrees	105	7	(6.7)	1.39	0.43-4.52	0.768
Neck flexor muscle endurance						
- >37 sec	86	3	(3.5)	1.00		
- ≤37 sec	121	9	(7.4)	2.22	0.58-8.47	0.366
Neck extensor muscle endurance						
- >522 sec	161	8	(5.0)	1.00		
- ≤522 sec	46	4	(8.7)	1.82	0.52-6.34	0.472
Rt. Elbow angle from ULTT						
- >160 degrees	101	3	(3.0)	1.00		
- ≤160 degrees	106	9	(8.5)	3.03	0.80-11.53	0.206
Lt. Elbow angle from ULTT						
->158 degrees	114	6	(5.3)	1.00		
-≤158 degrees	93	6	(6.5)	1.24	0.39-3.99	0.771

* Statistical significance at $p \leq 0.2$

Table H.7 Incidence of developing upper back symptoms in undergraduate student using notebook computer and crude odd ratio (OR) with 95% confidence intervals (95% CI) (n=317)

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Individual factors						
Gender						
- Male	79	20	(25.3)	1.00		
- Female	238	73	(30.7)	1.31	0.73-2.32	0.395
Age						
- 18-20	282	84	(29.8)	1.00		
- 21-25	35	9	(25.7)	0.82	0.37-1.82	0.697
BMI						
- 18.5-24.9	214	67	(31.3)	1.00		
- <18.5	75	22	(29.3)	0.91	0.51-1.62	0.750
- ≥25	28	4	(14.3)	0.37	0.12-1.10	0.072*
Year of study						
- 1styear	87	27	(31.0)	1.00		
- 2ndyear	167	49	(29.3)	0.92	0.52-1.62	0.780
- 3rdyear	62	17	(27.4)	0.84	0.41-1.72	0.634
- 4thyear	0	0	(0.0)	0.00	-	-
- 5thyear	1	0	(0.0)	0.00	0	1.000
Field of study						
- Art/Humanities	107	30	(28.0)	1.00		
- Science/Health science	210	63	(30.0)	1.10	0.66-1.84	0.794
Frequency of weekly exercise sessions						
- Regularly	60	22	(36.7)	1.00		
- Occasionally	223	64	(28.7)	0.66	0.38-1.27	0.235
- Never exercise	34	7	(20.6)	0.45	0.17-1.20	0.109*
Computer use related factors						
Year of computer use						
- <4	74	20	(27.0)	1.00		
- 4-7	99	30	(30.3)	1.17	0.60-2.29	0.638
- 8-10	116	31	(26.7)	0.99	0.51-1.90	0.963
- >10	28	12	(42.9)	2.03	0.82-5.02	0.128*

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Hours of daily computer use						
- ≤3	199	57	(28.6)	1.00		
- >3	118	36	(30.5)	1.09	0.67-1.80	0.799
Percentage time of computer use for study						
- ≤70	296	89	(30.1)	1.00		
- >70	21	4	(19.0)	0.55	0.18-1.67	0.333
Percentage time of computer use for entertainment						
- ≤70	255	72	(28.2)	1.00		
- >70	62	21	(33.9)	1.30	0.72-2.35	0.437
Feet are flat on the floor						
- Yes	115	29	(25.2)	1.00		
- No	202	64	(31.7)	1.38	0.82-2.30	0.249
Hip are positioned at 90 degree angle						
- Yes	106	29	(27.4)	1.00		
- No	211	64	(30.3)	1.16	0.69-1.94	0.604
Knee are positioned at 90 degree angle						
- Yes	73	17	(23.3)	1.00		
- No	244	76	(31.1)	1.49	0.81-2.73	0.241
Ankles are positioned at 90 degree angle						
- Yes	83	17	(20.5)	1.00		
- No	234	76	(32.5)	1.87	1.03-3.40	0.279
Elbows are positioned at 90 degree angle						
- Yes	68	19	(27.9)	1.00		
- No	249	74	(29.7)	1.09	0.60-1.98	0.881
Neck is supported						
- Yes	8	3	(37.5)	1.00		
- No	309	90	(29.1)	0.67	0.16-2.93	0.697

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Upper back is supported						
- Yes	144	44	(30.6)	1.00		
- No	173	49	(28.3)	0.90	0.55-1.46	0.711
Low back is supported						
- Yes	144	45	(31.3)	1.00		
- No	173	48	(27.7)	0.85	0.52-1.37	0.536
Elbows are supported						
- Yes	64	17	(26.6)	1.00		
- No	253	76	(30.0)	1.19	0.64-2.20	0.647
Forearms are supported						
- Yes	103	26	(25.2)	1.00		
- No	214	67	(31.3)	1.35	0.79-2.29	0.294
Wrists are supported						
- Yes	200	62	(31.0)	1.00		
- No	117	31	(26.5)	0.80	0.48-1.33	0.444
Computer screen is positioned at a level horizontal with the eyes						
- Yes	121	30	(24.8)	1.00		
- No	196	63	(32.1)	1.44	0.86-2.39	0.204
Keyboard height						
- Suitable	208	57	(27.4)	1.00		
- Too high	64	21	(32.8)	1.29	0.71-2.37	0.403
- Too low	45	15	(33.3)	1.33	0.66-2.64	0.425
Mouse height						
- Suitable	228	65	(28.5)	1.00		
- Too high	55	17	(30.9)	1.12	0.59-2.13	0.725
- Too low	34	11	(32.4)	1.20	0.55-2.60	0.645
Duration of keyboard use during desktop						
- ≤70%	311	90	(28.9)	1.00		
- >70%	6	3	(50.0)	2.46	0.49-12.40	0.364

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Duration of mouse use during desktop						
- ≤70%	260	72	(27.7)	1.00		
- >70%	57	21	(36.8)	1.52	0.83-2.78	0.199*
Duration of keyboard use during laptop						
- ≤50%	260	76	(29.2)	1.00		
- >50%	57	17	(29.8)	1.03	0.55-1.93	1.000
Duration of mouse use during laptop						
- ≤50%	241	73	(30.3)	1.00		
- >50%	76	20	(26.3)	0.82	0.46-1.47	0.565
Duration of touchpad use during laptop						
- ≤50%	267	75	(28.1)	1.00		
- >50%	50	18	(36.0)	1.44	0.76-2.72	0.310
Touch typing						
- Yes	61	16	(26.2)	1.00		
- No	256	77	(30.1)	1.21	0.64-2.27	0.640
Posture						
- Posture 1	45	9	(20.0)	1.00		
- Posture 2	35	11	(31.4)	1.83	0.66-5.09	0.245
- Posture 3	92	30	(32.6)	1.94	0.83-4.53	0.128*
- Posture 4	115	36	(31.3)	1.82	0.80-4.18	0.156*
- Posture 5	25	5	(20.0)	1.00	0.30-3.40	1.000
- Posture 6	5	2	(40.0)	2.67	0.39-18.42	0.320
Psychosocial factors						
Mental health status						
- Normal	157	43	(27.4)	1.00		
- Better than normal	133	43	(32.3)	1.27	0.76-2.10	0.359
- Worse than normal	27	7	(25.9)	0.93	0.37-2.35	0.875
Clinical factors						
Neck flexion						
- >52 degrees	154	42	(27.3)	1.00		
- ≤52 degrees	163	51	(31.3	1.21	0.75-1.97	0.461

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Neck extension						
- >75 degrees	168	57	(33.9)	1.00		
- ≤75 degrees	149	36	(24.2)	0.62	0.38-1.02	0.064*
Neck Rt. Lateral flexion						
- >44 degrees	157	42	(26.8)	1.00		
- ≤44 degrees	160	51	(31.9)	1.28	0.79-2.08	0.327
Neck Lt. lateral flexion						
- >44 degrees	138	35	(25.4)	1.00		
- ≤44 degrees	179	58	(32.4)	1.41	0.86-2.31	0.213
Neck Rt. Rotation						
- >70 degrees	141	45	(31.9)	1.00		
- ≤70 degrees	176	48	(27.3)	0.80	0.49-1.30	0.387
Neck Lt. Rotation						
- >71 degrees	146	50	(34.2)	1.00		
- ≤71 degrees	171	43	(25.1)	0.65	0.40-1.05	0.084*
Neck flexor muscle endurance						
- >37 sec	116	37	(31.9)	1.00		
- ≤37 sec	201	56	(27.9)	0.83	0.50-1.36	0.446
Neck extensor muscle endurance						
- >522 sec	231	61	(5.4)	1.00		
- ≤522 sec	86	32	(9.1)	1.65	0.98-2.80	0.071*
Rt. Elbow angle from ULTT						
- >160 degrees	157	51	(32.5	1.00		
- ≤160 degrees	160	42	(26.3)	0.74	0.46-1.20	0.267
Lt. Elbow angle from ULTT						
->158 degrees	158	44	(27.8)	1.00		
-≤158 degrees	159	49	(30.8)	1.15	0.71-1.87	0.622

* Statistical significance at $p \leq 0.2$

Table H.8 Incidence of persistent upper back symptoms in undergraduate student using notebook computer and crude odd ratio (OR) with 95% confidence intervals (95% CI) (n=317)

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Individual factors						
Gender						
- Male	79	3	(3.8)	1.00		
- Female	238	18	(7.6)	2.01	0.59-7.23	0.305
Age						
- 18-20	282	18	(6.4)	1.00		
- 21-25	35	3	(8.6)	1.38	0.38-4.93	0.715
BMI						
- 18.5-24.9	214	18	(8.4)	1.00		
- <18.5	75	3	(4.0)	0.45	0.13-1.59	0.216
- ≥25	28	0	(0.0)	0.00	0	0.998
Year of study						
- 1^{st}year	87	4	(4.6)	1.00		
- 2^{nd}year	167	16	(9.6)	2.20	0.71-6.79	0.171*
- 3^{rd}year	62	1	(1.6)	0.34	0.04-3.12	0.340
- 4^{th}year	0	0	(0.0)	0.00	-	-
- 5^{th}year	1	0	(0.0)	0.00	0	1.000
Field of study						
- Art/Humanities	107	6	(5.6)	1.00		
- Science/Health science	210	15	(7.1)	1.30	0.49-3.44	0.812
Frequency of weekly exercise sessions						
- Regularly	60	3	(5.0)	1.00		
- Occasionally	223	16	(7.2)	1.47	0.41-5.22	0.552
- Never exercise	34	2	(5.9)	1.19	0.19-7.48	0.855
Computer use related factors						
Year of computer use						
- <4	74	4	(5.4)	1.00		
- 4-7	99	5	(5.1)	0.93	0.24-3.59	0.917
- 8-10	116	8	(6.9)	1.30	0.38-4.47	0.681
- >10	28	4	(14.3)	2.92	0.68-12.58	0.151*

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Hours of daily computer use						
- ≤3	199	12	(6.0)	1.00		
- >3	118	9	(7.6)	1.29	0.53-3.15	0.643
Percentage time of computer use for study						
- ≤70	296	21	(7.1)	1.00		
- >70	21	0	(0.0)	0.00	-	0.379
Percentage time of computer use for entertainment						
- ≤70	255	15	(5.9)	1.00		
- >70	62	6	(9.7)	1.71	0.64-4.62	0.265
Feet are flat on the floor						
- Yes	115	7	(6.1)	1.00		
- No	202	14	(6.9)	1.15	0.45-2.93	1.000
Hip are positioned at 90 degree angle						
- Yes	106	4	(3.8)	1.00		
- No	211	17	(8.1)	2.24	0.73-6.82	0.230
Knee are positioned at 90 degree angle						
- Yes	73	5	(6.8)	1.00		
- No	244	16	(6.6)	0.95	0.34-2.70	1.000
Ankles are positioned at 90 degree angle						
- Yes	83	5	(6.0)	1.00		
- No	234	16	(6.8)	1.15	0.41-3.23	1.000
Elbows are positioned at 90 degree angle						
- Yes	68	2	(2.9)	1.00		
- No	249	19	(7.6)	2.73	0.62-12.01	0.269
Neck is supported						
- Yes	8	0	(0.0)	1.00		
- No	309	21	(6.8)	0.00	-	1.000

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Upper back is supported						
- Yes	144	8	(5.6)	1.00		
- No	173	13	(7.5)	1.38	0.56-3.43	0.508
Low back is supported						
- Yes	144	10	(6.9)	1.00		
- No	173	11	(6.4)	0.91	0.38-2.21	1.000
Elbows are supported						
- Yes	64	2	(3.1)	1.00		
- No	253	19	(7.5)	2.52	0.57-11.10	0.269
Forearms are supported						
- Yes	103	7	(6.8)	1.00		
- No	214	14	(6.5)	0.96	0.38-2.46	1.000
Wrists are supported						
- Yes	200	17	(8.5)	1.00		
- No	117	4	(3.4)	0.38	0.13-1.16	0.302
Computer screen is positioned at a level horizontal with the eyes						
- Yes	121	4	(3.3)	1.00		
- No	196	17	(8.7)	2.78	0.91-8.46	0.067*
Keyboard height						
- Suitable	208	13	(6.3)	1.00		
- Too high	64	5	(7.8)	1.27	0.44-3.71	0.661
- Too low	45	3	(6.7)	1.07	0.29-3.93	0.917
Mouse height						
- Suitable	228	16	(7.0)	1.00		
- Too high	55	3	(5.5)	0.76	0.22-2.72	0.678
- Too low	34	2	(5.9)	0.83	0.18-3.77	0.807
Duration of keyboard use during desktop						
- ≤70%	311	20	(6.4)	1.00		
- >70%	6	1	(16.7)	2.91	0.32-26.11	0.339

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Duration of mouse use during desktop						
- ≤70%	260	18	(6.9)	1.00		
- >70%	57	3	(5.3)	0.75	0.21-2.63	1.000
Duration of keyboard use during laptop						
- ≤50%	260	19	(7.3)	1.00		
- >50%	57	2	(3.5)	0.46	0.10-2.04	0.390
Duration of mouse use during laptop						
- ≤50%	241	16	(6.6)	1.00		
- >50%	76	5	(6.6)	0.99	0.35-2.80	1.000
Duration of touchpad use during laptop						
- ≤50%	267	17	(6.4)	1.00		
- >50%	50	4	(8.0)	1.28	0.41-3.97	0.755
Touch typing						
- Yes	61	7	(11.5)	1.00		
- No	256	14	(5.5)	0.45	0.17-1.16	0.146*
Posture						
- Posture 1	45	1	(2.2)	1.00		
- Posture 2	35	2	(5.7)	2.67	0.23-30.67	0.431
- Posture 3	92	3	(3.3)	1.48	0.15-14.67	0.736
- Posture 4	115	12	(10.4)	5.13	0.65-40.64	0.122*
- Posture 5	25	2	(8.0)	3.83	0.33-44.47	0.284
- Posture 6	5	0	(0.0)	-	-	0.100
Psychosocial factors						
Mental health status						
- Normal	157	12	(7.6)	1.00		
- Better than normal	133	7	(5.3)	0.67	0.26-1.76	0.417
- Worse than normal	27	2	(7.4)	0.97	0.20-4.58	0.966
Clinical factors						
Neck flexion						
- >52 degrees	154	12	(7.8)	1.00		
- ≤52 degrees	163	9	(5.5)	0.69	0.28-1.69	0.500

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Neck extension						
- >75 degrees	168	18	(10.7)	1.00		
- ≤75 degrees	149	6	(4.1)	0.47	0.05-1.09	0.202
Neck Rt. Lateral flexion						
- >44 degrees	157	13	(8.3)	1.00		
- ≤44 degrees	160	8	(5.0)	0.58	0.24-1.45	0.266
Neck Lt. lateral flexion						
- >44 degrees	138	8	(5.8)	1.00		
- ≤44 degrees	179	13	(32.4)	1.27	0.51-3.16	0.655
Neck Rt. Rotation						
- >70 degrees	141	10	(7.1)	1.00		
- ≤70 degrees	176	11	(6.3)	0.87	0.36-2.12	0.822
Neck Lt. Rotation						
- >71 degrees	146	11	(7.5)	1.00		
- ≤71 degrees	171	10	(5.8)	0.76	0.31-1.85	0.652
Neck flexor muscle endurance						
- >37 sec	116	7	(6.0)	1.00		
- ≤37 sec	201	14	(7.0)	1.17	0.45-3.00	0.819
Neck extensor muscle endurance						
- >522 sec	231	13	(5.6)	1.00		
- ≤522 sec	86	8	(9.3)	1.72	0.69-4.31	0.308
Rt. Elbow angle from ULTT						
- >160 degrees	157	14	(8.9)	1.00		
- ≤160 degrees	160	7	(4.4)	0.47	0.18-1.20	0.118*
Lt. Elbow angle from ULTT						
->158 degrees	158	10	(6.3)	1.00		
-≤158 degrees	159	11	(6.9)	1.10	0.45-2.67	1.000

* Statistical significance at $p \leq 0.2$

Table H.9 Incidence of developing low back symptoms in undergraduate student using desktop computer and crude odd ratio (OR) with 95% confidence intervals (95% CI) (n=207)

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Individual factors						
Gender						
- Male	59	18	(30.5)	1.00		
- Female	148	49	(28.4)	0.90	0.47-1.75	0.865
Age						
- 18-20	191	57	(29.8)	1.00		
- 21-25	16	3	(18.8)	0.54	0.15-1.98	0.566
BMI						
- 18.5-24.9	134	41	(30.6)	1.00		
- <18.5	58	14	(24.1)	0.72	0.36-1.46	0.364
- ≥25	15	5	(33.3)	1.13	0.37-3.53	0.828
Year of study						
- 1st year	96	29	(30.2)	1.00		
- 2nd year	80	17	(21.3)	0.62	0.31-1.24	0.180*
- 3rd year	29	14	(48.3)	2.16	0.92-5.04	0.076*
- 4th year	0	0	(0.0)	0.00	-	-
- 5th year	2	0	(0.0)	0.00	-	0.999
Field of study						
- Art/Humanities	68	18	(26.5)	1.00		
- Science/Health science	139	42	(30.2)	1.20	0.63-2.30	0.627
Frequency of weekly exercise sessions						
- Regularly	39	12	(30.8)	1.00		
- Occasionally	145	37	(25.5)	0.77	0.36-1.67	0.511
- Never exercise	23	11	(47.8)	2.06	0.71-5.98	0.182*
Computer use related factors						
Year of computer use						
- <4	18	7	(38.9)	1.00		
- 4-7	84	27	(32.1)	0.74	0.26-2.13	0.582
- 8-10	86	19	(22.1)	0.45	0.15-1.31	0.141*
- >10	19	7	(36.8)	0.92	0.24-3.46	0.898

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Hours of daily computer use						
- ≤3	138	38	(27.5)	1.00		
- >3	69	22	(31.9)	1.23	0.66-2.31	0.520
Percentage time of computer use for study						
- ≤70	194	56	(28.9)	1.00		
- >70	13	4	(30.8)	1.01	0.32-3.70	1.000
Percentage time of computer use for entertainment						
- ≤70	171	51	(29.8)	1.00		
- >70	36	9	(25.0)	0.78	0.35-1.79	0.687
Feet are flat on the floor						
- Yes	107	31	(29.0)	1.00		
- No	100	29	(29.0)	1.00	0.55-1.83	1.000
Hip are positioned at 90 degree angle						
- Yes	90	22	(24.4)	1.00		
- No	117	38	(32.5)	1.49	0.80-2.76	0.220
Knee are positioned at 90 degree angle						
- Yes	57	14	(24.6)	1.00		
- No	150	46	(30.7)	1.36	0.68-2.72	0.493
Ankles are positioned at 90 degree angle						
- Yes	74	18	(24.3)	1.00		
- No	133	42	(31.6)	1.44	0.75-2.74	0.338
Elbows are positioned at 90 degree angle						
- Yes	64	14	(21.9)	1.00		
- No	143	46	(32.2)	1.69	0.85-3.37	0.140*
Neck is supported						
- Yes	9	3	(33.3)	1.00		
- No	198	57	(28.8)	0.81	0.20-3.34	0.720

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Upper back is supported						
- Yes	131	39	(29.8)	1.00		
- No	76	21	(27.6)	0.90	0.48-1.69	0.874
Low back is supported						
- Yes	118	24	(20.3)	1.00		
- No	89	36	(40.4)	2.66	1.44-4.93	0.002*
Elbows are supported						
- Yes	65	15	(23.1)	1.00		
- No	142	45	(31.7)	1.55	0.79-3.04	0.249
Forearms are supported						
- Yes	84	21	(25.0)	1.00		
- No	123	39	(31.7)	1.39	0.75-2.60	0.350
Wrists are supported						
- Yes	139	38	(27.3)	1.00		
- No	68	22	(32.4)	1.27	0.68-2.39	0.515
Computer screen is positioned at a level horizontal with the eyes						
- Yes	100	29	(29.0)	1.00		
- No	107	31	(29.0)	0.99	0.55-1.82	1.000
Keyboard height						
- Suitable	162	43	(26.5)	1.00		
- Too high	21	11	(52.4)	3.04	1.21-7.67	0.018*
- Too low	24	6	(25.0)	0.92	0.34-2.48	0.873
Mouse height						
- Suitable	154	41	(26.6)	1.00		
- Too high	38	13	(34.2)	1.43	0.67-3.06	0.353
- Too low	15	6	(40.0)	1.84	0.62-5.48	0.275
Duration of keyboard use during desktop						
- ≤70%	210	56	(27.9)	1.00		
- >70%	6	2	(33.3)	2.18	0.92-29.07	0.160*

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Duration of mouse use during desktop						
- ≤70%	167	48	(28.7)	1.00		
- >70%	40	12	(30.0)	1.06	0.50-2.26	0.849
Duration of keyboard use during laptop						
- ≤50%	176	50	(28.4)	1.00		
- >50%	31	10	(32.3)	1.20	0.53-2.73	0.671
Duration of mouse use during laptop						
- ≤50%	173	53	(30.6)	1.00		
- >50%	34	7	(20.6)	0.59	0.24-1.43	0.303
Duration of touchpad use during laptop						
- ≤50%	190	54	(28.4)	1.00		
- >50%	17	6	(35.3)	1.37	0.48-3.90	0.581
Touch typing						
- Yes	42	11	(26.2)	1.00		
- No	165	49	(29.7)	1.19	0.55-2.57	0.707
Posture						
- Posture 1	51	13	(25.5)	1.00		
- Posture 2	14	3	(21.4)	0.80	0.19-3.31	0.755
- Posture 3	68	15	(22.1)	0.83	0.35-1.94	0.663
- Posture 4	63	27	(42.9)	2.19	0.98-4.90	0.056*
- Posture 5	9	2	(22.2)	0.84	0.15-4.54	0.835
- Posture 6	2	0	(0.0)	0.00	-	0.999
Psychosocial factors						
Mental health status						
- Normal	117	37	(31.6)	1.00		
- Better than normal	69	17	(24.6)	0.71	0.36-1.38	0.312
- Worse than normal	21	6	(28.6)	0.87	0.31-2.41	0.781
Clinical factors						
Rt.Quadriceps muscle length						
- <115 degrees	112	29	(25.9)	1.00		
- ≥115 degrees	95	31	(32.6)	1.40	0.76-2.53	0.356

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Lt. Quadriceps muscle length						
- <115 degrees	108	24	(22.2)	1.00		
- ≥115 degrees	99	36	(36.4)	2.00	1.09-3.69	0.032*
Rt.Hamstrings muscle length						
- >151 degrees	93	28	(30.1)	1.00		
- ≤151 degrees	114	32	(28.1)	0.91	0.50-1.66	0.760
Lt. Hamstrings muscle length						
- >152 degrees	101	24	(23.8)	1.00		
- ≤152 degrees	106	36	(34.0)	1.65	0.90-3.04	0.126*
Trunk flexion flexibility						
- >5.9 cm.	108	32	(29.6)	1.00		
- ≤5.9 cm.	99	28	(28.3)	0.94	0.51-1.71	0.879
Trunk extension flexibility						
- >2.8 cm.	103	29	(28.2)	1.00		
- ≤2.8 cm.	104	31	(29.8)	1.08	0.59-1.98	0.878
Trunk Rt. Lateral flexion						
- >20 cm.	104	29	(27.9)	1.00		
- ≤20 cm.	103	31	(30.1)	1.11	0.61-2.03	0.761
Trunk Lt. Lateral flexion						
- >20 cm.	103	30	(29.1)	1.00		
- ≤20 cm.	104	30	(28.8)	0.99	0.54-1.80	1.000
Trunk flexor muscle endurance						
- >38 sec	88	25	(28.4)	1.00		
- ≤38 sec	119	35	(29.4)	1.05	0.57-1.93	1.000
Trunk extensor endurance						
- >73 sec	97	23	(23.7)	1.00		
- ≤73 sec	110	37	(33.6)	1.63	0.88-3.01	0.127*
Rt. Hip flexion form SLR						
- >72 degrees	98	28	(28.6)	1.00		
- ≤72 degrees	109	32	(29.4)	1.04	0.57-1.90	1.000
Lt. Hip flexion from SLR						
- >73 degrees	103	26	(25.2)	1.00		
- ≤73 degrees	104	34	(32.7)	1.44	0.79-2.63	0.284

* Statistical significance at $p \leq 0.2$

Table H.10 Incidence of persistent low back symptoms in undergraduate student using desktop computer and crude odd ratio (OR) with 95% confidence intervals (95% CI) (n=207)

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Individual factors						
Gender						
- Male	59	4	(6.8)	1.00		
- Female	148	14	(9.5)	1.44	0.45-4.56	0.785
Age						
- 18-20	191	18	(9.4)	1.00		
- 21-25	16	0	(0.0)	-	-	0.370
BMI						
- 18.5-24.9	134	12	(9.0)	1.00		
- <18.5	58	6	(10.3)	1.17	0.42-3.29	0.762
- ≥25	15	0	(0.00)	0.00	-	0.999
Year of study						
- 1^{st}year	96	11	(11.5)	1.00		
- 2^{nd}year	80	3	(3.8)	0.30	0.08-1.12	0.073*
- 3^{rd}year	29	4	(13.8)	1.24	0.36-4.22	0.735
- 4^{th}year	0	0	(0.0)	0.00	-	-
- 5^{th}year	2	0	(0.0)	0.00	-	0.999
Field of study						
- Art/Humanities	68	5	(7.4)	1.00		
- Science/Health science	139	13	(9.4)	1.30	0.44-3.81	0.795
Frequency of weekly exercise sessions						
- Regularly	39	2	(5.1)	1.00		
- Occasionally	145	14	(9.7)	1.98	0.43-9.09	0.381
- Never exercise	23	2	(8.7)	1.76	0.23-13.44	0.585
Computer use related factors						
Year of computer use						
- <4	18	1	(5.6)	1.00		
- 4-7	84	11	(13.1)	2.56	0.31-21.21	0.383
- 8-10	86	5	(5.8)	1.05	0.12-9.56	0.966
- >10	19	1	(5.3)	0.94	0.06-16.32	0.969

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Hours of daily computer use						
- ≤3	138	12	(8.7)	1.00		
- >3	69	6	(8.7)	1.00	0.36-2.79	1.000
Percentage time of computer use for study						
- ≤70	194	18	(9.3)	1.00		
- >70	13	0	(0.0)	-	-	0.610
Percentage time of computer use for entertainment						
- ≤70	171	16	(9.4)	1.00		
- >70	36	2	(5.6)	0.57	0.13-2.60	0.745
Feet are flat on the floor						
- Yes	107	9	(8.4)	1.00		
- No	100	9	(9.0)	1.08	0.41-2.83	1.000
Hip are positioned at 90 degree angle						
- Yes	90	6	(6.7)	1.00		
- No	117	12	(10.3)	1.60	0.58-4.44	0.459
Knee are positioned at 90 degree angle						
- Yes	57	4	(7.0)	1.00		
- No	150	14	(9.3)	1.36	0.43-4.33	0.784
Ankles are positioned at 90 degree angle						
- Yes	74	4	(5.4)	1.00		
- No	133	14	(10.5)	2.06	0.65-6.50	0.304
Elbows are positioned at 90 degree angle						
- Yes	64	4	(6.3)	1.00		
- No	143	14	(9.8)	1.62	0.51-5.16	0.594
Neck is supported						
- Yes	9	0	(0.0)	1.00		
- No	198	18	(9.1)	-	-	1.000

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Upper back is supported						
- Yes	131	11	(8.4)	1.00		
- No	76	7	(9.2)	1.11	0.41-2.99	1.000
Low back is supported						
- Yes	118	7	(5.9)	1.00		
- No	89	11	(12.4)	2.24	0.83-6.02	0.135*
Elbows are supported						
- Yes	65	4	(6.2)	1.00		
- No	142	14	(9.9)	1.67	0.53-5.28	0.439
Forearms are supported						
- Yes	84	4	(4.8)	1.00		
- No	123	14	(11.4)	2.57	0.82-8.10	0.132*
Wrists are supported						
- Yes	139	14	(10.1)	1.00		
- No	68	4	(5.9)	0.56	0.18-1.77	0.433
Computer screen is positioned at a level horizontal with the eyes						
- Yes	100	9	(9.5)	1.00		
- No	107	9	(8.4)	0.93	0.35-2.44	1.000
Keyboard height						
- Suitable	162	15	(9.3)	1.00		
- Too high	21	2	(9.5)	1.03	1.22-4.86	0.969
- Too low	24	1	(4.2)	0.43	0.05-3.38	0.420
Mouse height						
- Suitable	154	14	(9.1)	1.00		
- Too high	38	2	(5.3)	0.57	0.12-2.56	0.450
- Too low	15	2	(13.3)	1.54	0.32-7.52	0.595
Duration of keyboard use during desktop						
- ≤70%	210	18	(9.0)	1.00		
- >70%	6	0	(0.0)	-	-	1.000

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Duration of mouse use during desktop						
- ≤70%	167	16	(9.6)	1.00		
- >70%	40	2	(5.0)	0.50	0.11-2.25	0.535
Duration of keyboard use during laptop						
- ≤50%	176	16	(9.1)	1.00		
- >50%	31	2	(6.5)	0.69	0.15-3.16	1.000
Duration of mouse use during laptop						
- ≤50%	173	17	(9.8)	1.00		
- >50%	34	1	(2.9)	0.28	0.04-2.16	0.318
Duration of touchpad use during laptop						
- ≤50%	190	18	(9.5)	1.00		
- >50%	17	0	(0.0)	-	-	0.999
Touch typing						
- Yes	42	5	(11.9)	1.00		
- No	165	13	(7.9)	0.63	0.21-1.89	0.373
Posture						
- Posture 1	51	4	(7.8)	1.00		
- Posture 2	14	1	(7.1)	0.90	0.09-8.80	0.931
- Posture 3	68	4	(5.9)	0.73	0.18-3.01	0.674
- Posture 4	63	9	(14.3)	1.96	0.57-6.78	0.288
- Posture 5	9	0	(0.0)	0.00	-	0.999
- Posture 6	2	0	(0.0)	0.00	-	0.999
Psychosocial factors						
Mental health status						
- Normal	117	11	(9.4)	1.00		
- Better than normal	69	7	(10.1)	1.09	0.40-2.95	0.868
- Worse than normal	21	0	(0.0)	0.00	-	0.998
Clinical factors						
Rt.Quadriceps muscle length						
- <115 degrees	112	8	(7.1)	1.00		
- ≥115 degrees	95	10	(10.5)	1.53	0.58-4.05	0.462

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Lt. Quadriceps muscle length						
- <115 degrees	108	7	(6.5)	1.00		
- ≥115 degrees	99	11	(11.1)	1.80	0.67-4.85	0.324
Rt.Hamstrings muscle length						
- >151 degrees	93	9	(9.7)	1.00		
- ≤151 degrees	114	9	(7.9)	0.80	0.30-2.11	0.805
Lt. Hamstrings muscle length						
- >152 degrees	101	7	(6.9)	1.00		
- ≤152 degrees	106	11	(10.4)	1.56	0.58-4.18	0.463
Trunk flexion flexibility						
- >5.9 cm.	108	9	(8.3)	1.00		
- ≤5.9 cm.	99	9	(9.1)	1.10	0.42-2.89	1.000
Trunk extension flexibility						
- >2.8 cm.	103	9	(8.7)	1.00		
- ≤2.8 cm.	104	9	(8.7)	0.99	0.38-2.60	1.000
Trunk Rt. Lateral flexion						
- >20 cm.	104	8	(7.7)	1.00		
- ≤20 cm.	103	10	(9.7)	1.29	0.49-3.41	0.631
Trunk Lt. Lateral flexion						
- >20 cm.	103	8	(7.8)	1.00		
- ≤20 cm.	104	10	(9.6)	1.26	0.48-3.34	0.806
Trunk flexor muscle endurance						
- >38 sec	88	4	(4.5)	1.00		
- ≤38 sec	119	14	(11.8)	2.80	0.89-8.82	0.083*
Trunk extensor endurance						
- >73 sec	97	8	(8.2)	1.00		
- ≤73 sec	110	10	(9.1)	1.11	0.42-2.94	1.000
Rt. Hip flexion form SLR						
- >72 degrees	98	7	(7.1)	1.00		
- ≤72 degrees	109	11	(10.1)	1.46	0.54-3.93	0.473
Lt. Hip flexion from SLR						
- >73 degrees	103	5	(4.9)	1.00		
- ≤73 degrees	104	13	(12.5)	2.80	0.96-8.16	0.082*

* Statistical significance at $p \leq 0.2$

Table H.11 Incidence of developing low back symptoms in undergraduate student using notebook computer and crude odd ratio (OR) with 95% confidence intervals (95% CI) (n=317)

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Individual factors						
Gender						
- Male	79	23	(29.1)	1.00		
- Female	238	77	(32.4)	1.16	0.67-2.03	0.676
Age						
- 18-20	282	88	(31.2)	1.00		
- 21-25	35	12	(34.3)	1.15	0.55-2.42	0.703
BMI						
- 18.5-24.9	214	70	(32.7)	1.00		
- <18.5	75	24	(32.0)	0.97	0.55-1.70	0.910
- ≥25	28	6	(21.4)	0.56	0.22-1.45	0.232
Year of study						
- 1styear	87	28	(32.2)	1.00		
- 2ndyear	167	50	(29.9)	0.90	0.52-1.57	0.713
- 3rdyear	62	21	(33.9)	1.08	0.54-2.16	0.829
- 4thyear	0	0	(0.0)	0.00	-	-
- 5thyear	1	1	(100.0)	-	-	1.000
Field of study						
- Art/Humanities	107	36	(33.6)	1.00		
- Science/Health science	210	64	(30.5)	0.87	0.53-1.42	0.610
Frequency of weekly exercise sessions						
- Regularly	60	20	(33.3)	1.00		
- Occasionally	223	66	(29.6)	0.84	0.46-1.55	0.577
- Never exercise	34	14	(41.2)	0.40	0.59-3.34	0.448
Computer use related factors						
Year of computer use						
- <4	74	23	(31.1)	1.00		
- 4-7	99	25	(25.3)	0.75	0.38-1.46	0.398
- 8-10	116	42	(36.2)	1.26	0.68-2.34	0.468
- >10	28	10	(35.7)	1.23	0.49-3.08	0.656

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Hours of daily computer use						
- ≤3	199	60	(30.2)	1.00		
- >3	118	40	(33.9)	1.19	0.73-1.93	0.532
Percentage time of computer use for study						
- ≤70	296	90	(30.4)	1.00		
- >70	21	10	(47.6)	2.08	0.85-5.07	0.142*
Percentage time of computer use for entertainment						
- ≤70	255	78	(30.6)	1.00		
- >70	62	22	(35.5)	1.24	0.70-2.24	0.451
Feet are flat on the floor						
- Yes	115	31	(27.0)	1.00		
- No	202	69	(34.2)	1.41	0.85-2.33	0.210
Hip are positioned at 90 degree angle						
- Yes	106	35	(33.0)	1.00		
- No	211	65	(30.8)	0.90	0.54-1.49	0.702
Knee are positioned at 90 degree angle						
- Yes	73	21	(28.8)	1.00		
- No	244	79	(32.4)	1.19	0.67-2.10	0.667
Ankles are positioned at 90 degree angle						
- Yes	83	24	(28.9)	1.00		
- No	234	76	(32.5)	1.18	0.68-2.05	0.585
Elbows are positioned at 90 degree angle						
- Yes	68	18	(26.5)	1.00		
- No	249	82	(32.9)	1.36	0.75-2.49	0.377
Neck is supported						
- Yes	8	1	(12.5)	1.00		
- No	309	99	(32.0)	3.30	0.40-27.19	0.443

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Upper back is supported						
- Yes	144	50	(34.7)	1.00		
- No	173	50	(28.9)	0.76	0.48-1.23	0.277
Low back is supported						
- Yes	144	40	(27.8)	1.00		
- No	173	60	(34.7)	1.38	0.85-2.23	0.225
Elbows are supported						
- Yes	64	25	(39.1)	1.00		
- No	253	75	(29.6)	0.66	0.37-1.16	0.175*
Forearms are supported						
- Yes	103	31	(30.1)	1.00		
- No	214	69	(32.2)	1.11	0.66-1.84	0.796
Wrists are supported						
- Yes	200	56	(28.0)	1.00		
- No	117	44	(37.6)	1.55	0.95-2.52	0.081*
Computer screen is positioned at a level horizontal with the eyes						
- Yes	121	38	(31.4)	1.00		
- No	196	62	(31.6)	1.01	0.62-1.65	1.000
Keyboard height						
- Suitable	208	67	(32.2)	1.00		
- Too high	64	20	(31.3)	0.96	0.52-1.75	0.885
- Too low	45	13	(28.9)	0.86	0.42-1.73	0.664
Mouse height						
- Suitable	228	71	(31.1)	1.00		
- Too high	55	20	(36.4)	1.26	0.68-2.34	0.457
- Too low	34	9	(26.5)	0.80	0.35-1.79	0.582
Duration of keyboard use during desktop						
- ≤70%	311	99	(31.8)	1.00		
- >70%	6	1	(16.7)	0.43	0.05-3.72	0.669
Duration of mouse use during desktop						
- ≤70%	260	82	(31.5)	1.00		
- >70%	57	18	(31.6)	1.00	0.54-1.86	1.000

Factors	N	Incidence	n (%)	OR	95%CI	***P***
Duration of keyboard use during laptop						
- ≤50%	260	82	(31.5)	1.00		
- >50%	57	18	(31.6)	1.00	0.54-1.86	1.000
Duration of mouse use during laptop						
- ≤50%	241	74	(30.7)	1.00		
- >50%	76	26	(34.2)	1.17	0.68-2.03	0.574
Duration of touchpad use during laptop						
- ≤50%	267	82	(30.7)	1.00		
- >50%	50	18	(36.0)	1.27	0.67-2.39	0.508
Touch typing						
- Yes	61	23	(37.7)	1.00		
- No	256	77	(30.1)	0.71	0.40-1.27	0.284
Posture						
- Posture 1	45	9	(20.0)	1.00		
- Posture 2	35	7	(20.0)	1.00	0.33-3.02	1.000
- Posture 3	92	35	(38.0)	2.46	1.06-5.71	0.037*
- Posture 4	115	36	(31.0)	1.82	0.80-4.18	0.156*
- Posture 5	25	8	(32.0)	1.92	1.26-10.79	0.187*
- Posture 6	5	1	(20.0)	1.00	0.10-10.07	1.000
Psychosocial factors						
Mental health status						
- Normal	157	56	(35.7)	1.00		
- Better than normal	133	38	(28.6)	0.72	0.44-1.19	0.199*
- Worse than normal	27	6	(22.2)	0.52	0.20-1.35	0.178*
Clinical factors						
Rt.Quadriceps muscle length						
- <115 degrees	181	55	(30.4)	1.00		
- ≥115 degrees	136	45	(33.1)	1.13	0.70-1.83	0.672
Lt. Quadriceps muscle length						
- <115 degrees	193	56	(29.0)	1.00		
- ≥115 degrees	124	44	(35.5)	1.35	0.83-2.18	0.265

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Rt.Hamstrings muscle length						
- >151 degrees	159	45	(28.3)	1.00		
- ≤151 degrees	158	55	(34.8)	1.35	0.84-2.18	0.228
Lt. Hamstrings muscle length						
- >152 degrees	142	51	(35.9)	1.00		
- ≤152 degrees	175	49	(28.0)	0.69	0.43-1.12	0.146*
Trunk flexion flexibility						
- >5.9 cm.	166	53	(31.9)	1.00		
- ≤5.9 cm.	151	47	(31.1)	0.96	0.60-1.55	0.904
Trunk extension flexibility						
- >2.8 cm.	163	54	(33.1)	1.00		
- ≤2.8 cm.	154	46	(29.9)	0.86	0.54-1.38	0.548
Trunk Rt. Lateral flexion						
- >20 cm.	154	45	(29.2)	1.00		
- ≤20 cm.	163	55	(33.7)	1.23	0.77-1.98	0.400
Trunk Lt. Lateral flexion						
- >20 cm.	145	42	(29.0)	1.00		
- ≤20 cm.	172	58	(33.7)	1.25	0.77-2.01	0.397
Trunk flexor muscle endurance						
- >38 sec	124	40	(32.3)	1.00		
- ≤38 sec	193	60	(31.1)	0.95	0.58-1.54	0.902
Trunk extensor endurance						
- >73 sec	132	50	(37.9)	1.00		
- ≤73 sec	185	42	(31.8)	0.67	0.38-0.98	0.458*
Rt. Hip flexion form SLR						
- >72 degrees	156	53	(34.0)	1.00		
- ≤72 degrees	161	47	(29.2)	0.80	0.50-1.29	0.398
Lt. Hip flexion from SLR						
- >73 degrees	171	60	(35.1)	1.00		
- ≤73 degrees	146	40	(27.4)	0.70	0.43-1.13	0.148*

* Statistical significance at $p \leq 0.2$

Table H.12 Incidence of persistent low back symptoms in undergraduate student using notebook computer and crude odd ratio (OR) with 95% confidence intervals (95% CI) (n=317)

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Individual factors						
Gender						
- Male	79	10	(12.7)	1.00		
- Female	238	21	(8.8)	0.67	0.30-1.49	0.381
Age						
- 18-20	282	26	(9.2)	1.00		
- 21-25	35	5	(14.3)	1.64	0.59-4.59	0.362
BMI						
- 18.5-24.9	214	21	(9.8)	1.00		
- <18.5	75	9	(12.0)	1.25	0.54-2.87	0.594
- ≥25	28	1	(3.6)	0.34	0.04-2.63	0.302
Year of study						
- 1^{st}year	87	9	(10.3)	1.00		
- 2^{nd}year	167	17	(10.2)	0.98	0.42-2.31	0.967
- 3^{rd}year	62	5	(8.1)	0.76	0.24-2.39	0.639
- 4^{th}year	0	0	(0.0)	0.00	-	-
- 5^{th}year	1	0	(0.0)	0.00	-	1.000
Field of study						
- Art/Humanities	107	12	(11.2)	1.00		
- Science/Health science	210	19	(9.0)	0.79	0.37-1.69	0.553
Frequency of weekly exercise sessions						
- Regularly	60	6	(10.0)	1.00		
- Occasionally	223	21	(9.4)	0.94	0.36-2.43	0.891
- Never exercise	34	4	(11.8)	1.20	0.31-4.59	0.790
Computer use related factors						
Year of computer use						
- <4	74	9	(12.2)	1.00		
- 4-7	99	6	(6.1)	0.47	0.16-1.37	0.166*
- 8-10	116	14	(12.1)	0.99	0.41-2.42	0.985
- >10	28	2	(7.1)	0.57	0.11-2.74	0.471

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Hours of daily computer use						
- ≤3	199	20	(10.1)	1.00		
- >3	118	11	(9.3)	0.92	0.42-1.99	1.000
Percentage time of computer use for study						
- ≤70	296	27	(9.1)	1.00		
- >70	21	4	(19.0)	2.34	0.74-7.47	0.136*
Percentage time of computer use for entertainment						
- ≤70	255	26	(10.2)	1.00		
- >70	62	5	(8.1)	0.77	0.28-2.10	0.812
Feet are flat on the floor						
- Yes	115	10	(8.7)	1.00		
- No	202	21	(10.4)	1.22	0.55-2.69	0.697
Hip are positioned at 90 degree angle						
- Yes	106	10	(9.4)	1.00		
- No	211	21	(10.0)	1.06	0.48-2.34	1.000
Knee are positioned at 90 degree angle						
- Yes	73	6	(8.2)	1.00		
- No	244	25	(10.2)	1.28	0.50-3.24	0.822
Ankles are positioned at 90 degree angle						
- Yes	83	11	(13.3)	1.00		
- No	234	20	(8.5)	0.61	0.28-1.34	0.281
Elbows are positioned at 90 degree angle						
- Yes	68	4	(5.9)	1.00		
- No	249	27	(10.8)	1.95	0.66-5.77	0.259
Neck is supported						
- Yes	8	0	(0.0)	1.00		
- No	309	31	(10.0)	-	-	1.000

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Upper back is supported						
- Yes	144	14	(9.7)	1.00		
- No	173	17	(9.8)	1.01	0.48-2.13	1.000
Low back is supported						
- Yes	144	11	(7.6)	1.00		
- No	173	20	(11.6)	1.58	0.73-3.42	0.261
Elbows are supported						
- Yes	64	8	(12.5)	1.00		
- No	253	23	(9.1)	0.70	0.30-1.65	0.479
Forearms are supported						
- Yes	103	9	(8.7)	1.00		
- No	214	22	(10.3)	1.20	0.53-2.70	0.840
Wrists are supported						
- Yes	200	14	(7.0)	1.00		
- No	117	16	(13.7)	1.76	1.07-4.77	0.433
Computer screen is positioned at a level horizontal with the eyes						
- Yes	121	14	(11.6)	1.00		
- No	196	17	(8.7)	0.73	0.34-1.53	0.439
Keyboard height						
- Suitable	208	19	(9.1)	1.00		
- Too high	64	7	(10.9)	1.22	0.49-3.05	0.668
- Too low	45	5	(11.1)	1.24	0.44-3.53	0.682
Mouse height						
- Suitable	228	20	(8.8)	1.00		
- Too high	55	7	(12.7)	1.52	0.61-3.79	0.373
- Too low	34	4	(11.8)	1.39	0.44-4.34	0.574
Duration of keyboard use during desktop						
- ≤70%	311	31	(10.0)	1.00		
- >70%	6	0	(0.0)	-	-	1.000
Duration of mouse use during desktop						
- ≤70%	260	27	(10.4)	1.00		
- >70%	57	4	(7.0)	0.65	0.22-1.94	0.623

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Duration of keyboard use during laptop						
- ≤50%	260	24	(9.2)	1.00		
- >50%	57	7	(12.3)	1.38	0.56-3.37	0.465
Duration of mouse use during laptop						
- ≤50%	241	22	(9.1)	1.00		
- >50%	76	9	(11.8)	1.34	0.59-3.04	0.508
Duration of touchpad use during laptop						
- ≤50%	267	28	(10.5)	1.00		
- >50%	50	3	(6.0)	0.55	0.16-1.87	0.441
Touch typing						
- Yes	61	23	(9.8)	1.00		
- No	256	77	(9.8)	0.99	0.39-2.54	1.000
Posture						
- Posture 1	45	2	(4.4)	1.00		
- Posture 2	35	1	(2.9)	0.63	0.06-7.27	0.713
- Posture 3	92	13	(14.1)	3.54	0.76-16.41	0.107*
- Posture 4	115	8	(7.0)	1.61	0.33-7.88	0.558
- Posture 5	25	4	(16.0)	5.19	1.25-36.76	0.226
- Posture 6	5	1	(20.0)	5.38	0.39-73.09	0.207
Psychosocial factors						
Mental health status						
- Normal	157	17	(10.8)	1.00		
- Better than normal	133	10	(7.5)	0.67	0.30-1.52	0.336
- Worse than normal	27	4	(14.8)	1.43	0.44-4.64	0.549
Clinical factors						
Rt.Quadriceps muscle length						
- <115 degrees	181	13	(7.2)	1.00		
- ≥115 degrees	136	18	(13.2)	1.97	0.93-4.18	0.086*
Lt. Quadriceps muscle length						
- <115 degrees	193	15	(7.8)	1.00		
- ≥115 degrees	124	16	(12.9)	1.76	0.84-3.70	0.174*

Factors	N	Incidence	n (%)	OR	95%CI	*P*
Rt.Hamstrings muscle length						
- >151 degrees	159	15	(9.4)	1.00		
- ≤151 degrees	158	16	(10.1)	1.08	0.52-2.27	0.852
Lt. Hamstrings muscle length						
- >152 degrees	142	16	(11.3)	1.00		
- ≤152 degrees	175	15	(8.6)	0.74	0.35-1.55	0.451
Trunk flexion flexibility						
- >5.9 cm.	166	18	(10.8)	1.00		
- ≤5.9 cm.	151	13	(8.6)	0.78	0.37-1.64	0.572
Trunk extension flexibility						
- >2.8 cm.	163	18	(11.0)	1.00		
- ≤2.8 cm.	154	13	(8.4)	0.74	0.35-1.57	0.456
Trunk Rt. Lateral flexion						
- >20 cm.	154	11	(7.1)	1.00		
- ≤20 cm.	163	20	(12.3)	1.82	0.84-3.93	0.135*
Trunk Lt. Lateral flexion						
- >20 cm.	145	14	(9.7)	1.00		
- ≤20 cm.	172	17	(9.9)	1.03	0.49-2.16	1.000
Trunk flexor muscle endurance						
- >38 sec	124	13	(10.5)	1.00		
- ≤38 sec	193	18	(9.3)	0.88	0.41-1.86	0.847
Trunk extensor endurance						
- >73 sec	132	15	(11.4)	1.00		
- ≤73 sec	185	16	(8.6)	0.74	0.35-1.55	0.447
Rt. Hip flexion form SLR						
- >72 degrees	156	15	(9.6)	1.00		
- ≤72 degrees	161	16	(9.9)	1.04	0.49-2.18	1.000
Lt. Hip flexion from SLR						
- >73 degrees	171	20	(11.7)	1.00		
- ≤73 degrees	146	11	(7.5)	0.62	0.28-1.33	0.257

* Statistical significance at $p \leq 0.2$

APPENDIX I

LETTER OF ACCEPTANCE FOR PUBLICATION

---------- Forwarded message ----------

From: Prawit Janwantanakul <Prawit.J@chula.ac.th>

Date: Mon, Apr 4, 2011 at 10:05 PM

Subject: Fwd: Re: Status of Manuscript Submitted to WORK

To: Siriluck Chetpiyawong <junesiriluck@gmail.com>

Dear Dr. Janwantanakul,

Congratulations! Your manuscript is now officially accepted to WORK. I anticipate that it will be published in late 2012/ early 2013. We are happy to report that due to an increase in submissions to WORK, we are able to increase the size of each issue. However, we may still have a longer than usual delay in publishing manuscripts. We will do our best to publish manuscripts as soon as possible, but will be unable to make changes to an already scheduled sequence of issues. Thank you for your understanding.

Best,

Victoria

On Fri, Apr 1, 2011 at 11:42 PM, Prawit Janwantanakul <Prawit.J@chula.ac.th> wrote:

Dear Victoria Hall, Editor's Assistant

Thank you very much for giving us an opportunity to revise the manuscript. I am confident that they will make the manuscript sound more scientific and also make it easier to read. I have revised the manuscript according to the reviewers' remarks (see attachment).

Correspondence about the paper should be directed to Prawit Janwantanakul at the following address:

Department of Physical Therapy
Faculty of Allied Health Sciences, Chulalongkorn University
Bangkok 10330
Thailand
Telephone: 66 2 218 3767
Fax: 66 2 218 3766
Email: prawit.j@chula.ac.th

Sincerely yours,

Prawit Janwantanakul, PhD, PT

---- Original message ----
>Date: Tue, 15 Mar 2011 21:05:23 -0400
>From: Victoria Hall <victoria.e.hall@gmail.com>
>Subject: Status of Manuscript Submitted to WORK
>To: prawit.j@chula.ac.th
>Cc: Karen Jacobs <kjacobs@bu.edu>

> Dear Dr. Janwantanakul,
>
> It is with great pleasure that I conditionally
> accept your manuscript entitled, Prevalence of and
> factors associated with musculoskeletal symptoms in
> the spine attributed to computer use in
> undergraduate students for publication in WORK: A
> Journal of Prevention, Assessment, & Rehabilitation.
>
> The reviews were good and the editorial changes that
> are needed are on the two reviewers' feedback
> forms and one edited manuscript. It is very
> important that you address all of this feedback in
> your revised manuscript. Please highlight in blue in
> the manuscript where you have made the changes and
> include them in a separate document to direct the
> reviewer.
>
> Once you have made these editorial changes, please
> e-mail me a copy of your revised manuscript. I would
> like to receive your revision by May 1, 2011.
>
> Thank you for submitting a very interesting
> manuscript.
>
> Karen, the editor of WORK sends you her best.
>
> Sincerely,
> Victoria
> --

> Victoria (Vicki) Hall

> Editor's Assistant

> WORK: A Journal of Prevention Assessment, and

> Rehabilitation

> --

> District 7910 Rotaract Chair, 2009-2011

> www.rotary7910.org

> --

> victoria.e.hall@gmail.com

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BIOGRAPHY

Mrs. Siriluck Kanchanomai was born on June 16th, 1976 in Bangkok, Thailand. She graduated a Bachelor degree of Science (Physiotherapy) from Mahidol University in 1998 and a Master degree of Science (Physiotherapy) from the same University in 2002. She has worked as an instructor in Department of Physiotherapy, Faculty of Allied Health Sciences, Thammasat University since 2002. She has studied for a Docterate degree in Biomedical Sciences Program at Graduated School, Chulalongkorn University since 2006.