Original Article

Comparing the Normal Range and Changes Process of Lumbar Curve in Male and Female Students Aged 10 to 18 Years

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A R T I C L E   I N F O

A B S T R A C T

Background: In recent years, several studies on the body posture have been done at schools, most of which have shown a high prevalence of varying abnormality among students. The aim of this study was to investigate the normal range and changes process of lumbar curve in students, both girls and boys, in the age group of 10 to 18 years.

Methods: A total number of 1800 students (male and female), in the age group of 10 to 18 years were selected to participate in the present study. The student samples were chosen from the different cities of the Isfahan province in a randomized and clustered manner. Each age category included 100 male and female students each. The flexible ruler was used to measure the lumbar curve angle. The factorial ANOVA method, in SPPS16, was used for data analysis with α=0.05.

Results: The data analysis showed that the age changes factor and gender factor have a significant effect on lumbar curve changes in the level of P<0.05. However, the interaction between gender and age was not significant (P>0.05). This means that the changes process is similar in both gender groups.

Conclusion: The lumbar curve angle is generally higher in girls. Moreover, this angle increases in both genders as age increases to 18 years. The extent of the lumbar curve exceeds the normal limit in girls after 13 years of age with the onset of puberty, which means that girls in this age group need additional attention from the concerned authorities in order to prevent spinal abnormalities.

Introduction

Body posture is commonly described as the relative arrangement of the different parts of the body in relation to each other. In fact, the desired body posture is a state of musculoskeletal balance which protects the supportive structures of the body against injury or deformity. It is believed that the musculoskeletal balance is responsible for both, the optimal performance of muscles as well as exerting the least pressure to the body [1]. Abdominal pain and headaches are the most common types of pain

among children in the early years of entering school; however, in later years including the high school period, children's common pain types become similar to those of adults, with most of the prevalent pains observed in the musculoskeletal system [2]. Therefore, attention to the role of the spine and examining its trend of changes and development is of high importance, particularly since the spine as the movement axis of the body could suffer from injuries and abnormalities due to various physical activities and causes [3].

Lumbar lordosis is a curve of the spine with a forward convex and a backward concavity. This curve provides the required control against pressure resulting from the force of gravity, while simultaneously offering a certain amount of movement and flexibility to the body [4]. Normal

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lumbar lordosis protects the posterior ligament system against excessive strain and acts as a shock absorbing agent against sudden application of vertical forces [5]. An increase in the lumbar curve, called hyperlordosis, may have dangerous complications for individuals suffering from this deformity. In this complication, the movement is restricted due to the severe lumbar curve, causing the patient to incline his/her legs sideways while walking, with the body weight being pushed backwards on the heels in order to prevent imbalance or falling forward [6]. Commonly, the space between the vertebrae L_5 and S_1 increases in the anterior region and decreases in the posterior region, which in advanced cases, causes lesions in the posterior part of the lumbar disc, leading to pain in the lumbar region [7].

In recent years, numerous studies have been conducted in schools on body posture and deformities; many findings indicate a high incidence of various skeletal deformities among students. These deformities cause the body to disengage from a normal biomechanical state and impose abnormal and unusual pressures on the joints and muscles, which in the long run, causes discomfort that could even lead to disability in some cases [8]. Therefore, studying information on the normal range of lumbar curve is necessary. In a study by Rajabi et al., aimed to provide the norms for lordosis and kyphosis curve, it was found that the degree of the lordosis curve increased to 45–65 degree with increase in the age but decreased thereafter [9]. Taheri et al., during a study with the aim of determining the norms for lordosis and kyphosis curve among male students, showed that the lordosis curve degree decreased from the age of 12 to 14 years and then increased from 14 to 17 years [10]. In a study by Williamson using a flexible ruler, it was observed that the lordosis angle increased with age in both males and females, but this increase was not significant. They also indicated that this increase in the lordosis angle was higher among girls than boys [11]. Giglio et al. in a study using a pantograph on 718 subjects in the age range of 7 to 18 years, stated that the degree of the lumbar curve increases as the age increased [12].

Using a valid, reliable, safe, portable, and low-cost technique along with measurement tools is important in any research pursuit. In addition, the measurement of lumbar lordosis using a flexible ruler is considered a noninvasive, quick, user-friendly, and harmless method. This tool was used in several studies for lumbar lordosis measurement, where four lumbar lordosis measurements were used with its validity and reliability reported to be high by researchers [13]. Considering the importance of the lumbar curve in daily routine activity as well as its abnormalities and associated problems, through this study we decided to assess the trend of changes of this arc in girls and boys during the ages of maximum growth spurt in the province of Isfahan, Iran.

Methods

The statistical population considered were students, both male and female, from the Isfahan province in 2016. A total of 1800 students in the age range of 10 to 18 years

participated in this study. The subjects were selected as random clusters from different cities of the Isfahan province. The samples were selected from 12 schools in eight different cities.

Inclusion Criteria

This included government school students, having no history of spinal fractures, with no disease complications.

Exclusion Criteria

Students that indulged in exercises that affected the spinal column as well as those unwilling to undergo the tests were excluded.

Finally, 100 female students and 100 male students from each age group participated in the study. The height and weight of the participants were measured.

A flexible ruler was used in order to measure the lordosis curve. Seidi et al. (2009) in a study on the validity and reliability of a flexible ruler to measure the lumbar lordosis, indicated a high validity and reliability (89% and 92%, respectively) for this tool [13]. The vertebrae L_1 and L_5 were first identified and marked for measuring of the lumbar curve. Then the flexible ruler was placed on the spinal column and a gentle pressure was applied so that the ruler take the form of the spinal column. Then points L_1 and L_5 were marked on the ruler, the ruler was removed slowly from the vertebrae column and placed on the paper, and its marks were specified after drawing the arc on the paper. In the next step, in order to obtain quantitative data, the two points specified on the arc were connected to each other, and then the length of this line was recorded and designated with L. Moreover, the deepest part was determined and measured in order to obtain H. In the last step, in order to obtain the angle of curve, L and H of each was substituted in the formula

$$\theta = 4 arc\, tan(2H/L) \quad [14].$$

Due to the presence of two factors, namely gender and age groups, the factorial analysis of variance method was used in order to analyze data in the SPSS software version 16, with the significance level of the findings set at 0.05. Furthermore, EXCEL software was used to draw the graphs and tables (Figure 1).

Results

Table 1 represents the participants' demographic information.

The information on Factorial ANOVA is provided in Table 2; the first row shows the gender information. As can be observed, these changes are significant at P<0.05 level (P≤0.001), i.e. the change in the lumbar lordosis angle between both the genders is significantly different. The second row of the table includes data on the age group variation. The data in this row indicates significant changes in lordosis for the different age groups (P≤0.001). The third row of this table is related to the interaction between gender and the age group. The results of this section, contrary to the previous two results, are not significant (P=0.14). This indicates that the trend of
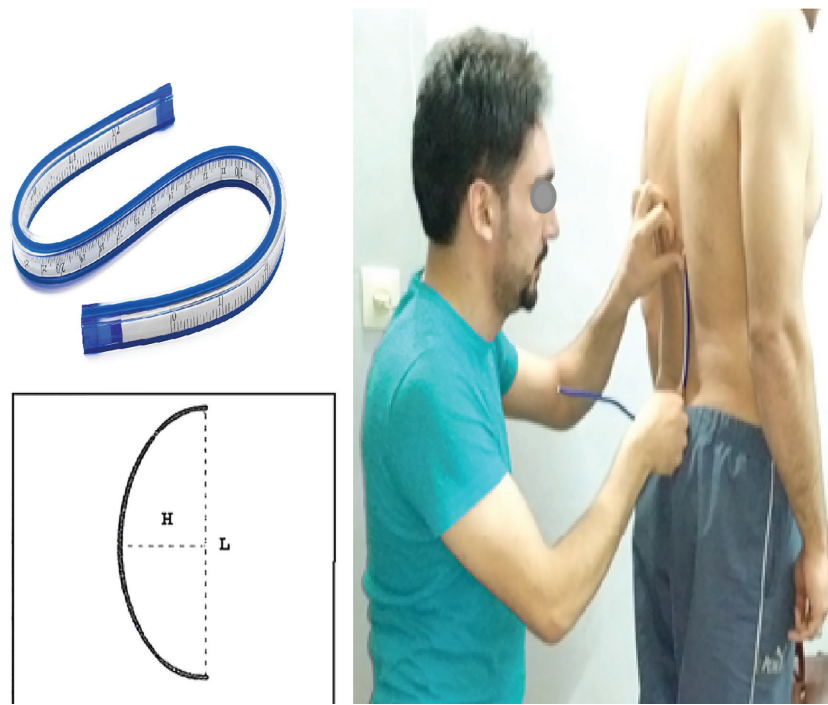
Figure 1: Flexible ruler measurement method

Table 1: Participant demographic data (height (m) and weight (kg))

Ages		10	11	12	13	14	15	16	17	18
Boys	Height	1.4±0.7	1.41±0.6	1.45±0.7	1.5±0.8	1.56±0.8	1.62±0.7	1.68±0.7	1.7±0.8	1.72±0.7
	Weight	33.4±5.9	34.8±6.8	36.6±7.4	40.2±8.3	44.2±9.6	52.3±9.2	57.9±8.9	63.8±8.6	66.2±7.8
Girls	Height	1.42±0.8	1.44±0.7	1.47±0.9	1.51±0.8	1.55±0.9	1.56±0.6	1.58±0.5	1.6±0.9	1.61±0.7
	Weight	35.1±6.2	38.2±7.3	40.6±9.9	45.1±8.8	45.5±9.7	47.5±7.9	50.6±6.8	52.2±7.3	54.9±5.9

Table 2: Results of the Factorial ANOVA test

Source	Sum of Squares	df	Mean Square	F	Sig.
Gender	1984.9	1	557.6	228.1	0.00
Ages	980.09	8	559.8	11.9	0.00
Gender* ages	131.91	8	2180.2	1.4	0.14

changes in lordosis between the two genders does not differ with increase in age, or, in other words, the trend of changes is the same across both gender groups, as obvious from Figure 2. As seen in this figure, the slope of changes is almost the same and identical in both the gender groups.

Discussion

Good posture alignment is the knowledge that everyone should be familiar with its principles and observe them in his/her life, in order to benefit from the comfort of the body while preventing skeletal abnormalities. This
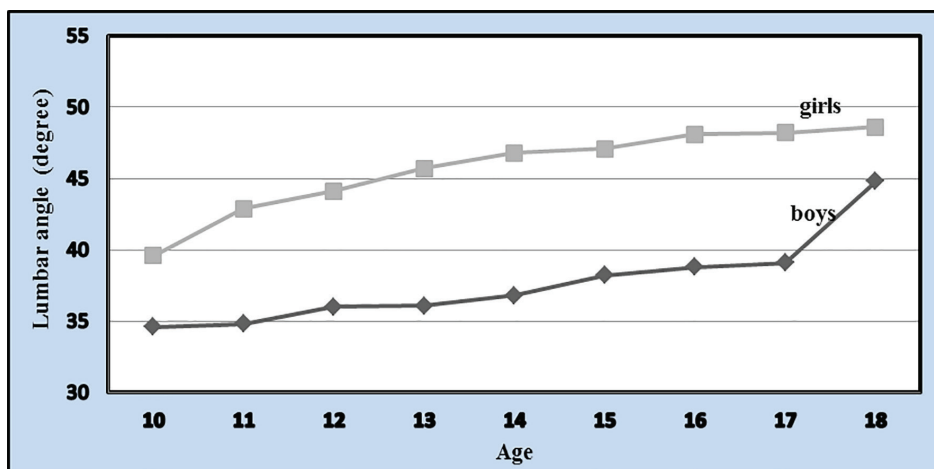

Figure 2: Graph of linear changes in lumbar lordosis curve in the two gender groups.

requires recognizing standard natural conditions and getting familiar with the weaknesses and abnormalities in the body posture as well as investigating the incidence of each of them in various communities [15]. Lumbar curve is a most important part of the spinal column, which is particularly important due to its unique position and direct relation with the pelvis. Any increase or decrease in its angles affects body balance and causes various abnormalities in the lumbo-pelvic region [16]. The prevalence of spine deformities among young adults has been reported more than 60% in various studies [17]. Therefore, in case of lack of timely detecting and treating these deformities, irreversible outcomes will emerge, including muscle fatigue, joint deformations, body biomechanical imbalance, psycho-social problems, and muscular-nervous pains [18]. This study was done with the aim to determine the lumbar lordosis among girls and boys and its trend of change during the main growth ages.

The findings obtained from the study indicated a significant difference in gender in lumbar lordosis ($F_{(1, 8)}$=228.1, P≤0.001); this difference is greater among girls according to the data in table 2 and figure 1. Moreover, changes in different age groups are significant. This means that the lumbar curve increases with an increase in age. This increase in lumbar lordosis with the age increase is not unexpected, as the progression of life years along with changes in soft tissues and mineral content of bones, especially the vertebrae influenced by this change, shows changes based on increase or decrease in curve angle [19]. The insignificant interaction of gender and age is another important issue. This indicates similar changes in both genders along with the age increase among participants. These changes are as the increase in the level of the lumbar curve

The normal range of the lumbar curve angle is 20 to 45 degrees [14]. Considering the mean angles among different age groups, the changes in angle are in the normal range among boys during the ages 10 to 18 years, however, this angle exceeds 45 degrees, which is the normal limit of the lumbar lordosis angle, among girls since the age of 13, which naturally requires more attention to this age group among girls. In the early stages of the adolescence period, a rapid phase of physical growth, wrong sitting habits, and placement of the body in inappropriate posture for long-term can cause problems in the lumbar region of these individuals [14]. Paying attention to this important point can be greatly useful in the timely prevention of this complication.

The girls' growth puberty usually begins at the age of 9 years, however, the boys' growth puberty starts at about 11 years of age. The growth rate of boys gradually stops at age 17 and significantly increases at the end of the age of 18 years [20]. The results of the present study are in a high agreement with the mentioned trend. As can be seen in figure 1, this growth trend among girls from the age of 10 years old, which is of the ages of the onset of growth mutation in girls, has a faster increase in growth and with passage from this age and getting farther from this trend, its increasing trend decreases. In addition, if

the slope of the line indicates the changes in the boys' group, the growth trend of the lordosis angle quickens from the age of 11 and continues until the age of 17, and is accompanied by a significant increase at the end of the age of 18 years.

The results obtained from the study showed an increase in lordosis angle in both genders with increasing age. This is consistent with the studies by Rajabi, Williamson, and Giglio [9, 11, 12]. Furthermore, the results indicated more lordosis angle among girls than boys; this was also consistent with the results of the research by Williamson. Furthermore, Letafatkar et al. found that the rate of lumbar lordosis among women was more compared to men [21]. Zulugan also showed that the level of lumbar lordosis among women is far more than that of men [22]. Youdas et al. indicated that gender has a great impact on the lumbar curve in the standing position, in addition, women have more lumbar arch relative to men in the standing position. In their study, the mean lumbar curve of women was about 6.5 degrees higher than men [23]. Daneshmandi et al. in a research, generally found the rate of deformities among girls to be higher than boys; this can be due to social constraints and, hence, their less participation in physical activities [15]. In a study carried out by Nourbakhsh et al., the degree of lumbar lordosis among women was obtained higher than that of men in the same age. They stated that long-term sitting and also inactive lifestyle can result in increased lumbar lordosis degree and eventually, lower back pain. Moreover, in their research, it was found that the degree of lumbar curve has a positive relationship with age, number of pregnancies, and height of subjects [24]. Various studies have indicated the relationship between lumbar lordosis with sacrum slope [25, 26]. Given the fact that the lordosis value is associated with the angle of the fifth lumbar vertebra and sacrum, this angle is higher among women compared to that of men, and finally, the lumbar curve of women is greater [27]. In addition to this, women have less muscular power than men. Furthermore, more pressure is applied to the vertebral column during the menstrual period. Also, secretion of the Relaxin hormone in women has a loose effect on all joints of the body, including the vertebral column [28, 29], which can be because of the greater lumbar lordosis angle among women compared to men.

Conclusion

Therefore, the present study was carried out with the aim to provide a clear image of the normal state of the lumbar curve angle among students with the age of 10 to 18 years, which is one of the most important age periods of every individual. Therefore, the possible anomalies can be timely diagnosed, hence, this problem can be prevented and treated using corrective exercises which are of the most important areas of physical education.

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Conflict of interest: None declared.

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