The influence of computer use on the sitting posture of high school students who develop neck and shoulder pain

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ABSTRACT: *The prevalence of neck and shoulder pain (NSP) is increasing in adolescents and is related to increased time spent on computers. The influence of sitting posture on the development of computer-related NSP among adolescents is unclear. This study investigated how the sitting posture of the upper quadrant changes over a ten minute period of computer use in once asymptomatic adolescents who later developed NSP.*
Method: *Sitting alignment was measured using the Photographic Posture Analysis Method. The students performed a typing task while two consecutive photographs were taken ten minutes apart. The students were followed for six months and the photographs of those who developed NSP were analyzed.*
Results: *The results show that there is no significant change in sitting posture over time. Observationally the most common pattern was to move from a more flexed posture to a more upright posture and there were greater postural changes in the case group (students with extreme cervical angles) compared to the control group (students with the preferred cervical ROM (34.75º - 43.95º)), although both findings were not statistically significant.*
Conclusion: *There was no change, over a ten minute period, in the sitting posture of computing high school students who developed computer-related NSP after six months therefore students should be encouraged to avoid monotonous sitting in front of computers because this could be associated with NSP.*

KEYWORDS: SITTING POSTURE, COMPUTER, NECK AND SHOULDER PAIN, ADOLESCENTS.

Introduction

Musculoskeletal symptoms of pain, discomfort or stiffness are becoming a common health complaint among adolescents. There exists a higher prevalence of neck and shoulder pain (NSP) compared to low back pain among this group (Diepenmaat et al 2006; Vikat et al 2000). The monthly prevalence rates for adolescent NSP can be up to 30% (Diepenmaat et al 2006; Smith et al 2008a; Straker et al 2008a). A recent study conducted among high school students of the Western Cape found a neck pain prevalence of 20% (Smith et al 2008a). The risk factors associated with adolescent NSP include both physical and psychosocial factors (Diepenmaat et al 2006; Vikat et al 2000).

The vast increase in computer usage among school students in the Western Cape of South Africa is due to the Khanya project which aims to promote the use of computers among students in order to address educator shortage, to deliver curriculum and to equip students for the Knowledge Economy of the 21st Century (www.khanya.co.za/projectinfo/?catid=32). Posture has become an important component of the physical risk factors associated with computer-related musculoskeletal pain among adults (Straker et al 2008b; Szeto et al 2005). However there is no published literature that has investigated the association between sitting postures while using computers and NSP among adolescents (Straker et al 2008a). A prospective study by Brink et al (2008) found that the end-of-range (EOR) lower cervical angle was predictive of computer-related NSP among adolescents. Studies have found positive associations between static or flexed working postures and NSP among adolescents (Murphy et al 2004; Niemi et al 1996) as well as positive associations between prolonged sitting during computer use and NSP among adolescents (Auvinen et al 2007; Smith et al 2008a). It is generally assumed that sitting with a neutral spinal posture will be beneficial to the musculoskeletal structures and therefore reduce musculoskeletal pain symptoms (Barrero and Hedge 2002). Straker et al (2008c), however, have found that when adolescents use desktop computers their sitting posture resembles a neutral spinal posture better

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than any other form of information technology. What is unclear is whether there is a specific sitting postural alignment, maintained during computer use that is predictive of NSP among adolescents.

The aim of the current study was to investigate the effect of time on sitting posture and to describe the change in sitting posture of high school students, who developed NSP due to computer use.

METHOD

Study design

A prospective study was conducted over a six-month time period. As part of this larger study, students who developed NSP were identified within the cohort of computer users. The change in sitting posture for the symptomatic students, over a ten minute time period, is reported in this paper.

Participants

Ethical approval was obtained from the Committee for Human Research of Stellenbosch University. The Western Cape Education Department gave permission for the study to be conducted in the schools in the Cape Metropolitan region. The high schools who offered either Computer Studies or Compu-typing as subjects were pooled and six high schools were randomly selected using a computerized programme. The grade ten students (15-17 years), who enrolled for Computer Studies or Compu-typing for the first time at the beginning of the 2007 academic school year, were invited to participate in the study. The students were screened for musculoskeletal pain by using the Computer Usage Questionnaire (CUQ). This instrument's reliability and validity were previously tested and has shown to be suitable for capturing information on the musculoskeletal health of high school students and issues related to computer use (Smith et al 2008b). The students, identified as asymptomatic by the CUQ, were selected to participate and given informed consent letters to be completed by the parents/legal guardians. These originally asymptomatic participants were tracked prospectively over the next six months and those who developed NSP, as a result of computer use, were analyzed.

Postural measurements

Sitting postural alignment was measured according to the Photographic Posture Analysis Method (PPAM). This tool's reliability and validity have shown to be excellent (Van Niekerk et al 2008). The measurement tool measured five postural angles in the sagittal plane by taking digital photographs of the student's dominant side.

Head tilt – the angle between a line drawn from the canthus to the midpoint of the tragus and the horizontal line through the tragus (Raine and Twomey 1997) **Cervical angle** – the angle between a line drawn from the midpoint of the tragus to the C7 spinous process (SP) and the horizontal line through the C7 SP (Raine and Twomey 1997) **Cranio-cervical angle** – the angle between a line drawn from the canthus to the midpoint of the tragus and a line drawn from the midpoint of the tragus to the C7 SP (Straker et al 2008a) **Shoulder angle** – the angle between a line drawn from the midpoint of the humeral head to the C7 SP and the horizontal line through the midpoint of the humeral head (Raine and Twomey 1997) **Thoracic angle** – the angle between a line drawn from the C7 SP to the midpoint of the superior border of the manubrium and a line drawn from the T8 SP to the midpoint of the superior border of the manubrium (Szeto et al 2005). Figure 1, (a) to (e), shows the five postural angles. Retro-reflective markers were placed on the relevant anatomical point as defined above.

Figure 1(a) Head tilt

Figure 1(b) Cervical angle

Figure 1(c) Cranio-cervical angle

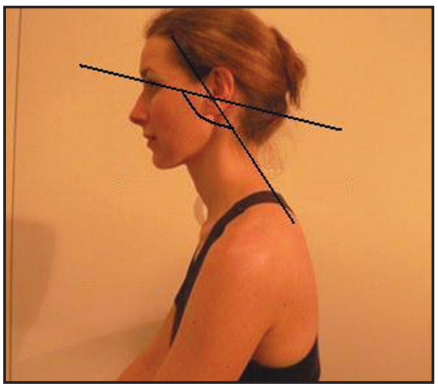


Figure 1(d) Shoulder angle

Figure 1(e) Thoracic angle

Data collection Procedure

Once the retro-reflective markers were placed on the students, the students were instructed to perform a ten-minute curriculum-specific typing task while the postural measurements were taken (Straker et al 2008b). Three photographs were taken during the ten minutes. The first photograph was taken after the student was settled behind his/her computer and had commenced the task, the second photograph at five and the third photograph at ten minutes. The first (beginning of the task) and third (ten minutes into the task) photographs were analyzed using specially designed Intellect software in a similar manner to the process followed in the validity and reliability testing of the PPAM (Van Niekerk et al 2008).

Data Organization

Brink et al (2008) reported that the only postural angle that predicted the onset of NSP, was an extreme cervical angle either ≤ 34.75º or ≥ 43.95º. Therefore the group was subdivided into two groups. The first (case) group contained the students who had extreme cervical angles, either for the duration of the ten minutes or those who ended with an extreme cervical posture. The second (control) group contained the students who stayed within the preferred cervical ROM (34.75º - 43.95º) and those who ended with a good cervical posture. The independent variables were group (case vs control) and time (two repeated measures during ten minute typing-task).

Statistical Analysis

Descriptive results are presented as means, standard deviations, median values and 95% CI for the five postural angles. Repeated measures analysis of variance (ANOVA) was performed to determine the effect of group, time and group by time on the five postural angles.

RESULTS

Sample description

At six months post baseline, 27 out of 104 students developed NSP over the previous months that were related to seated activities such as sitting behind a computer or school desk. The mean age for the pain group was 15.96 (± 0.65). More boys (n=18) reported pain than girls (n=9). The pain group comprised of 18 students in the first (case) group and nine students in the second (control) group.

Postural measurements at baseline

The descriptive data for the postural angles of the first (beginning of the task) and third (ten minutes into the task) photographs are presented in Table 1. The values represent the changes that occurred in the sitting posture of students who developed NSP after six months. The mean values for the angles increased very little from baseline to ten minutes of which the cervical angle increased the most (2.1º). This result suggests that the students either maintained a static posture over time or assumed a more upright posture after ten minutes of typing.

Mean sitting postures and postural changing patterns

Figure 2 demonstrates the model posture of students, who developed NSP, at the onset of the typing task (baseline). This posture represents the mean values for the baseline sitting posture found in symptomatic students.

Figure 2:
Model posture at baseline

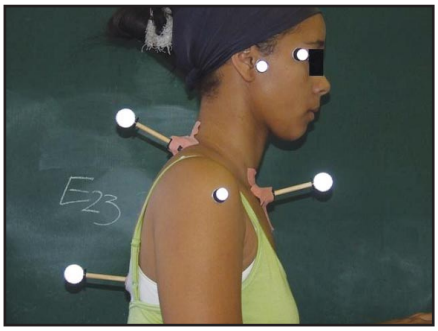


Figure 3 demonstrates the model posture of these students after ten minutes of computer use, again based on the mean values for each angle.

Table 1: Descriptive data of the postural angles (in degrees) of the symptomatic students (n=27)

	Time	Maximum	Minimum	Mean	Std	Median
Head tilt	beginning	27.5	-13.2	12.6	9.1	14.6
Head tilt	tenth minute	32.6	-13.1	13.9	9.6	14.7
Cervical angle	beginning	53.1	15.8	37.9	8.6	37.8
Cervical angle	tenth minute	52.8	18.8	40.0	9.5	42.2
Cranio-cervical angle	beginning	176.8	139.8	153.6	8.4	154.3
Cranio-cervical angle	tenth minute	173.4	136.6	154.3	9.9	153.2
Shoulder angle	beginning	178.5	75.9	130.2	22.3	130.2
Shoulder angle	tenth minute	173.5	81.4	130.8	19.7	132.1
Thoracic angle	beginning	78.6	53.3	66.9	7.2	66.8
Thoracic angle	tenth minute	81.3	39.3	67.4	9.3	67.9

Figure 3: Model posture at 10 minutes

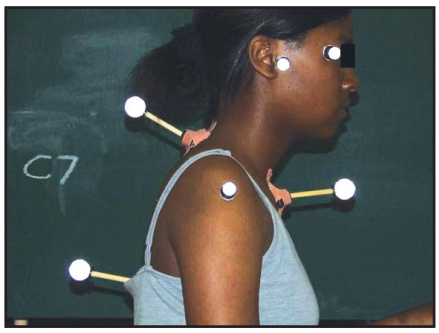
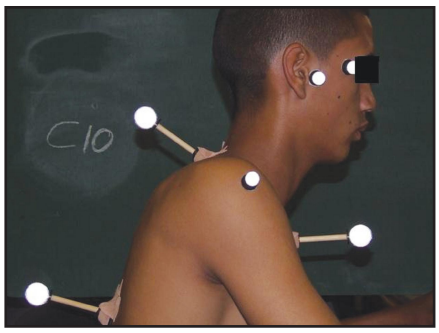
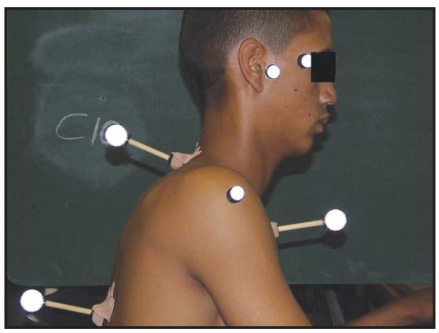


Figure 4: Most common postural change over ten minutes





The postural changing pattern that occurred the most after ten minutes of sitting were ↓ head tilt, ↑ cervical angle, ↓ cranio-cervical angle, ↑ thoracic angle (n=5) as shown in Figure 4 (the shoulder angle was not considered due to the angle's large standard deviation and great variability).

Posture over time

Table 2 presents the means, std and 95% CI of the dependant variables (postural angles) of the case and control groups. The results reveal little change over time for both groups however there are greater changes in the mean sitting posture of the case group compared to the control group. The greatest change occurred in the cervical angle for the case group (increase of 2.8º) and in the shoulder angle for the control group (increase of 1.7º).

There was no significant difference between the groups or over time for the postural angles. The *p values*, (with significance level set at < 0.05) for group, time and group x time for the dependant variables, are summarized in Table 3.

DISCUSSION

This is the first study to report on the change over time in the sitting posture of computing high school students who developed NSP. The study found very little change in the sitting posture over time, which is similar to the study by Straker et al (2008c), who evaluated the sitting posture of asymptomatic children over time (ten minutes of computer use) and found that all the measured angles showed little variability. These results emphasize the monotonous sitting posture assumed by children while using the computer. Murphy et al (2004) also concluded that neck and upper back pain are significantly associated with children who assume static sitting postures. The results from Murphy et al (2004) and Straker et al (2008c) apply only to children, however Straker et al (2008b) found less variability in the sitting posture of young computing adults than for children and therefore suggests even greater monotonous sitting postures with increased age. This monotonous activation of low-level muscle contractions could damage muscle and lead to musculoskeletal symptoms (Straker et al 2008c).

Even though the change over time in the sitting posture was not significant for the group, the results showed that the mean angles did increase slightly resulting in an increased upper and lower cervical extension, increased thoracic extension and increased shoulder protraction. There is no other published literature that can explain this observation. Cross-sectional studies by Straker et al (2008d) and Straker et al (2007)

Table 2: Descriptive data of the postural angles (in degrees) of the case (n=18) and control groups (n=9)

	Case (n=18)			Control (n=9)			
	Time	**Mean (º)**	**Std**	**95 % CI**	**Mean (º)**	**Std**	**95 % CI**
Head tilt	beginning	13.0	9.8	8.1-17.8	11.9	8.2	5.6–18.2
Head tilt	tenth minute	14.4	10.6	9.1-19.7	12.9	7.5	7.1–18.7
Cervical angle	beginning	37.4	10.0	32.5-42.0	38.8	5.3	34.7-42.9
Cervical angle	tenth minute	40.2	11.7	34.4-46.0	39.8	2.2	38.0-41.5
Cranio-cervical angle	beginning	152.7	9.4	148.1-157.4	155.1	6.2	150.3-159.9
Cranio-cervical angle	tenth minute	154.2	11.4	148.1-159.5	154.5	6.3	149.6-158.6
Shoulder angle	beginning	133.5	24.9	121.1-145.9	123.5	15.1	111.9-135.1
Shoulder angle	tenth minute	133.6	21.8	122.8-144.4	125.2	14.4	114.2-136.3
Thoracic angle	beginning	65.1	6.8	61.7-68.5	70.7	6.9	65.4-75.9
Thoracic angle	tenth minute	65.9	7.1	62.4-69.5	70.3	12.6	60.6-80.0

Table 3: Summary of the univariate analysis for the postural angles

Postural angle	Effect	Univariate analysis *(P value)*
Head tilt	*group*	0.74
	time	0.25
	group x time	0.84
Cervical angle	*group*	0.90
	time	0.16
	group x time	0.48
Cranio-cervical angle	*group*	0.70
	time	0.80
	group x time	0.48
Shoulder angle	*group*	0.27
	time	0.74
	group x time	0.76
Thoracic angle	*group*	0.11
	time	0.88
	group x time	0.67

Significance level < 0.05

found that adolescents, with prolonged NSP, sit with more flexed thoracic spines and that a higher amount of computer use (≥ seven hours per week) was associated with more flexed head and neck angles for boys and more lumbar lordosis and anterior pelvic tilt for girls. However neither study measured sitting posture while using computers. The adolescents from this study were without any NSP when the measurements were taken at baseline and only developed NSP at a later stage. These students did not reveal any postural changes while they were still asymptomatic. It could be argued that ten minutes was not enough time to observe any postural changes that could lead to musculoskeletal pain and that postural changes are a gradual process that needs to be evaluated over time i.e. months or years. However, Straker et al (2008a) and Straker et al (2008d) also found no association between head and neck angles and NSP among adolescents.

The postural changing pattern that was more frequently found among the high school students revealed a change towards increased upper cervical flexion with increased lower cervical and thoracic extension. It could be argued that the changing posture represents a forward sway from the hips (increased hip flexion angle). This could possibly result in more upper cervical flexion, lower cervical and thoracic extension in order for the eyes to remain focused on the computer screen. Although lumbopelvic posture was not measured in this study, Falla et al (2007) reported that a change in the sitting lumbopelvic posture can change the activation of the deep cervical flexors and affect cervical stability, consequently leading to NSP. It is therefore necessary to evaluate the lumbopelvic sitting posture simultaneously with the thoracic and cervical sitting postures when evaluating postural sitting alignment over time and its association with NSP among adolescents.

Brink et al (2008) reported that only an EOR or extreme cervical angle (as defined in the methodology) was a risk factor for the development of NSP among computing adolescents. Therefore differences between the students who had extreme cervical angles (case) and those who did not (control) were investigated in the current study. No significant differences in the amount of change over time for either groups were found. Although there was no significant difference between the groups, the results demonstrated that the cervical angle changed the most for the case compared to the control group. This suggests that greater movement occurs in the sitting posture of the case group compared to the control group. On the contrary, Straker et al (2008c) reported that the cervical angle was significantly less variable over time than any of the other measured angles.

It needs to be acknowledged that this was a small study sample and that ten minutes may not have been enough time to observe any change. Also, this study does not comment on the influence of muscle activity that is needed to control bony alignment. Therefore further research is recommended in this field, using greater samples and evaluating adolescents' sitting postures over months or years in an attempt to better define the association between sitting postural alignment and the development of NSP among adolescents.

CONCLUSION

There was no change over time (minutes during one computer session) in the sitting posture of computing high school students who developed NSP after six months. Although prolonged sitting in front of computers is associated with increased pain prevalence among adolescents (Auvinen et al 2007; Smith et al 2008a) there is still no clear indication as to whether sitting postural alignment should be addressed when managing computer-related NSP among adolescents or whether there are more crucial factors such as psychosocial issues that need to be addressed. However, it appears that more attention should be paid to the lower cervical flexion/extension position when advising this population re. posture, and that students should at minimum be encourage to avoid static, monotonous sitting.

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