One-year Incidence and Risk Factors of Thoracic Spine Pain in Undergraduate Students

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Abstract. [Purpose] This study aimed to examine the 1 year incidence and identify biopsychosocial factors predicting the onset and persistence of thoracic spine pain in undergraduate students. [Subject] A 1 year prospective study was carried out among 684 healthy undergraduate students. [Methods] At baseline, a self-administered questionnaire and standardized physical examination were employed to gather biopsychosocial data. Follow-up data on the incidence of thoracic spine pain were collected every 3 months. Two regression models were built to analyze factors predicting the onset and persistence of thoracic spine pain. [Results] The 1 year incidence of thoracic spine pain was 27%, and 23% of subjects reported persistent symptoms. The onset of thoracic spine pain was predicted by female gender, poor neck extensor muscle endurance and high percentage duration of mouse use during computer work. Female students being in the second year of their studies and unsupported elbows during computer use were predictors of persistent symptoms. [Conclusion] Thoracic spine pain is quite common among undergraduate students and many of them may have persistent symptoms. Interventions aimed at reducing the occurrence of symptoms in undergraduate students should, at the least, include teaching 2nd year female students how to perform computer work safely.

Key words: Musculoskeletal symptoms, Computer, Young adult

INTRODUCTION

About 54%–80% of people experience spinal pain at least once in their adult life, with a point prevalence of 15%, and 1 year prevalences ranging from 4% to 51%1). Spinal pain causes considerable personal suffering due to pain, disability, and impaired quality of work and life in general2–6). The economic consequences of treating disabling spinal pain are significant7, 8). For example, in the Netherlands, the total cost of neck pain in 1996 was estimated at 686 million US dollars9), whereas in the United States, the total cost of low back pain in 2006 was estimated to exceed 100 billion US dollars10).

Unlike neck and low back pain, upper back or thoracic spine pain, which is defined as pain localized in the area of upper back or middle back, between vertebrae T1-T12, across the posterior aspect of the trunk11), has received limited attention12). Thoracic spine pain can be equally disabling, imposing similar burdens on the individual, community, and workforce11–13). Evidence suggests a high prevalence of thoracic spine pain among undergraduate students, ranging from 13–39%14, 15). A study of a Swedish cohort of university students reported the 1 year incidence of neck or thoracic spine pain was 15%16). Adolescents with spinal pain are at high risk of having such symptoms in adulthood17, 18). Thus, to reduce the prevalence of spinal pain in adults, knowledge regarding factors that can predict its onset and persistence in the younger population is important17, 18).

Musculoskeletal pain is assumed to be of multi-factorial origin, indicating that individual, physical and psychosocial factors can contribute to its onset and persistence17–19). Briggs et al.20) systematically reviewed 33 cross-sectional and prospective studies and found that female gender, postural changes associated with backpack use, backpack weight, other musculoskeletal symptoms, participation in specific sports, chair height at school and difficulty with homework were associated with thoracic spine pain in children and adolescents. Also, poor mental health and age transition from early to late adolescence were risk factors of new-onset thoracic spine pain. Little is known about the factors that can predict the onset and persistence of thoracic spine pain in undergraduate students. The aims of the present study were to examine the 1 year incidence and persistence of thoracic spine pain and to explore its biopsychosocial risk factors in undergraduate students.

SUBJECTS AND METHODS

A convenience sample of undergraduate students aged between 18–25 years was invited to participate in this study.
Subjects were excluded if they had reported thoracic spine pain in the previous 3 months, had any physician-diagnosed central/peripheral neurological or musculoskeletal disorders, or a history of upper extremity or spinal surgery. Those who were eligible for the study were invited to undergo a laboratory physical examination. The study was approved by Thammasat University Human Ethics Committee.

A prospective cohort study with 1 year follow-up was conducted to examine the 1 year incidence and persistence of thoracic spine pain and to explore its biopsychosocial risk factors in undergraduate students. At baseline, a self-administered questionnaire was delivered by hand to the undergraduate students and a researcher returned to collect the completed questionnaires after a few days. Subjects were followed every 3 months for 12 months by telephone. The yes/no question “Have you experienced any thoracic spine pain lasting more than 24 hours during the past 3 months?” was asked at each follow-up. If subjects answered “Yes”, follow-up questions about the cause of thoracic spine pain were asked. Subjects who reported an accident preceding the thoracic spine pain episode or physician diagnosis of congenital anomaly of the spine, rheumatoid arthritis, infection of the spine or discs, ankylosing spondylitis, cervical spondylosis, malignant tumor, systemic lupus erythematosus, or osteoporosis were excluded from the study. Those who reported thoracic spine pain for ≥ 2 consecutive follow-ups were categorized as having persistent symptoms.

The self-administered questionnaire comprised three sections designed to gather data on individual, computer use-related, and psychosocial factors as well as thoracic spine pain.

Individual factors included gender (male or female), age (18–20 or 21–25 years), body mass index (< 18.5, ≥ 18.5–< 25, or ≥ 25 kg/m²), year of study (first to fifth year), chronic diseases (yes or no), field of study (art/humanities or science), and weekly frequency of exercise (regular, occasional, or no exercise).

Computer use-related factors included type of computer (desktop or notebook), years of computer use (< 5, 5–7, 8–9, or > 9 years) and average amount of daily computer use (< 3 or ≥ 3 hours/day). Respondents were asked whether their head, upper back, low back, and arms were supported, their feet were flat on the floor, and their elbows, hips, knees, and ankles were positioned at 90° flexion during computer use (yes or no). The questionnaire asked respondents, based on their own perceptions, to indicate the position of the computer screen (whether the top of the screen was positioned at a level horizontal with the eyes when they sat and looked straight ahead) and the appropriateness of the position of the keyboard and mouse during computer use (suitable, too high, or too low). Respondents were also asked about the percentage of time of computer use for study and entertainment as well as percentage duration keyboard and mouse/touchpad use (< 70% or ≥ 70%).

Psychosocial factors were assessed by the Thai Mental Health Indicator Questionnaire (TMHI-15), a reliably validated instrument. The questionnaire consisted of 15 questions assessing general well-being, confidence in coping, kindness and altruism, self-esteem, and supporting factors. Each question is rated on 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 thus ranged from 0 to 45. The mental health score was scaled into three groups (≤ 27 = worse than normal; 28–34 = normal; 35–45 = better than normal).

To assess thoracic spine pain during the previous 3 months, the question “Have you experienced any thoracic spine pain lasting more than 24 hours during the past 3 months?” was included in the questionnaire. The area of the thoracic spine was defined according to the standardized Nordic questionnaire, i.e. the region between vertebrae T1-T12 on the posterior aspect of the trunk.

The physical examination was performed based on the hypothetical effect of prolonged computer use on body parts, which may lead to forward head posture, rounded shoulders and kyphotic upper thoracic spine. These changes are likely to decrease neck mobility, neck muscle endurance, and nerve mobility as well as increase muscle tightness. Each participant underwent a physical examination following standardized protocol and the examiner was blinded to the questionnaire outcomes. The physical examination included the following items and took a 45-minute single session to complete.

Neck range of motion assessment: Active neck flexion, extension, lateral flexion and rotation were assessed using a Myrin goniometer. In the starting position, each subject looked directly forward with the neck in the neutral position. The subject was then asked to move the head towards each direction as far as possible, and the degree of neck motion in each direction was recorded.

Muscle length assessment: Pectoralis major muscle length on both sides was assessed according to the guidelines described by Kendall and McCreary. The subject’s arm was positioned at approximately 135° shoulder abduction and lateral rotation with the elbow fully extended. The arm was dropped to table level with the low back remaining flat on the table. The examiners recorded the position of the arm relative to table level. To be regarded as normal, the extended arm had to drop down to table level.

Muscle endurance assessment: Neck extensor and flexor endurance were assessed according to the procedures described by Lee and Harris et al. For the neck extensor muscles endurance test, the subject lay prone on a plinth with the head and neck over the edge of the plinth. The subject was instructed to hold the head steady in a position with the chin retracted and the cervical spine horizontal, as monitored by a Myrin goniometer placed immediately above the tip of the right ear. The test was terminated if the subject was not able to hold the position because of fatigue or pain, or if the subject showed more than 5° of upper cervical spine retraction for longer than 5 seconds. The examiner recorded the muscle performance in seconds.

For the neck flexor muscles endurance test, the subject lay on a plinth. The subject was instructed to lift the head until it was approximately 2.5 cm above the plinth while keeping the chin retracted to the chest. The test was terminated if the
subject’s head touched the plinth for longer than 1 second. The examiner recorded the muscle performance in seconds.

Nerve tension assessment: Upper limb nerve tension was assessed according to the procedure described by Butler. The subject lay supine on the plinth and the examiner depressed the shoulder girdle, then abducted the shoulder 110°, flexing the elbow 90°, supinating the forearm, extending both wrist and fingers, laterally rotating the shoulder, and extending the elbow. The examiner carefully extended the elbow to the point where the subject began to feel ache, pain, tingling, or discomfort. The range of elbow extension was measured by a standard goniometer aligned with the mid-humeral shaft, medial epicondyle, and ulnar styloid.

Repeatability of answers to the questionnaire and physical examination measurements was assessed using 20 undergraduate students. Each subject was tested on two occasions, separated by an interval of 7 days between answering the questionnaire, and 1 day for the physical examination.

For the reliability study of questionnaire outcomes, the intraclass correlation coefficient (ICC [1,1]) was calculated for continuous data and Spearman’s rho (ρ) for nominal and ordinal data. ICC (3,1) was calculated for the physical examination outcomes.

Subject characteristics are described by means or percentages. Percentage of missing data in the individual, computer use-related, and psychosocial factor categories were 0.1%, 1.3%, and 0.2%, respectively. To retain the statistical power of the database, missing data were handled by 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 for which information was missing. This procedure was conducted for each missing value until the dataset was complete.

Two regression models were built to analyze risk factors for onset and persistence of thoracic spine pain. Initially, univariate analysis was carried out to determine significant differences in the onset and persistence of thoracic spine pain with various biopsychosocial characteristics. Separate multivariate logistic regression models were then performed to assess associations between the onset and persistence of thoracic spine pain and biopsychosocial factors. Backward selection procedures were used in the statistical modeling. Any factors with p values ≤ 0.2 in the univariate analysis were eligible for addition to the modeling procedures. Odds ratios (OR) associated with particular factors were adjusted for the effect of all other factors in the model. Adjusted ORs and 95%CI for the final models are presented. Statistical significance was accepted at the 5% level. All statistical analyses were performed using SPSS statistical software, version 17.0 (SPSS Inc, Chicago, IL, USA).

RESULTS

The reliability results demonstrated moderate (0.60) to excellent (1.00) repeatability for questionnaire outcomes, and moderate (0.71) to excellent (0.86) repeatability for the physical examination outcomes. In total, 524 students were followed for 1 year (Fig. 1). Table 1 presents the demographic characteristics of the study population. There were 239 (27%) students reporting new onset of thoracic spine pain during the follow-up, of whom 33 (23%) reported persistent symptoms.

Multivariate logistic regression analysis revealed that neck extensor endurance, gender, and percentage duration of mouse use were associated with thoracic spine pain (Table 2). Female students had a higher risk of developing thoracic spine pain than their male counterparts (adjusted OR = 1.65, 95%CI = 1.01–2.71).

The average neck extensor muscle endurance of the participating students was 522 seconds. Thus, neck extensor muscle endurance was divided into two categories (1: >522 sec, 2: ≤522 sec). Students who had neck extensor endurance ≤522 sec were at greater risk of developing thoracic spine pain than those having neck extensor endurance >522 sec.

![Flow of participants through the study](image)

Table 1. Characteristics of undergraduate students

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

(n=524)
Table 2. Incidence of thoracic spine pain and adjusted odds ratio (ORadj) with 95% confidence intervals (95%CI) with respect to factors in the final model

<table>
<thead>
<tr>
<th>Factors</th>
<th>N</th>
<th>Incidence n (%)</th>
<th>ORadj</th>
<th>95%CI</th>
</tr>
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<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Male</td>
<td>138</td>
<td>27 (19.6)</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>- Female</td>
<td>386</td>
<td>114 (29.5)</td>
<td>1.65</td>
<td>1.01–2.71*</td>
</tr>
<tr>
<td>Neck extensor endurance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- &gt;522 seconds</td>
<td>392</td>
<td>45 (24.5)</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>- ≤522 seconds</td>
<td>132</td>
<td>96 (34.1)</td>
<td>1.16</td>
<td>1.02–2.48*</td>
</tr>
<tr>
<td>Knee flexed at 90 degrees</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Yes</td>
<td>130</td>
<td>26 (20.0)</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>- No</td>
<td>394</td>
<td>115 (29.2)</td>
<td>1.55</td>
<td>0.94–2.57</td>
</tr>
<tr>
<td>Percentage duration of mouse use</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- ≤70%</td>
<td>427</td>
<td>108 (25.3)</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>- &gt;70</td>
<td>97</td>
<td>33 (34.0)</td>
<td>1.64</td>
<td>1.01–2.68*</td>
</tr>
</tbody>
</table>

(n=524) Significance and OR_adj with 95%CI from multivariate analysis. *p<0.05.

(adjusted OR = 1.16, 95%CI = 1.02–2.48).

Percentage duration of mouse use was divided into two categories (1: ≤70%, 2: >70%). Students who reportedly used a mouse during computer work for more than 70% of the time were at higher risk of developing thoracic spine pain than those who used a mouse during computer work for 70% or less of the time (adjusted OR = 1.64, 95%CI = 1.01–2.68).

Multivariate logistic regression analysis revealed that gender, year of study, and elbows not being supported were associated with persistent thoracic spine pain (Table 3). Female students were at greater risk of experiencing persistent thoracic spine pain than male students (adjusted OR = 3.39, 95%CI = 1.15–9.96).

Second year students were at significantly higher risk of experiencing persistent thoracic spine pain than first year students (adjusted OR = 3.14, 95%CI = 1.32–7.51).

Students reporting that their elbows were not supported during computer use were at higher risk of experiencing persistent thoracic spine pain than those reporting their elbows were supported during computer use (adjusted OR = 3.73, 95%CI = 1.11–12.59).

DISCUSSION

The first aim of the present study was to determine the annual incidence and persistence of thoracic spine pain among undergraduate students. The findings demonstrate that thoracic spine pain was quite common in our study population. Chang et al. reported the incidence of thoracic spine pain in 27 undergraduate students in one semester to be as high as 40%. Earlier studies show that persistent musculoskeletal symptoms are common among young populations. In this study, about one fourth of students who reported new onset of thoracic spine pain experienced persistent symptoms. Grimby-Ekman et al. followed 1204 Swedish undergraduate students and found that 52% had ongoing neck or thoracic spine pain. Conceivably, these findings highlight the need to give further attention to developing specific measures to prevent thoracic spine pain and to reduce the impact of thoracic spine pain later in the lives of young subjects as they are important to the future workforce and economy.

A second aim of the study was to identify factors that can predict the onset and persistence of thoracic spine pain in undergraduate students. The results indicate that a set of individual (gender, year of study, and neck extensor muscle endurance) and computer-related (percentage duration of mouse use during computer works and elbow support during computer use) factors are risk factors of the onset and persistence of thoracic spine pain in undergraduate students. Interestingly, in this study no psychosocial factors could differentiate students at high risk of developing or having persistent thoracic spine pain from those at low risk, a result which is similar to those of our previous studies on neck and low back pain in undergraduate students. A systematic review by Brigg et al. on the association between psychosocial status and the prevalence/incidence of thoracic spine pain in children, adolescents and adults indicated that poor mental health was a significant predictor of thoracic spine pain in the current study, the Thai Mental Health Indicator Questionnaire was employed to assess various components of mental health, including general well-being, confidence in coping, kindness and altruism, self-esteem and supporting factors. However, these psychosocial aspects may not be risk factors of the onset and persistence of thoracic spine pain in our study population. Further study is required before any final conclusion regarding the predictive effect of psychosocial factors on the onset and persistence of musculoskeletal symptoms.
symptoms in undergraduate students can be reached.

Female students were at higher risk of developing thoracic spine pain than male students. Several previous studies have indicated that gender is a risk factor of the development of musculoskeletal pain\(^1\). Hanvold et al.\(^{37}\) found a higher number of female technical school students reporting neck, shoulder, and thoracic spine pain than their male counterparts.

Students with poor neck extensor endurance were at risk of developing thoracic spine pain. Since computer use and document work require a sitting posture, the association between poor neck extensor endurance and thoracic spine pain may relate to a prolonged sitting posture. Falla et al.\(^{38}\) found that subjects with neck pain demonstrated a forward drift of the head of a magnitude 4.4 ± 4.1 degrees in association with an increase in thoracic curvature of 8.2 ± 4.8 degrees in a 10-minute computer task. Although forward head and thoracic kyphosis may improve visual contact with objects manipulated in front of the body, this position, if held for an extended period, leads to continuous low-intensity contraction of the neck and thoracic spine muscles and, subsequently, induces Ca\(^{2+}\) accumulation and homeostatic disturbances in the active muscles due to poor blood circulation and an impaired metabolic waste removal mechanism\(^{39}\). These pathological changes in the active muscles lead to micro-lesions, oversuse injury, and pain due to the absence of oxygenation and nutrition\(^{23}\). Thus, good neck extensor and trunk extensor endurance may increase the ability to maintain an upright posture during computer use and document work.

Onset of thoracic spine pain was also predicted by a high percentage of mouse use during computer work. Several studies of computer users have indicated that high intensity mouse use is associated with hand/wrist and shoulder symptoms\(^{40–42}\). Mouse use has been found to lead to more constrained and non-neutral postures of the wrist and shoulder compared to keyboard use\(^{43}\). Thus, a plausible explanation for the association between the high percentage of mouse use and thoracic spine pain relates to less variation in working posture during mouse use, which would potentially lead to static loading of back muscles\(^{44}\).

Female gender, which is a risk factor of the onset of thoracic spine pain, is also a predictor of the persistence of thoracic spine pain in undergraduate students. The similarity of risk factors causing the onset of symptoms and their persistence has been reported in other studies\(^{45–46}\). Stähl et al.\(^{45}\) found that frequent musculoskeletal pain or physical and psychological symptoms, such as headache, depressive mood, and sleep difficulties, were risk factors of the occurrence and persistence of weekly neck pain during a 4-year follow-up. Our results suggest that female gender plays a dominant role in relation to thoracic spine pain in undergraduate students.

The risk of persistent thoracic spine pain was higher for second-year students than for first-year students, which is consistent with our previous study on neck pain\(^{47}\). Clinically, symptoms in the neck may refer to the thoracic spine or vice versa, indicating an intricate link between the two regions. Ndetan et al.\(^{48}\) found that chiropractic students are predominantly exposed to injury risk factors during their first, third, and sixth academic trimesters. However, this finding may not necessarily reflect other student groups.

To our knowledge, our study is the first to demonstrate that year of undergraduate study significantly correlates with thoracic spine pain. Identification of persons at risk would allow resource allocation to those most in need and most likely to benefit from it. This information is of importance because, without this information, a large number of people would receive intervention which would likely compromise its effectiveness\(^{47}\).

Elbows not being supported during computer use was also a risk factor of persistent thoracic spine pain in undergraduate students. Previous studies have shown that the presence of chair armrests is associated with a decreased risk of neck and shoulder symptoms\(^{48}\). Results of EMG measurements both in laboratory and field studies, show that forearm support on a table top reduces static muscle load in the trapezius and erector spinae at the L3 level\(^{49}\). In addition, Nag et al.\(^{50}\) proposed that forearm and wrist supports were useful for professional computer users as they maintain the elbow flexion of almost 90 degrees, a position which substantially reduces the EMG activity of the upper trapezius muscles.

The major strength of this study was its prospective design and the evaluation of a broad range of biopsychosocial factors for their contribution to thoracic spine pain. However, the study had two weak points. First, the nature of several biopsychosocial factors and the diagnosis of thoracic spine pain were subjective, which may have led to inaccuracy. Further studies should consider the inclusion of objective information to increase the accuracy of the data. Second, the use of a convenience sample of undergraduate students, who were recruited from only one university, restricts the external validity of this study. Thus, generalization of the results to other undergraduate student populations may be limited.

In conclusion, the annual incidence of thoracic spine pain in the present sample of undergraduate students was 27%, of whom 23% experienced persistent upper back pain. Female gender was a significant predictor of the onset and persistence of thoracic spine pain. Poor neck extensor endurance and high percentage duration of mouse use were associated with the onset of thoracic spine pain, while second year study and unsupported elbows during computer use were risk factors of persistent thoracic spine pain. The health of undergraduate students deserves consideration because they are important to the future workforce and economy. One possible preventive measure is to educate those at risk (e.g. 2nd year, female students) on how to perform computer work safely to avoid thoracic spine pain.

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REFERENCES


7) Mankinis S, Gray A: The economic burden of back pain in the UK. Pain, 2000, 84: 95–103. [Medline] [CrossRef]


33) Grimby-Ekman A, Andersson EM, Hagberg M: Analyzing musculoskeletal neck pain, measured as present pain and periods of pain, with three different regression models: a cohort study. BMC Musculoskeletal Disord, 2009, 10: 73. [Medline] [CrossRef]
