**นิพนธ์ต้นฉบับ**

# ปัจจัยที่มีผลต่อความไม่สบายกายจากการทำงานด้วยคอมพิวเตอร์ที่บ้าน

**วรธีร์ เดชารักษ์, พ.บ[1], กฤตภาส กิจกูล, พ.บ.[1], ธนวินท์ วงศ์แสงจันทร์, พ.บ.[1], สุพักตรา เจษฎาภัทรกุล, พ.บ.[2]**

[1]ภาควิชากายวิภาคศาสตร์ คณะแพทยศาสตร์ศิริราชพยาบาล มหาวิทยาลัยมหิดล,
[2]หน่วยเวชศาสตร์ฟื้นฟู ฝ่ายการแพทย์ ศูนย์การแพทย์กาญจนาภิเษก คณะแพทยศาสตร์ศิริราชพยาบาล มหาวิทยาลัยมหิดล

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## บทคัดย่อ

**ที่มาของปัญหา:** การใช้คอมพิวเตอร์ทำให้ปวดหรือไม่สบายกายได้ ในประเทศไทยเคยมีการศึกษาปัจจัยที่มีผลต่อความไม่สบายกายในที่ทำงาน แต่ยังไม่มีการศึกษาในสภาพแวดล้อมที่บ้าน

**วัตถุประสงค์:** ศึกษาปัจจัยที่มีผลต่อความปวดหรือไม่สบายกาย ในผู้ใช้คอมพิวเตอร์ที่บ้าน

**วิธีการศึกษา:** การศึกษาภาคตัดขวาง ในผู้ใช้คอมพิวเตอร์ที่บ้านอายุ 18-60 ปี ใช้แบบสอบถามออนไลน์เก็บข้อมูลพื้นฐาน ความปวดหรือไม่สบายกายโดย Cornell Musculoskeletal Discomfort Questionnaires และ ท่าทางการนั่งโดย Rapid Office Strain Assessment (ROSA) ฉบับออนไลน์ปรับปรุงภาษาไทย หาความสัมพันธ์ระหว่างปัจจัยโดย multiple logistic regression

**ผลการศึกษา:** จากกลุ่มตัวอย่างพบความไม่สบายกาย ร้อยละ 97.9 ส่วนใหญ่เป็นแบบเรื้อรัง (ร้อยละ 48.5) และรุนแรง (ร้อยละ 53) โดยพบบ่อยสุดบริเวณคอ (ร้อยละ 87.7) พบคะแนนรวม ROSA ตั้งแต่ 5 ขึ้นไปร้อยละ 63.2 โดยสูงสุดในส่วนเก้าอี้ (ค่ามัธยฐาน 4) ปัจจัยที่มีผลต่อความไม่สบายกายรุนแรง คือ ดัชนีมวลกาย ความเครียดระดับสูง และคะแนนรวมของ ROSA ตั้งแต่ 5 ขึ้นไป

**สรุป:** ความไม่สบายกายที่เรื้อรังและรุนแรงพบได้บ่อย โดยพบบ่อยสุดบริเวณคอ ความไม่สบายกายรุนแรงสัมพันธ์กับดัชนีมวลกาย ความเครียดระดับสูง และคะแนนรวม ROSA ตั้งแต่ 5 ขึ้นไป ซึ่งเป็นปัจจัยที่ปรับเปลี่ยนได้ที่ควรส่งเสริมการแก้ไข

**คำสำคัญ:** ความเจ็บปวด, คอมพิวเตอร์, ท่านั่ง, บ้าน

ORIGINAL ARTICLE

# Factors Associated with Physical Discomfort in Computer Users at Home

**Woratee Dacharux, M.D.[1], Krittapas Kijkool, M.D. [1], Dhanawin Wongsaengchan, M.D. [1], Supaktra Jetsadapattarakul, M.D.[2]**

[1]Department of Anatomy, Faculty of Medicine Siriraj Hospital, Mahidol University

[2]Department of Rehabilitation Medicine, Faculty of Medicine Golden Jubilee Medical Center, Mahidol University

## ABSTRACT

**BACKGROUND:** Computer usage can lead to physical discomfort. In Thailand, there are many studies about the risk of discomfort in workplaces but there is none in the user's home setting.

**OBJECTIVES:** To investigate factors associated with physical discomfort in computer users in the home environment

**METHODS:** Cross-sectional study. A web-based survey of computer users aged 18-60 years who worked from home in a sitting position. The baseline characteristics, physical discomfort by online modified Thai Cornell Musculoskeletal Discomfort Questionnaires (CMDQ), and self-assessed posture by online modified Thai Rapid Office Strain Assessment (ROSA) were recorded. Factors affecting discomfort were analyzed by multiple logistic regression.

**RESULTS:** Almost all had discomfort (97.9%). Most had chronic discomfort (48.5%). Discomfort was commonly found at the neck (87.7%). There were 53% of participants in the severe group. The final ROSA score of five and greater was found at 63.2%. The highest ROSA score was in the chair section (4, median). BMI, high-stress level, and the final ROSA score of five and greater were associated with severe discomfort.

**CONCLUSIONS:** Severe chronic discomfort was commonly found. The most common area was the neck. Severe physical discomfort was associated with BMI, high-stress level, and the final ROSA score of five and greater. Correcting those modifiable factors should be encouraged.

**KEYWORDS:** pain, computers, sitting position, home environment

## INTRODUCTION

Humans increasingly use electronic devices for both their work and personal usage[1]. Usually, the users are moving repeatedly in a relatively static position, especially the sitting position. This kind of condition leads to musculoskeletal disorders (MSD). Pain in the neck, shoulders, and back are commonly found ranging from 17.7-83.3% among company workers[2]. Force and duration of work, duration of break, and working posture are also known as risk factors[3]. Rapid Office Strain Assessment (ROSA) is commonly used and more specific to assess computer working posture[1,4]. The final ROSA score indicates the level of the risk to develop MSD. Although ROSA is the assessment tool designed to be used with an assessor, some studies used ROSA as an online questionnaire[1]. ROSA is already translated into Thai with good validity and reliability[4].

Physical discomfort and pain are commonly found in MSD. Discomfort can be pain, tightness, or any feeling of uncomfortable. Cornell Musculoskeletal Discomfort Questionnaires (CMDQ) are commonly used to assess these conditions[1]. CMDQ assesses severity, frequency, and the interference to work of the discomfort regarding each specific body area. Shariat A, et al. reported a low to moderate association between the pain in the neck, shoulder, and lower back and the score of the online version of ROSA[1]. In Thailand. there is one particular study that showed exercise and computer usage behavior predict the pain in the neck, shoulder, and back in personnel at a private company[5].

With technological advancement, people are more able to work from their homes. A study in India found 70.5% of the computer users at home had physical discomfort[6]. To our knowledge, there is no study in the user's home setting in Thailand yet. The present study aims to investigate factors associated with the physical discomfort of Thai computer users in their homes and the risk of developing MSD.

## METHODS

This study was a cross-sectional study. It was approved by the Siriraj Institutional Review Board (SIRB), Faculty of Medicine Siriraj Hospital, Mahidol University 620/2564 (IRB3), certification number 828/2021

**Participants**

Participants aged 18-60 years old who used computers or other electronic devices in a sitting position at home for more than 50 percent of the total time using computers or other electronic devices. They had to use the devices more than 2 hours/day, at least 3 days/week for at least 2 months.

The participants were excluded if they had a history of a musculoskeletal or neurological condition or surgery that resulted in abnormal sensation or discomfort in a sitting position.

From the study of Janwantanakul P[7], the prevalence of severe low back pain assessed by CMDQ was 0.3. Based on a level of confidence of 95%; 5% tolerated margin of error, 323 participants were required.

**Tools**

We used Google Forms as the platform for a web-based survey. Details were described and a consent form was requested before starting the questionnaire. Only anonymous data were recorded.

Stress levels in the past few weeks were 0-4 Likert scale (0 = none, 4 = very stressful)

CMDQ assessed physical discomfort in different body areas. Each area was asked for the severity of the discomfort by the Discomfort score; slightly, moderately, and very uncomfortable. The frequency of the discomfort was represented by the

Frequency score; never, 1-2 times last week, 3-4 times last week, once every day, and several times every day. The effect of the discomfort on the participant's work was represented by the Interference score; not at all, slightly interfered, and substantially interfered. We modified Thai CMDQ by selected areas of interest only at the neck, left and right shoulders, left and right upper back, and left and right lower back to limit questionnaire length.

For ROSA, posture and duration of usage were translated to the score for each device; chairs, monitors, telephones, mouses, and keyboards. The scores were calculated from the scoring method into the final ROSA score. The final ROSA score ranges from 1 to 10. The more the final ROSA score was, the higher the risk of developing MSD. A cut-off value of five and greater indicated a high-risk level and immediate action was needed. We also modified Thai ROSA. Not using chairs scored two points in each seat height and seat depth section. Not using telephones scored zero in the telephone section. If the participants used other objects differently from the questionnaire, we advised the participants to score themselves based on their working posture.

**Data collection**

Between Nov 29$^{th}$ to Dec 28$^{th}$, 2021 the researchers sent an invitation and the self-assessed questionnaire link through various social media. The requested information was as follows, baseline characteristics, stress levels, details of work, work-from-home duration, the onset of the discomfort, online modified Thai CMDQ, the electronic devices used, and online modified Thai ROSA

There were 366 participants who answered the questionnaire. Of those, one rejected the consent and 31 met the exclusion criteria. In the end, there were 334 participants analyzed.

**Statistical analysis**

Data were analyzed using SPSS version 18.0 program. A *p*-value of 0.05 or less was accepted as statistical significance in comparing the severe and the non-severe groups.

Quantitative baseline data were shown as counts and percentages. Means and standard deviations were used as summary measures for normally distributed data. Medians and interquartile ranges (IQ) were used for non-normally distributed data. Pearson's chi-squared test was performed to analyze the differences in categorical data. Independent t-test and Mann–Whitney test were used to analyze the differences between quantitative data with normal distribution and non-normal distribution, respectively. Multiple logistic regression analysis was used to find associations between possible variables and the main outcome. Mean was used instead of the error data for weight in one participant and height in another participant. There were missing data only in the interference score of the online modified Thai CMDQ in nine participants. We analyzed 325 participants in this section.

We divided the participants into two groups based on the Discomfort score of the online modified Thai CMDQ. For the participants who had more than one discomfort area, the most severe Discomfort score was used. No discomfort, slightly uncomfortable, and moderately uncomfortable groups were combined into non-severe discomfort group. The very uncomfortable group was labeled as severe group.

## RESULTS

Almost all had discomfort (97.9%) and most had it for more than 12 weeks (48.5%). There were 47 % in the non-severe group and 53 % in the severe group. Most were females (70.36%). The average

age was 35 years. The average BMI was 23.01 kg/$m^2$, which was within the normal range for Asians according to World Health Organization. Most participants had less stress (58.7%, Likert 0-2). Working hours excluding mealtimes were eight hours or less in 76.3%. Mostly, the duration was more than one hour for a work session (70.7%) and 15-30 mins (30.8%) for a break. 50.9% of the participants regularly exercised equal to or more than 15 mins. Only 9.9 % of the participants did not usually use chairs when working with electronic devices. Laptop computers were the most used device (66.1%). The final score of the online modified Thai ROSA of five or greater was found in most of the participants (63.2%). (Table 1)

Table 1 Participant variables comparing severe and non-severe discomfort (n=334)

| | **Total n (%)** | **Non-severe n=160 (47)** | **Severe n=174 (53)** | ***p*-value** |
|---|---|---|---|---|
| Age (mean±SD) | 35±7.3 | 35.7 (7.6) | 34.3 (6.9) | 0.07 |
| Sex Female | 235 (70.4) | 111(69.4) | 124 (71.3) | 0.71 |
| BMI (mean±SD) | 23.0±4.7 | 22.6 (4.2) | 23.5 (4.8) | 0.06 |
| Exercise | | | | |
| No exercise or <15 min/time | 164 (49.1) | 78 (48.8) | 86 (49.4) | 0.90 |
| Exercise and ≥15 min/time | 170 (50.9) | 82 (51.2) | 88 (50.6) | |
| Working hours/day | | | | |
| ≤8 hours | 255 (76.3) | 133 (83.1) | 122 (70.1) | 0.005 |
| >8 hours | 79 (23.7) | 27 (16.9) | 52 (29.9) | |
| Working duration/session | | | | |
| ≤1 hour | 98 (29.3) | 56 (35.0) | 42 (24.1) | 0.03 |
| > 1 hour | 236 (70.7) | 104 (65.0) | 132 (75.9) | |
| Break duration | | | | |
| <15 minutes | 87 (26.1) | 38 (23.8) | 49 (28.2) | |
| 15-30 minutes | 103 (30.8) | 50 (31.3) | 53 (30.5) | 0.64 |
| 31-60 minutes | 97 (29.0) | 46 (28.7) | 51 (29.3) | |
| >60 minutes | 47 (14.1) | 26 (16.2) | 21 (12.0) | |
| Stress level (Likert) | | | | |
| 0-2 | 196 (58.7) | 122 (76.2) | 74 (42.5) | <0.001 |
| 3-4 | 138 (41.3) | 38 (23.8) | 100 (57.5) | |
| Chair use No | 33 (9.9) | 20 (12.5) | 13 (7.5) | 0.12 |
| Final ROSA score | | | | |
| 1-4 | 123 (36.8) | 75 (46.9) | 48 (27.6) | <0.001 |
| 5-10 | 211 (63.2) | 85 (53.1) | 126 (72.4) | |
| Interference score (n=325) | | | | |
| Not at all | 49 (15.1) | 46 (30.5) | 3 (1.7) | |
| Slightly interfered | 158 (48.6) | 88 (57.6) | 70 (40.5) | |
| Substantially interfered | 118 (36.3) | 18 (11.9) | 100 (57.8) | <0.001 |

Table 1 Participant variables comparing severe and non-severe discomfort (n=334)

| | Total n (%) | Non-severe n=160 (47) | Severe n=174 (53) | *p*-value |
|---|---|---|---|---|
| Frequency of pain | | | | |
| No pain | 7 (2.1) | 6 (3.7) | 1 (0.6) | |
| 1-2 time/week | 14 (4.2) | 4 (2.5) | 10 (5.8) | |
| 3-4 time/week | 98 (29.35) | 83 (51.9) | 15 (8.6) | <0.001 |
| 1 time every day | 98 (29.35) | 48 (30) | 50 (28.7) | |
| Several times every day | 117 (35) | 19 (11.9) | 98 (56.3) | |
| Onset of discomfort | | | | |
| <6 weeks | 123 (36.8) | | | |
| 6-12 weeks | 49 (14.7) | | | |
| >12 weeks | 162 (48.5) | | | |
| Work-from-home duration | | | | |
| <6 months | 108 (32.4) | | | |
| 6-12 months | 132 (39.5) | | | |
| >12 months | 94 (28.1) | | | |
| Electronic devices used | | | | |
| Laptop computer | 221 (66.1) | | | |
| Desktop computer | 73 (21.9) | | | |
| Mobile phone | 29 (8.7) | | | |
| Tablet | 10 (3) | | | |
| Laptop and desktop | 1 (0.3) | | | |

The online modified Thai CMDQ (Table 2) showed the frequency of discomfort was mostly at the neck (87.7%), right shoulder (79.9%), left shoulder (75.4%), and right lower back (75.4%).

**Table 2** Areas of the discomfort from online modified Thai CMDQ (n = 334)

| Areas | n (%) |
|---|---|
| Neck | 293 (87.7) |
| Lt. shoulder | 252 (75.4) |
| Rt. shoulder | 267 (79.9) |
| Lt.upper back | 229 (68.6) |
| Rt.upper back | 234 (70.1) |
| Lt.lower back | 246 (73.7) |
| Rt.lower back | 252 (75.4) |

For the components of the workstations, a median of the scores was highest in the chair section at a score of four. The mouse, monitor, and keyboard sections were equal at three with the telephone section being the least at one. (Table 3)

**Table 3** Online modified Thai ROSA scores

| Chair | Monitor | Phone | Mouse | Keyboard | Final ROSA |
|---|---|---|---|---|---|
| Median (P25, P75) | | | | | |
| 4.0 | 3.0 | 1.0 | 3.0 | 3.0 | 5.0 |
| (3.0, 5.0) | (2.0, 4.0) | (0, 2.0) | (2.0, 3.0) | (2.0, 4.0) | (4.0, 6.0) |

From demographic data, statistical significance was found in working hours per day of more than 8 hours, working duration per session of more than 1 hour, and stress level of 3-4. (Table 1) From the ROSA score, statistical significance was found in the final ROSA score of five or greater. From multiple logistic regression, the factors associated with severe discomfort were only the final ROSA score of five or greater, BMI, and stress level of 3-4 (Table 4).

**Table 4** Analysis of factors independently associated with severe discomfort using multiple logistic regression

| Variables | Unadjusted odd ratio (CI) | *p*-value | Adjusted Odd ratio (95% CI) | *p*-value |
|---|---|---|---|---|
| Final ROSA score ≥5 | 2.32 (1.47-3.65) | <0.001 | 2.10 (1.28-3.46) | 0.003 |
| BMI | 1.05 (0.997-1.10) | 0.06 | 1.07 (1.01-1.13) | 0.03 |
| Stress level (Likert 3-4) | 4.34 (2.71-6.96) | <0.001 | 4.04 (2.47-6.61) | <0.001 |
| Working hours/day >8 hr | 2.10 (1.24-3.55) | 0.005 | 1.48 (0.83-2.64) | 0.19 |
| Working duration/session >1 hr | 1.69 (1.05-2.72) | 0.03 | 1.34 (0.79-2.25) | 0.28 |

## DISCUSSION

We found a very high prevalence of discomfort among participants at 97.9%. Most of the participants had chronic discomfort (48.5%). This was reasonable because more than half of the participants had been working from home for more than 6 months (67.6%). Although most had severe discomfort (53%) they reported the low Interference score (48.6%). This finding is similar to Aegerter's finding in Swiss office workers[8]. The most common area of discomfort was at the neck (87.7%) which is similar to the other studies[5,6,8,9]. We think this might be because most of the participants used laptop computers (66.1%). Gerding T also found that laptop computers are the most commonly used device at home[9]. Due to the nature of the device, this forces the users to flex their necks. Flexing the neck can be translated to the ROSA score of two, that was what we found in our study (2, median). The prevalence was less in the lower back areas (73.7 % for the left and 75.4 % for the right).

CMDQ scoring guidelines proposed a scoring method by multiplying the Frequency score by the Discomfort score by the Interference score. We disagree with this method because these scores are different data types. Multiplying them results into composite results. We also found the Discomfort score strongly related to the Frequency score and Interference score ($p$<0.001) (Table 1). We chose the Discomfort score to group the participants.

Among demographic characteristics, the high-stress level was the only factor associated with severe discomfort ($p$<0.001). It was reported to have a strong correlation with chronic non-specific neck and arm pain[10]. This finding is consistent with those from other studies[11-13]. For BMI, we found an association after multiple logistic regression analyses ($p$ = 0.03). Unlike the other studies that classified the participants into underweight, normal, overweight, and obese and found no association[14]. We found that

the greater the BMI, including non-classified, the greater the level of risk of severe discomfort. Increased mechanical workloads, adipokines up-regulation, and many other proposed pathways are possible explanations[14,15].

We found no association between severe pain and the number of hours per day and working duration per session ($p$=0.19 and 0.28, respectively). And most of them had normal working hours per day (76.3%) and long enough break duration (73.9 %, 15 minutes or greater). There are studies both do and do not support this finding[8,13].

There was a study that reported working ergonomics at home to be worse than at the office[8]. To compare with the study of Rittideah D[5] in an office environment, the present study found fewer participants (63.2%) having the final ROSA score of five and greater compared to 74.1%. For ROSA scores of each workstation component between studies, we found quite the same level of ROSA score for chairs (4, median) but less ROSA score for the other components. In addition, we found only 9.9% did not use chairs compared to 42.6% in another study in India6. But we found no statistical significance for this factor ($p$=0.12). This might be the case because the participants in our study should be more flexible at home in modifying their workstations. The original ROSA is designed to use with an assessor and a cut-off value of five or greater of the final ROSA score is proposed that immediate action is needed. In our study as a self-assessment questionnaire, we also found a strong association between severe discomfort and the final ROSA score of five or greater ($p$=0.003). This agrees with many other studies that poor posture relates to discomfort, pain, or musculoskeletal disorders[5,9].

The present study had limitations. First, the original ROSA was intended to be used by an assessor. Due to our research question to assess a sitting position at home, especially with this number of participants, it required a lot of resources to do as the tool was intended. However, we still found a strong correlation between this self-assessed online modified Thai version and severe discomfort. Second, we modified both online Thai CMDQ and ROSA. Some studies used CMDQ and ROSA as online questionnaires, but those are all in English, there is no validity study of our online modified Thai version. And third, the prevalence of discomfort in our study was very high. Perhaps because this study was more interested in the people who had discomfort rather than those who had not.

Some computer users used their devices partially or mainly at home. The findings in this study emphasized the importance of the sitting posture of computer users in home environment. Other modifiable factors such as BMI should also be corrected. For further studies, a correlation between each component of a workstation and the area of discomfort should be interesting.

Severe chronic discomfort was mostly found. The neck was the most common area. Severe physical discomfort was associated with BMI, high-stress level, and the final ROSA score of five and greater. Correcting those modifiable factors should be encouraged.

**Conflicts of Interest:** None

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