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The effect of lying on the stomach on the spine angles of 13-18-year-old students in Karaj

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Abstract

Introduction: The objective of the present study was to investigate the effect of lying on the stomach on the spine angles of 13-18-year-old students in Karaj.

Martials and Methods: This study was quasi-experimental and comparative conducted by field method. For this purpose, 105 13-18-year-old students of girls' schools in District 3 of Karaj during the academic year 2020-2021, who were accustomed to lying on the stomachs, randomly participated in the study by convenience sampling method and based on the number of study hours per day, less than 1 h, between 1 and 2 h and more than 2 h placed in three groups. Research variables including angles of forward head, unequal shoulder, lumbar lordosis, dorsal kyphosis and scoliosis were assessed using standard tests with high validity and reliability. The data were analyzed using one-way analysis of variance and Bonferroni post hoc test at the significance level of 0.05.

Results: A significant difference was between lumbar lordosis and forward head angle abnormalities among students who were less than 1 h and more than 2 h accustomed to lying on their stomachs ($P<0.05$). But this difference was not significant for variables of uneven (dropped) shoulder, dorsal kyphosis and scoliosis ($P>0.05$). The students who studied for more than 2 h a day while lying on their stomachs had abnormalities of lumbar lordosis and forward head angle.

Conclusion: Lumbar and prefrontal lordosis abnormalities are common in students who study lying on their stomachs and repeat the condition for at least 2 h a day.

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1. Introduction

Development of industry and mechanization of life on the one hand, and changes in lifestyle on the other hand, have endangered the health of the people and exposed them to the occurrence of posture abnormalities [1]. These abnormalities are caused by inactivity, having bad habits and using non-standard equipment. People are exposed to various postures during the day and night, some of which cause abnormalities due to recurrence in long term. Also, non-compliance with ergonomic standards of equipment used continuously by people; The anthropometric dimensions can lead to physiological and structural disorders [2].

As long as students were trained in person, homework and study hours were shorter at home, but after education became online, students spent all of their hours at home; Often they do not observe standard posture while studying and doing homework. Therefore, the risk of developing musculoskeletal abnormalities increases. Several studies have shown that doing homework while lying on the stomach leads to many complications and discomfort such as humpback, Venus dimples (lumbar arch), chest pain and forward head [3]. Lying on the stomach while studying, if repeated for a long time, can cause irreversible complications in the person including the shoulders and spine automatically take on a new posture that will cause pain. But if the spine is normal while studying, the muscles have the least extra action; Minimal pressure is applied to the vertebrae, energy use is minimized, body height control is improved, and as a result, no pain is felt in the spine [4]. Also, the pressure on the spine and then the posture of the head causes the person to breathe only through the mouth, which puts pressure on the muscles of the chest and diaphragm and causes fatigue. Therefore, it seems that a small problem can cause a wrong posture and a series of anomalies [5].

In order to eliminate the posture abnormalities of students with bad habits of lying on the stomach while studying, it is necessary, first to identify the angles of the spine so that at the later stages it can be done by corrective movements to reduce complications. Relying on the correction of complications and physical deviations among students, the occurrence of structural and incurable complications can be largely prevented. In previous researches on the study and rest style of students, the most of results indicate that most of them do not have a good life and study style. In this regard, Aytari et al. (2020) showed that students' musculoskeletal pain increased during distance learning in Covid-19 pandemic [6]. Mongkonkansai et al. (2020) showed that the use of smartphones (sitting and lying), which is mainly a sleeping position, was significantly associated with head abnormalities in school children (6-12 years old) [7]. Dianat et al. (2018) showed that the way students sit in the classroom had a significant effect on neck and shoulder pain and these factors were among the physical factors affecting the risk of musculoskeletal injuries [8]. Zanganeh Tabar (2019) also showed that lumbar lordosis was significantly higher among those lying on the stomach. But dorsal kyphosis showed no significant difference based on the way of lying. Also, no significant difference was between lumbar lordosis and dorsal kyphosis based on bed, mattress and pillow type [4].

Despite previous studies, it seems that the main problem remains unknown and the type of musculoskeletal abnormalities and their relationship with study and use

inappropriate physical tools during the study have not been carefully studied. In general, investigation of skeletal abnormalities and pain caused by incorrect posture, as well as their relationship with rest and study habits at different ages have shown different results. Hence, the lack of research in this field in students and attention to posture and health, as well as investigation of spine status at an early age arise the question: "What is the posture, pain and range of motion in students with reading habits of lying on the stomach?" It is hoped that the results of the present study, while increasing knowledge, will improve posture indices and reduce pain and range of motion in students with the habit of studying of lying on the stomach.

2. Materials and Methods

This study was quasi-experimental and comparative conducted by field method. For this purpose, 105 13-18-year-old student girls in District 3 of Karaj during the academic year 2020-2021, who were accustomed to lying on the stomachs, randomly participated in the study. The habit of studying while lying on the stomach on a daily basis, accustomed for an academic year and online education were the study inclusion criteria. Drug use during the study, and irregular participation in the measurement process and tests were the study exclusion criteria. The subjects were studied in three groups of less than 1 h (n= 33), between 1 and 2 h (n= 37) and more than 2 h (n= 35) based on the number of study hours lying on the stomach.

2.1. Assessment of head forward

In order to assess head forward, the subject was first asked to sit in a sagittal position in a comfortable and natural posture. Then, the tragus of the ear and the 7th vertebra of the neck were identified and marked and the person was imaged. Using Forward Head Posture (FHP) software, the images were analyzed and the craniovertebral angle was obtained (Figure 1). The angles less than 49 degrees were considered as head forward. The reliability of this method and the intragroup correlation coefficient have been reported 0.984-0.998 [9].

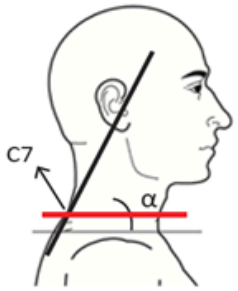

Figure 1. Assessment of the craniovertebral angle

2.2. Assessment of unequal shoulder

The subject was asked to stand in a comfortable and normal posture without shoes, then the acromioclavicular joints were marked and the tool bases were placed on the markers. After aligning the bubble in the middle of the inclinometer, the number was read (Figure 2). These stages were repeated three times for each subject and their mean was considered as the final number. The reliability of this method is 0.78-0.99 and the intragroup correlation coefficient was 0.82-0.91 [10].

Figure 2. Assessment of unequal shoulder

2.3. Assessment of lumbar lordosis

Two bony signs were considered in the spinous process of L1 vertebra as the starting point of the arch and from the spinous process of the second sacral

vertebra S2 as the end of the arch. The subject was asked to stand. Then, a flexible ruler was placed on the back of the person (lumbar). Without any change in the shape of the flexible ruler, it was gently and carefully removed and placed on white paper and the curvature from the inside was drawn. The points L1 and S2 were marked on it. After measuring the lines using a millimeter ruler, their values were placed in the following formula and the lordosis angle was calculated:

$$\theta=4\text{Arctan}\ (2H/L)$$

where the length of the curve (L) represents the distance between the first lumbar vertebra to the second sacral vertebra and the height of the curve (H) is the vertical line that has the greatest distance from the line L. For the lumbar arch, an angle equal to or greater than 30 degrees is known as lordosis abnormality [11].

2.4. Assessment of dorsal kyphosis

For assessment of dorsal kyphosis, two spinous processes of vertebrae T2 and T12 were identified as the starting and end points of the thoracic kyphosis arch. In order to calculate the kyphosis angle, after obtaining the values of H and L, which include the height and depth of the kyphosis curve obtained from the alignment of the ruler on the subjects' back, respectively, it was placed in the formula mentioned above and the kyphosis angle was calculated [12] (Figure 3).

Figure 3. Assessment of dorsal kyphosis

2.5. Assessment of scoliosis assessment

For assessment of scoliosis assessment, Adam's forward bend test was used. The scoliometer was placed perpendicular to the body along the abnormality, so that its zero mark was on the tip of the spinous process. The scoliometer rested lightly on the skin and the degree of rotation was recorded as the angle of scoliosis [14] (Figure 4).

Figure 4. Assessment of scoliosis

Data were analyzed using one-way ANOVA and Bonferroni post hoc test. For this purpose, SPSS-25 software was used at the significance level of 0.05.

3. Results

In terms of spinal abnormalities, lumbar lordosis was the most common (82.85%) among the subjects. After that, forward head (77.15%), dorsal kyphosis (23.80%), uneven shoulder (18.10%) and scoliosis (11.42%) were the abnormalities seen among the subjects, respectively. Mean and standard deviation of research variables are presented in Table 1.

The results of one-way analysis of variance (Table 2) showed no significant difference in mean uneven shoulder, dorsal kyphosis and scoliosis between groups ($P<0.05$). But the difference between the groups was significant in the mean forward head and lumbar lordosis angle ($P<0.05$).

For mean comparison of variables in different study hours, Bonferroni post hoc test was used (Table 3).

Table 1. Mean and standard deviation of research variables

Variable	Studying lying on the stomach			Total mean
	< 1 h	1-2h	> 2h	
Forward head (degree)	47.58±3.01	46.58±2.38	41.86±2.15	45.34±2.51
Uneven shoulder (deviation from zero)	0.40±0.05	0.45±0.11	0.33±0.12	0.39±0.09
Lumbar lordosis (degree)	35.54±2.14	38.69±2.65	42.70±3.36	38.97±2.71
Dorsal kyphosis (degree)	37.39±2.28	36.17±3.42	33.52±2.30	35.69±2.66
Scoliosis (degree)	1.24±0.23	1.11±0.19	0.83±0.17	1.06±0.19

Table 2. Results of one-way analysis of variance of posture indices

Variable	Source of variation	Total squares	Freedom degree	Mean squares	F	*P*
Forward head	Intergroup	647538.71	2	323769.35	17.21	0.000*
	Intragroup	215850.61	102	2116.18		
	Total	863389.32	104			
Uneven shoulder	Intergroup	48.45	2	24.22	1.37	0.186
	Intragroup	17.7	102	0.17		
	Total	66.15	104			
Lumbar lordosis	Intergroup	462810.03	2	231405.01	12.39	0.001*
	Intragroup	151628.92	102	1486.55		
	Total	614438.95	104			
Dorsal kyphosis	Intergroup	391105.18	2	195552.59	1.04	0.219
	Intragroup	125239.77	102	1227.84		
	Total	516344.95	104			
Scoliosis	Intergroup	367.41	2	183.7	0.85	0.388
	Intragroup	124.47	102	1.22		
	Total	491.88	104			

* significant

Table 3. Results of Bonferroni post hoc test of variables in different study hours

Variable	A significant difference between the two groups		
	< 1h 1-2 h	< 1h > 2 h	1-2 h > 2 h
Forward head	0.08	0.000*	0.010*
Lumbar lordosis	0.042*	0.018*	0.012*

* significant

The results of post hoc test showed that more than 2 h of lying on the stomach during the studying, compared to less than 2 h, had a greater effect on increasing forward head and lumbar lordosis angle in the subjects. Therefore, lying on the stomach for more than 2 h a day led to a further increase in forward head and lumbar lordosis angle in students.

4. Discussion

The results of the present study showed that the mean forward head and lumbar lordosis angle of the subjects increased significantly. However, the difference between other indices (uneven shoulder, dorsal kyphosis, and scoliosis) was not significant. Therefore, it can be said that students who were accustomed lying on the stomachs during studying were more likely to develop abnormalities in lumbar lordosis and forward head angle. Also, the study by lying on the stomach for more than 2 h showed a greater effect on increasing

forward head and lumbar lordosis angle in the subjects. Therefore, lying on the stomach for more than 2 h a day led to a further increase in forward head and lumbar lordosis angle in students. This finding was consistent with some studies [4, 7, 13, 14]. Inconsistent with these results, Ghorbanpoor et al. (2017) showed no significant relationship between resting habits of participants while studying and lordosis [15]. The possible causes of the difference include the posture while resting and the posture duration. In the present study, more than 2 h of lying on the stomach during studying led to an excessive increase in lumbar lordosis angle. This angle was less reported in subjects who studied less than 1 h/day. In terms of spinal abnormalities, lumbar lordosis was the most common in the present study (76.66%) among the subjects. The possible causes of this abnormality, as a result of studying lying on the stomach, are weakening of the serine, abdominal and hamstring muscles, as well as shortening of erector spinae, psoas, iliacus and front thigh muscles [14, 16].

After lumbar lordosis, the forward head angle was significantly higher than standard. So that its prevalence among the subjects was 65.5%. However, the mean of back kyphosis, uneven shoulder and scoliosis were reported to be optimal among the subjects. It seems that head was not okay when lying on the stomach, and by placing it to one side, the person prevents it from bending too much backwards, and has difficulty breathing or stretching and causing pain in the neck muscles and avoiding this posture [4]. The position of the head lying on the stomach while studying is such that it is completely down, so that its weight of 4-5 kg is pulled forward on the spine and over time the neck falls. Over time, the normal curvature of the neck reduces, the length of the spine reduces, the neck muscles become weak, and finally forward head develops [17].

In fact, using poor ergonomics in the workplace and having the wrong posture for a long time and even repetitive movements can lead to muscle imbalance and shortness in some agonist muscles and stretching in some antagonistic muscles. This can be effective on limiting the range of motion of the joints [18]. The posture while studying should be such that the wrong posture in different areas of the body, especially the back, neck, shoulders, arms, hands and wrists are lost and the student can do his homework with a proper posture. This principle is one of the most important principles of physical ergonomics while studying. Also, applying excessive force increases muscle load, fatigue and the risk of injury. Therefore, students should always use principled techniques in accordance with ergonomic science methods while studying and doing homework to reduce the application of excessive force on muscles and joints. For example, not using a table and chair while studying causes incorrect posture, excessive bending of the joints, increased postural stress, fatigue of the supporting muscles, and in the long time permanent elongation of the opening muscles and shortening of the flexor muscles of the spine. On the other hand, studying in a position that restricts the movement of the limbs causes the joints to close and in the long time causes injury and reduces the range of motion of the joints. According to the above and the study results, the more ergonomic while studying, the more an inverse effect on the range of motion of the joints and the range of motion of the joints will reduce [19, 20].

In general, it seems that lying on the

stomach increases the lumbar arch and put a lot of stress on the lumbar disc and the lumbar region in general, especially when the person is in this posture for a long time. In order to reduce the lumbar arch, placing a pillow below the stomach allows the discs to better withstand stress. According to the study results presented in this section, this way of lying puts a lot of pressure and force on the arches of the spine and muscles while studying, but it may not be the sole cause of abnormalities of the arches of the spine [13].

5. Conclusion

The results of the present study showed that spinal abnormalities such as lumbar lordosis and forward head are common in students who study lying on the stomachs and repeat this for at least 2 h a day. Also, the results showed that the range of motion of the spine was less and the pain was more than normal. The prevalence of these abnormalities as well as the reduction in range of motion and increasing in pain in these students was due to incorrect posture, excessive bending of the joints, increased postural stress, fatigue of the supporting muscles and in the long run permanent elongation of the extensor muscles and permanent shortening of the flexor muscles of the spine. Also, lack of knowledge of spinal abnormalities and not paying attention to the desired posture increased these abnormalities. The history of various congenital and acquired diseases of the subjects is one of the limitations of this study. It is suggested that health experts provide the necessary instructions to students to observe correct ergonomics while studying.

Conflict of interest

The authors declared no conflicts of interest.

Authors' contributions

All authors contributed to the original idea, study design.

Ethical considerations

The author has completely considered ethical issues, including informed consent, plagiarism, data fabrication, misconduct, and/or falsification, double publication and/or redundancy, submission, etc.

Data availability

The dataset generated and analyzed during the current study is available from the corresponding author on reasonable request.

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