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Research article

A comparison of neck and shoulder postures in symptomatic and asymptomatic female office workers in the actual work environment

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ABSTRACT

Objective: The present study aimed to compare the static and dynamic sitting posture during computer work among symptomatic and asymptomatic office workers in actual work environment.
Methods: Seventy female office workers were divided into two groups: asymptomatic (n = 35) and symptomatic (n = 35). Subsequent to this classification, adjustments to their respective workstations were implemented in accordance with Occupational Safety and Health Administration (OSHA) guidelines. The assessment of neck (CV) and shoulder (FS) angles were conducted during both a typical seated posture and at intervals of 20 min over a duration of 3 h of computer work.
Result: The asymptomatic group had a range of age from 26 to 40 years, a BMI of 21.11 ± 2.14, and a working experience ranged from 1 to 16 years. In contrast, the symptomatic group had an age range from 24 to 40 years, a BMI of 21.12 ± 2.27, and a working experience ranged from 3 to 16 years. During static sitting posture, significant differences were observed in both CV ($p = 0.01$) and FS angles ($p = 0.00$) between the two groups. Additionally, during computer work sessions lasting for 3 h, a significant time effect ($p = 0.00$) was noted for the CV angle. Furthermore, the FS angle exhibited significant group ($p = 0.00$), time ($p = 0.00$), and interaction ($p = 0.00$) effects during work.
Conclusion: This study underscores the development of neck flexion during prolong working in both groups. In addition, asymptomatic group experienced a progression more rounded shoulder during a 3-h working period. Prolonged periods of sitting and computer use appear to have adverse effects on neck and shoulder health, underlining the importance of implementing measures to mitigate these effects.

1. Introduction

Neck and shoulder symptoms frequently afflict office workers, often attributed to their work environment, prolonged sitting positions while using computers, static and awkward postures, as well as psychosocial risk factors [1,2]. These symptoms manifest as musculoskeletal discomfort in the neck or shoulder, either individually or in combination, and are typically not the result of acute trauma, neoplastic conditions, or systemic diseases [1,3,4]. It's important to note that these neck and shoulder problems are different

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from accidents that happen off-duty or from acute traumatic events [1,5,6]. It is important to note that office workers frequently have neck and shoulder pain [3,7,8]. Prolonged sitting in a fixed posture, without adequate breaks, is commonly associated with neck pain and can lead to forward neck posture, as observed in the study conducted by Celik and colleagues [3,4].

Improper posture is characterized by misalignment of various body parts, resulting in increased static muscle tension and added stress on cervical tissues [6]. Non-neutral postures of the neck and shoulders while seated are particularly relevant to discomfort experienced by office workers [5]. Forward head posture, defined as the forward displacement of the head on the cervical spine, and rounded shoulders, characterized by the protrusion of shoulders in the sagittal plane, are common manifestations of poor posture [6]. These postural deviations are likely contributing factors to nonspecific neck pain [8]. Moreover, research indicates that forward head posture and rounded shoulders tend to worsen over time in symptomatic office workers who engage in prolonged computer work without breaks [5,9]. Additionally, individuals with neck and shoulder symptoms often demonstrate a reduced ability to maintain an upright posture during computer tasks.

Forward head posture is characterized by the head being positioned forward of the center of the shoulders. This forward movement of the head results in a shift in the center of gravity. To counteract this shift, the upper body tends to lean backward, causing the shoulders to slouch forward, ultimately leading to the head being positioned anterior to the trunk [10–12]. Neck posture, on the other hand, pertains to the alignment of the cervical spine at a given point in time. It is typically assessed in various positions, with standing and sitting being the most common [5].

The existing literature is relatively limited when it comes to exploring the relationship between symptomatic individuals experiencing nonspecific neck pain and their neck/shoulder posture during Visual Display Unit (VDU) work. Furthermore, there is no consensus on whether the neck and shoulder posture of symptomatic subjects differs significantly from that of asymptomatic subjects due to office environmental factors and prolonged sitting. Consequently, a study conducted in a real workplace environment holds the potential to shed light on this complex and intriguing question. Thus, the objective of this study is to compare the neck and shoulder postures of office workers experiencing symptoms and those who are asymptomatic while they engage in computer work.

2. Material and method

2.1. Design

This is a case-control quasi experimental design.

2.2. Subjects

The study recruited a total of seventy female office workers employed in offices situated in Bangkok. The determination of the sample size was carried out using the G*Power program version 3.0.10. The calculation of the sample size was primarily based on the mean and standard deviation of the CV angle measurement, which served as the primary outcome measure for the study [11]. A statistical power of 0.95 was selected at a significance level (α) of 0.05, with an effect size of 0.8. Subsequently, the participants were segregated into two groups: the asymptomatic group, encompassing 35 individuals, and the symptomatic group, which also comprised 35 individuals. These groups were meticulously matched in terms of individual characteristics, including weight, height, BMI, and work experience with computers. The classification of participants into asymptomatic and symptomatic groups was achieved through the administration of both general and Nordic questionnaires [13] for categorization in this study.

Both groups were required to meet specific inclusion criteria. Participants in both the symptomatic and asymptomatic had to be between 20 and 40 years of age, and they should have worked with computer for a minimum of 5 days a week, with each workday spanning at least 4 h [9], and maintained their current work position for a minimum of 1 year. For individuals in the symptomatic group, additional inclusion criteria were applied. These criteria included the presence of discomfort in the neck and/or shoulder regions, with such discomfort being both current and having occurred at some point in the past 7 days, lasting for more than 3 months within the past year. In the case group, the threshold for discomfort complaint, as measured on the Visual Analog Scale (VAS), was set at a minimum score of 3. Participants who did not report any discomfort in the neck or shoulder regions within the preceding 3 months were designated as the asymptomatic group [9].

Participants with a body mass index (BMI) exceeding 25, individuals who had experienced symptoms originating in the neck–-shoulder and arm region due to traumatic incidents or accidents, those who underwent spinal or shoulder surgery, individuals exhibiting neurological deficits, pregnant or on maternity leave, and those with uncorrected eyesight impairments were excluded from the study [9].

To mitigate potential sources of bias, both the case and control group participants were drawn from the same occupational category of office workers, engaged in similar types of work, and exposed to equivalent working conditions. In addition, the anatomical boundary for the neck region was defined as extending from the inferior margin of the occiput to the level of T1.

2.3. Variables

The study utilized two primary outcome measures to assess participants. These measures were as follows:

Cervical (CV) Angle: This angle was defined as the angle formed at the point where a horizontal line passing through the spinous process of C7 intersects with a line extending to the tragus of the ear (see Fig. 1).

Shoulder (FS) Angle: The shoulder angle was defined as the angle formed at the intersection of a line drawn between the midpoint

of the humerus and the spinous process of C7, and a horizontal line passing through the midpoint of the humerus [10] (see Fig. 1).

In the present study, we considered 52° as the reference angle [14].

2.4. Instrumentation and procedures

2.4.1. Work station

Every participant received a suitable adjustable workstation in accordance with the guidelines outlined by the Occupational Safety and Health Administration (OSHA) for the setup of computer workstations [15].

2.4.2. Experimental procedure

The experimental sessions were conducted in the morning, and as part of the protocol, a reference sitting posture was documented for a duration of 2 min. This baseline measurement served the purpose of establishing the normal sitting posture of each subject before they commenced their computer-related tasks. Throughout the 3-h period of computer work, the neck and shoulder postures were continuously recorded using a VDO analysis system.

Cervical and shoulder postures were assessed using a photographic method aided by the Kinovea program [16] For this assessment, three reflective markers with a diameter of 12.5 mm were strategically positioned on the right side of each study participant, precisely at the following skeletal landmarks: the tragus, the spinous process of C7, and the lateral tip of the acromion process. To ensure consistency and precision, the placement of these markers was carried out by the same experienced physical therapist across all participants. Two specific angles of measurement, namely the Cervical (CV) angle and the Shoulder (FS) angle, were employed in the study's evaluation. These angles were determined based on data collected at various time intervals throughout the 3-h duration of office work, specifically at the 0th, 20th, 40th, 60th, 80th, 100th, 120th, 140th, 160th, and 180th minutes, which corresponded to specific positions as the T1-T10. This method was modified from the one employed by Chaikumarn and fellow researchers, wherein postural measurements were conducted at 20-min intervals specifically in the context of extended computer-related tasks [9].

To ensure the integrity of the study and the accuracy of participant selection, all assessments for inclusion and exclusion criteria were performed by a highly experienced physical therapist with 20 years of expertise in the field. Moreover, all measurements were consistently administered by the same researcher who possessed substantial experience in evaluating postural alignment. Prior to their participation, written consent was obtained from all study subjects, and the research protocol was duly approved by the Ethics Review Committee for Research Involving Human Research Subjects at Rangsit University.

2.5. Statistical analysis

Statistical analyses were conducted using SPSS version 17.0, with a predefined significance level of $p < 0.05$ indicating statistical significance. To ensure the comparability of study participants, meticulous matching was performed based on factors related to work profile, anthropometric characteristics, age, and then analyzed in term of range, and MEAN $\pm$ SD. To assess the impact of the variables under investigation, namely group, time, and their potential interaction, a repeated-measures analysis of variance (ANOVA) was employed. This analytical approach allowed for the examination of the primary effects of the group and time, as well as the potential interplay between these factors.

Fig. 1. a is Cervical (CV) angle and b is Shoulder (FS) angle [10].

Declarations

This study received ethical approval from the Research Ethics Review Committee for research involving human subjects of Rangsit University no. REC 24/2560. Participations in our study were voluntary and written consents were obtained from the participants before the study. All the ethical guidelines were followed.

3. Results

3.1. Subjects

Table 1 provides an overview of the characteristics of the subject groups. Importantly, there is no statistically significant differences were observed between the groups with respect to age, BMI, or work experience (see Table 2).

3.2. Cervical and shoulder angles

In the context of the CV angle, our study did not reveal any statistically significant differences associated with the group factor. However, a notable time effect was observed concerning the CV angle ($F(4.98, 306) = 16.36$, $p = 0.00$), indicating that over the course of the measurements, alterations in the CV angle were evident. Turning to the FS angle, we identified a significant group effect on the FS angle ($F(1, 34) = 20.46$, $p = 0.00$), signifying that differences in FS angles were indeed present between the two groups. Additionally, a significant time effect was noted for the FS angle ($F(6.27, 213.17) = 12.00$, $p = 0.00$), underscoring the dynamic changes in FS angles throughout the study. Furthermore, a significant interaction between group and time was identified with respect to FS angles ($F(9, 306) = 9.77$, $p = 0.00$), suggesting that the combined influence of group and time had a detectible impact on FS angles (see Table 3).

4. Discussion

4.1. Participants

Seventy office workers actively participated in this comprehensive study, evenly divided into two distinct groups: 35 individuals who were asymptomatic and 35 who exhibited symptoms related to their office work. Notably, rigorous statistical analysis revealed no statistically significant differences in terms of age, weight, height, BMI, or work experience between these two groups. This careful matching ensured that any observed effects could be attributed to the variable of interest rather than extraneous factors.

To delve into the specifics, at the onset of the study (T1 = 0^{th} minute), the average CV angle for the asymptomatic group was recorded at 52.60 (0.55), while the symptomatic group exhibited an average CV angle of 54.62 (0.54). Importantly, these measurements exhibited no significant disparities between the two groups, and both were deemed not to exhibit forward head posture as their CV angles exceeded the threshold of 50° [8,12]. This detailed evaluation emphasizes the comparability of the two groups and affirms their initial posture within acceptable parameters.

4.2. CV angle

In our current investigation, we did not uncover any statistically significant differences attributable to group factors concerning the CV angle. However, an important and noteworthy observation emerged concerning the CV angle over time ($F(4.98, 306) = 16.36$, $p = 0.00$). This finding implies that, irrespective of group, both sets of office workers demonstrated a progressive development towards a

Table 1
Characteristics of subjects.

	Asymptomatic (n = 35) Mean (SD)	Symptomatic (n = 35) Mean (SD)	*p value*
Age (year)	33.23 (4.77) Range 26-40	32.20 (4.19) Range 24-40	0.34
Weight (kg)	57.05 (8.45) Range 43-83	58.65 (8.43) Range 45-82	0.43
Height (cm)	161.46 (5.71) Range 151-171	162.97 (5.23) Range 155-175	0.25
BMI	21.11 (2.14) Range 15.94–24.97	21.12 (2.27) Range 15.94–24.65	1.00
Work experience (year)	6.8 (3.15) Range 1-16	7.5 (3.00) Range 3-16	0.34
Pain intensity	1.54(0.55) Range 0-2	4.57(1.38) Range 3-10	0.00*

Note: *Significance level at 0.05.
[a]Pain intensity from VAS scale: 0 = no pain, 10 = Most pain.

Table 2
Cervical and Shoulder angles (Mean ± SD) at the beginning of office working (0^{th} min or T1).

Angle	Asymptomatic (mean ± SD)	Symptomatic (mean ± SD)	*p value*
CV angle	52.60 ± 0.55	54.62 ± 0.54	<0.0001 *
FS angle	73.77 ± 1.24	61.60 ± 1.34	<0.0001*

Note: *Significant level between the groups, Significance level at 0.05.

Table 3
Cervical and Shoulder angles (Mean ± SD) during 3 –hr office working.

Angle		T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
CV	Asymptomatic	52.60 ±0.55	49.97 ±0.67	50.31 ±0.74	49.71 ±1.03	48.91 ±0.64	47.77 ±0.79	45.71 ±1.08	45.97 ±0.99	45.45 ±1.12	43.25 ±1.42
	Symptomatic	54.62 ±0.54	49.68 ±0.78	52.22 ±0.83	46.0 2 ± 1.51	47.17 ±1.24	46.42 ±1.10	45.54 ±1.45	46.48 ± 1.09	45.82 ±1.28	44.25 ±1.46
	Difference (Asy -Sym)	−2.02	0.29	−1.91	3.71	1.74	1.35	0.17	−0.51	−0.37	−1.00
FS	Asymtopmatic	73.77 ±1.24	68.25 ± 2.02	67.91 ±2.40	72.08 ±2.18	67.62 ±1.99	69.1 4 ± 1.97	71.80 ±1.66	66.97 ±1.93	72.71 ±1.75	68.77 ±1.53
	Symtomatic	61.60 ±1.34	59.71 ± 1.75	63.45 ±2.34	61.54 ±2.10	53.31 ±1.74	60.40 ±1.95	74.02 ±1.47	69.22 ±1.70	71.02 ±1.77	74.25 ±2.07
	Differences (Asy -Sym)	12.17	8.54	4.46	10.54	14.31	8.7	−2.22	−2.25	1.69	−5.48

Note: T1 = 0th min; T2-T10 = at the end of each 20-min working (180 min).

more flexed posture as the 3-h working period extended. This adjustment towards increased neck flexion aligns with the insights presented by Straker and colleagues [17], who posited that increased neck flexion angles during work activities result in greater moments applied to both the lower and upper cervical spine. Such moments, in turn, contribute to amplified stress on cervical tissues and an elevated susceptibility to developing a Musculoskeletal Disorders (MSDs) [18]. Furthermore, Szeto and colleagues observed that participants exhibited an approximate 10% escalation in forward head posture from their initial relaxed sitting positions when engaged in computer display tasks. However, no statistically significant alterations in posture were noted based on the duration of time spent at work [5]. Moreover, Szeto and co-researchers noted that individuals with symptoms exhibited patterns characterized by elevated head-neck flexion angles and extended ranges of movement compared to the asymptomatic group [19] (see Table 4).

4.3. FS angle

Our investigation yielded significant findings related to the FS angle, as we identified a group effect ($F(1, 34) = 20.46$, $p = 0.00$) and a time effect ($F(6.27, 213.17) = 12.00$, $p = 0.00$). These outcomes signify that both groups exhibited distinct FS angles during periods of stationary sitting and over the course of the 3-h work duration. Notably, when considering the temporal aspect, it becomes evident that the asymptomatic group experienced a progression towards more rounded shoulders. On the other hand, Szeto and associates noted that those who experienced symptoms tended to have forward acromion than those who did not demonstrate any symptoms [5]. This observation is particularly relevant as the FS angle serves as a quantifiable measure of the anterior positioning of the shoulder. A smaller FS angle indicates that the shoulder is situated further forward in relation to C7, reflecting a greater degree of roundedness in the shoulders [20]. Additionally, it is crucial to recognize that this phenomenon can contribute to an increase in static postural deviations [21,22]. These findings underscore the importance of maintaining proper shoulder alignment and minimizing the adverse effects of prolonged computer work on neck and shoulder health. The evidence regarding shoulder protraction as a protective mechanism during computer work is mixed. While it may offer some benefits in terms of muscle fatigue reduction and increased joint stability [23], it also carries risks of increased muscle tension, impingement, and decreased range of motion [5]. Therefore, it's important to maintain proper posture, take regular breaks, and stretch throughout the day to minimize the potential for negative consequences.

It is noteworthy that conventional physical examination measures, such as assessing the range of motion (ROM) of the neck and shoulder, were not incorporated into the methodology of this study. The absence of such assessments could potentially introduce confounding variables influencing the observed neck and shoulder angles between the two study groups. Consequently, we advocate for the inclusion of range of motion assessments for both the neck and shoulder in future research endeavors to enhance the

Table 4
Summary of repeated-measure analysis of variance on CV and FS angle.

Charactersitic	Factors		
	Group	Time	Group xTime
CV angle	$F(1, 34) = 0.06$, $p = 0.80$	$F(4.98, 306) = 16.36$, $p = 0.00$*	$F(9, 306) = 1.35$, $p = 0.23$
FS angle	$F(1, 34) = 20.46$, $p = 0.00$*	$F(6.27, 213.17) = 12.00$, $p = 0.00$*	$F(9, 306) = 9.77$, $p = 0.00$*

Note: *Significance level at 0.05.

comprehensiveness of the findings (see Table 4).

4.4. Pain intensity

Although inquiries regarding pain intensity in the neck and shoulder region were made, it is important to note that data pertaining to pain in alternative regions during the assigned task were not systematically gathered. This particular limitation presents an opportunity for insightful exploration into the pain behavior exhibited by participants. Despite the implementation of inclusion criteria necessitating the presence of discomfort in the neck and/or shoulder regions—this discomfort being both current and having occurred at some point within the past 7 days, with a duration exceeding 3 months within the preceding year—it is crucial to acknowledge the absence of specific data concerning the mean duration of pain. This information gap represents a notable limitation but also provides an avenue for exploring the pain behavior exhibited by symptomatic participants.

4.5. Limitation of study

It's important to note that our study predominantly focused on female office workers, a demographic that is known to be more susceptible to experiencing neck and shoulder pain. Consequently, the findings of our research may not be readily generalizable to the broader population. It is crucial to exercise caution when extrapolating our results to individuals outside of this specific group. Further research encompassing a more diverse sample would be necessary to draw more comprehensive and generalized conclusions about the relationships observed in this study. In addition, the assessment of participants' habitual physical activity levels was not conducted in this study. Physical activity can be one factor which influence on musculoskeletal discomfort and also an adaptation of the musculoskeletal system of worker during workday [24].

4.6. Strength of the study

The current investigation employed a case-control quasi-experimental design, executed within the genuine setting of an office environment, focusing on an extended duration of computer-related tasks.

5. Conclusion

The study's results revealed 3 main scientific outputs.

(1) The symptomatic and asymptomatic groups of female office workers demonstrated a progressive development towards an increased neck flexion following a 3-h working period in sitting position.
(2) The asymptomatic group experienced a progression towards more rounded shoulder during a 3-h working period.
(3) These findings highlight the importance of maintaining proper shoulder alignment and minimizing the adverse effects of prolonged computer work on neck and shoulder health.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author, [MC].

CRediT authorship contribution statement

Nuttika Nakphet: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Montakarn Chaikumarn:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:Nuttika Nakphet reports equipment, drugs, or supplies was provided by Rangsit University. Nuttika Nakphet reports a relationship with Rangsit University that includes: non-financial support. Both NN and MC have no conflict of interest by the reader If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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