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For further information about this article or if you need reprints, please contact:

Fateme Ghiasi
Department of Physiotherapy,
Razmjo-Moghadam Lab,
Kafami St,
P. O. Box 98136-64855,
Zahedan, Iran

Tel/Fax: +98 541 3254207

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The Relationship between Lumbar and Thoracic Curves with Body Mass Index and Low Back Pain in Students of Zahedan University of Medical Sciences

Mohammad Hoseinifar, Fateme Ghiasi and Asghar Akbari

Epidemiological evidence shows that low back pain is a multi-factorial problem. There may be an abnormality in spinal curves or Body Mass Index (BMI) above 25 kg m^{-2} was correlated to low back pain. The purpose of this study was to evaluate the relationship between spinal curves with BMI and low back pain. In 2006, an analytical cross-sectional study was conducted in Zahedan University of Medical Sciences. Three hundred subjects were assigned to either a control group (N = 150) or a low back pain group (N = 150) through simple non probability sampling. Lumbar lordosis and thoracic kyphosis was measured using flexible ruler. The body height (m), weight (kg) and BMI were measured with a standard clinical scale. The obtained data was analyzed using Pearson correlation and independent t-test. The mean angle of kyphosis and lordosis was 23.7±7.8 and 27.9±8.9 in healthy group and 23.7±8.1 and 25±11.4 in low back pain group, respectively. No significant difference was seen between chronic low back pain and healthy subjects in terms of angle of kyphosis and lordosis ($p>0.05$). There was no significant relationship between thoracic kyphosis and BMI ($p = 0.79$). However, a significant relationship was seen between lumbar lordosis and BMI ($p = 0.02$). The results showed that increased BMI, changes in lumbar lordosis and thoracic kyphosis may not individually lead to low back pain. Perhaps combination of several factors resulted in low back pain occurrence.

Key words: Low back pain, BMI, lumbar lordosis, thoracic kyphosis

Department of Physiotherapy, Zahedan University of Medical Sciences, Zahedan, Iran

INTRODUCTION

Back pain is a common condition which has been described as a serious public health problem (Rodacki *et al*., 2005). It has been estimated that over 80% of the population will report low back pain at some point in life (Jones and Macfarlane, 2005). Despite developments in modern medicine in general and growing knowledge of spinal diseases, the problem of nonspecific low back pain remains unsolved (Liebenson, 1996; Waddell and Waddell, 2000; Koes *et al*., 2001).

Approximately 40% of low back pain patients worry that pain affects their work ability, that it will cripple them (Waddell, 1998). Low back pain is a large and increasing problem in the western world (Frymoyer, 1996). It is also common among children and adolescents; the prevalence varies from 10 to 70%, according to different studies and definition of back pain (Balague *et al*., 1999).

There is ample evidence that low back pain is a multifactorial problem (Magora and Schwarz, 1976; Lavsky-Shulan *et al*., 1985; Buckwalter, 1995; Healy *et al*., 1996; Beattie and Meyers, 1998; Fujiwara *et al*., 1999). Aging, degenerative process, pregnancy and lifestyle might be important factors of back pain (Lavsky-Shulan *et al*., 1985; Hestbaek *et al*., 2006; Mogren, 2006). In a recent publication from a Danish survey, low back pain was correlated to BMI above 25 kg m^{-2} (Harreby *et al*., 1999). Youdas *et al*. (2000) showed that age and BMI were associated with pelvic inclination and lumbar lordosis was associated with only lumbar extension. Sjolie (2004) investigated the association between low back pain and body height, weight, BMI, hip abduction and hamstrings flexibility among adolescents. The results showed that low back pain was associated with BMI. Tuzun *et al*. (1999) did not find any statistically significant differences among the groups for angles of thoracic kyphosis, lumbar lordosis and sacral inclination; both lumbar lordosis and sacral inclination were increased with BMI. Korovessis *et al*. (1999) showed that increased thoracic kyphosis correlated with decreased lumbar lordosis in both groups. Increased thoracic kyphosis was seen more in the low back pain group than in the controls. Lumbar lordosis was more increased in the controls than in the low back pain group. Christie *et al*. (1995) investigated postural aberrations in acute and chronic low back pain and healthy subjects. Chronic pain patients exhibited an increased lumbar lordosis compared with controls. Acute patients had an increased thoracic kyphosis and a forward head position compared with controls. In sitting, acute patients had an increased thoracic kyphosis compared with controls. Jackson and McManus (1994) demonstrated that total lordosis was significantly less in the patients than healthy subjects and was not age or sex-related in both group. Both groups had similar thoracic kyphosis.

Investigators have claimed that anthropometric characteristics such as increased lumbar lordosis (Holt, 1954), body weight (Frymoyer *et al*., 1978), reduced mobility of the lumbar spine (Flint, 1955) and BMI (Sjolie, 2004) may be associated with low back pain and can increase the risk of the low back pain. The main aspects of previous studies which justify further research are: First, the obtained results were inconsistent differences, second, the previous researchers worked on different type's population and sample size, third, kyphosis and lordosis was not compared between low back pain and healthy subjects in previous studies and fourth, the relationship between intensity of back pain with lordosis and kyphosis were not assessed in previous studies. On the other hand, it would be important for physical therapists to know whether clusters of these characteristics, which can be objectively measured during a routine clinical examination, are commonly associated with chronic low back pain (Youdas *et al*., 2000). Therefore, the objectives of this study were to investigate: 1) relationship between BMI with lumbar lordosis and thoracic kyphosis, 2) relationship between pain intensity with lumbar lordosis and thoracic kyphosis, 3) Comparison of lumbar lordosis and thoracic kyphosis in low back pain and healthy subjects groups and 4) relationship between BMI and low back pain.

MATERIALS AND METHODS

Participants: This cross-sectional analytic study was conducted at a physiotherapy department, Razmjo-Moghadam outpatient's clinic, Zahedan University of Medical Sciences, Zahedan, Iran in 2006. A total of 300 non-athlete subjects with chronic low back pain (150 cases) and healthy subjects (150 cases) were recruited through simple non-probability sampling and through an approach to the consultant physician. Patients were selected according to the following inclusion criteria: (1) being current low back pain episode more than 3 months duration, (2) primary complaint of back pain and no leg pain, (3) age between 18-25 years old, (4) no history of neurological, respiratory, musculoskeletal or lower limb pathology and (5) no other physiotherapy program during this study. Healthy subjects were selected according to the following inclusion criteria: (1) no being current low back pain, (2) age between 18-25 years old and (3) no history of illness. Subjects with malignancies, ankylosing spondylitis, severe osteoporosis, osteoarthritis, progressive neurologic diseases, hemophilia, spinal infection, previous spinal surgery, severe psychiatric disease, or severe sciatica with a positive straight-leg raising and pregnancy were excluded. The purpose of the study and testing protocol to be used were explained to the subjects. The study was approved by the local ethical committee and all subjects gave their written voluntary informed consent before participation.

Procedures: The pilot study performed on 50 subjects in two low back pain and healthy groups determined that a total of 150 subjects with confidence at 95% and power at 90% were necessary for each group. A brief questionnaire was used to obtain each subject's history. Subjects were questioned regarding the history of their disease, duration of chronic low back pain and the site of pain.

Assessment procedure

Intensity of pain: Measurement of pain intensity for low back pain group was performed by visual analogue scale (VAS). A VAS for pain intensity from 0 to 100 mm, the zero score is no pain and 100 score is used for highest pain. Pain perception was measured using the visual analogue scale, a responsive pain scale that yields reliable and valid data, derived from the original McGill Pain Questionnaire (Melzack, 1975, 1987).

Anthropometric criteria: All subjects changed from their street attire into shorts to provide adequate exposure of the body. The body height (m) and weight (kg) of each subject were measured with a standard clinical scale. The accuracy of this device was checked on a weekly basis.

BMI defined as the ratio of weight (kg) divided by height squared (square meters) (Millar and Stephens., 1987). Subjects were classified as underweight if the BMI was less than or equal to 20, as having normal weight if the BMI was greater than 20 but less than or equal to 25, as overweight if the BMI was greater than 25 but less than or equal to 30 and as obese if the BMI was greater than 30 (Bener *et al.*, 2003).

Spinal curves measurement: Angle of lumbar lordosis and thoracic kyphosis was measured in standing position with flexible ruler. For lumbar lordosis and thoracic kyphosis measurement, the flexible curve molded to the contour of the subject's thoracic and lumbosacral spine. Two markers were fixed with double-sided adhesive tape to the skin of the spinous processes of T-12 and S-2. These marker positions facilitated lumbar lordosis measurements. Also, two markers were fixed with double-sided adhesive tape to the skin of the spinous processes of T-1 and T-12. These marker positions facilitated thoracic kyphosis measurements.

Sites along the flexible curve that intersected with adhesive dots marking were marked with twist-ties attached to the flexible curve. The shape of the curve's outline was traced on a piece of poster board and marks corresponding to the spinous processes were made along the curve's contour. Quantification of the curve (degrees) was done with a technique that involved drawing a line from one end of curve to other end of it (L line) and then drawing a right angle line from middle of L line to apex of the curve (H line). Then, the amount of curve calculated through following formula:

$$\theta = 4\left[\text{ARCtag}\left(\frac{2H}{L}\right)\right]$$

The intratester and intertester reliability of this method had already proven (Lundon *et al.*, 1998). All of measurements were accomplished in both groups.

Two measurements of each variable were obtained from each subject to permit estimation of intratester reliability. The resting time between two measurements was generally 2-3 min. Red adhesive dots used to mark the spinous processes of T-12, S-2 and T-1, were removed after the first examination and replaced by fresh dots before the second examination. ICCs were greater than 0.89 and on the basis of the ICCs it found that all measurements are reproducible.

Statistics: The data was analyzed with SPSS11. Kolmogorov-Smirnov test for normality was performed for all outcome variables. Leaven's test was used for equality of variances. Correlation between thoracic kyphosis and BMI, thoracic kyphosis and low back pain, lumbar lordosis and BMI, lumbar lordosis and low back pain, low back pain and BMI, were calculated using Pearson test. Amounts of thoracic kyphosis and lumbar lordosis between both groups were compared using independent t-test. Descriptive statistics were used for prevalence of thoracic kyphosis and lumbar lordosis. The level of significance was set at $p<0.05$. All data are presented as mean±SD.

RESULTS

A total of 300 subjects (50 pilot + 250 main trial subjects) met the inclusion/exclusion criteria and all of them were participated in the study. Duration of pain for the low back pain group was 16±3.7 weeks. The mean age, height, weight and BMI (BMI) of the control group was 20.0±1.3 year, 1.70±0.09 m and 68.1±12.9 kg and 23.5±4.2 kg m^{-2} and that of the low back pain group was 21.0±1.3 year, 1.73±0.06 m and 70.1±10.9 kg and 24.2±4.0 kg m^{-2}, respectively (Table 1). The 110 female and 190 male participated in this study. Both groups were matched based on age. This study lasted for 9 months.

Table 1: Demographic data of the control group and back pain group

Parameters	Control group	Back pain group
Age (years)	20.00±1.30*	21.10±1.300
Height (m)	1.70±0.09	1.73±0.060
Weight (kg)	68.10±12.9	70.10±10.90
BMI (kg m^{-2})	23.50±4.20	24.20±4.000

*: Mean±SD

Table 2: Frequency of normal, hypo kyphosis and hyper kyphosis and normal, hypo lordosis and hyper lordosis of both back pain and control groups

	Back pain group		Control group	
Parameters	N	Relative frequency (%)	N	Relative frequency (%)
Kyphosis				
Normal	86	57.2	88	59.1
Hypo kyphosis	50	33.5	47	31.5
Hyper kyphosis	14	9.3	14	9.4
Lordosis				
Normal	44	29.2	51	34.2
Hypo lordosis	97	65.1	94	63.1
Hyper lordosis	9	5.7	4	2.7

Table 3: Comparison of angles of lordosis and kyphosis between two groups

Disease	Back pain group Mean±SD	Control group Mean±SD	p-value
Lordosis	25.0±11.4	27.9±8.9	0.05*
Kyphosis	23.7± 8.1	23.7±7.8	0.98*

**: $p \leq 0.05$ is significant

Table 4: Relationship between angle of lumbar lordosis and thoracic kyphosis with pain and BMI

	Pain intensity		BMI	
Disease	Pearson coefficient	p-value	Pearson coefficient	p-value
Lordosis	-0.06	0.39	0.16	0.02*
Kyphosis	0.04	0.56	-0.019	0.79*

*: $p \leq 0.05$ is significant

Descriptive analysis showed that kyphosis was normal in 59.1% (88/150) of healthy subjects. Hypo kyphosis and hyper kyphosis was seen in 31.5% (47/150) and 9.4% (14/150) of healthy subjects, respectively. The frequency of normal lordosis, hyper lordosis and hypo lordosis in healthy groups were 34.2% (51/150), 2.7% (4/150) and 63.1% (94/150), respectively. Normal kyphosis was seen in 57.2% (86/150) of back pain subjects. Hypo kyphosis and hyper kyphosis was seen in 33.5% (50/150) and 9.3% (14/150) of back pain subjects, respectively. The frequency of normal lordosis, hyper lordosis and hypo lordosis in back pain groups were 29.2% (44/150), 5.7% (9/150) and 65.1% (97/150), respectively (Table 2).

The mean of variables was compared between two groups to determine the difference between two groups in measure of lumbar lordosis and thoracic kyphosis. The mean angle of kyphosis was 23.7±7.8 in healthy group and 23.7±8.1 in low back pain group. Comparison of thoracic kyphosis showed that there was no significant difference between chronic low back pain and healthy subjects ($p = 0.98$). The mean angle of lordosis was 27.9±8.9 in healthy group and 25±11.4 in low back pain group. There was no significant difference between two groups regarding to lumbar lordosis ($p = 0.05$) (Table 3).

The finding showed that there was no significant relationship between angle of thoracic kyphosis and BMI ($p = 0.79$), low back pain and BMI ($p = 0.82$). But, there was significant relationship between angle of lumbar lordosis and BMI ($p = 0.02$). There was no significant relationship between low back pain intensity and angle of thoracic kyphosis ($p = 0.56$) and angle of lumbar lordosis ($p = 0.39$) (Table 4).

DISCUSSION

The findings did not show any significant difference between healthy subject and low back pain patients in terms of angle of lumbar lordosis and thoracic kyphosis. Thoracic kyphosis was not correlated with BMI and low back pain, as well; lumbar lordosis was not correlated with low back pain. However, a significant correlation was seen between lumbar lordosis and BMI. On the other hand, significant correlation was not seen between BMI and low back pain.

Previous reports showed that there were no association between low back pain and degree of lumbar lordosis. Hansson (1985) demonstrated that there was no differences between low back pain subjects and healthy subjects regard to lumbar lordosis and thoracic kyphosis. Youdas *et al*. (2000) not found increased lumbar lordotic curve or angle of pelvic inclination in subjects with chronic low back pain. Day *et al*. (1994) reported no difference in lumbar lordosis and pelvic inclination between subjects with and without low back pain. Likewise, Pope *et al*. (1999) found no difference in the magnitude of lumbar lordosis between adults without low back pain and patients with chronic low back pain. Tuzun *et al*. (1999) concluded that there were no statistically significant differences among the acute low back pain, chronic low back pain and healthy group for angles of thoracic kyphosis, lumbar lordosis and sacral inclination. In contrast, Korovessis *et al*.(1999) showed that increased thoracic kyphosis, especially in the sixth decade, was seen more in the low back pain group than in the control group and Lumbar lordosis, especially in the sixth decade, was more increased in the controls than in the low back pain group. The different results may signify that perhaps the subjects in the study by Korovessis (1999) had different types of age (young to adult). Christie *et al*. (1995) reported that chronic low back pain patients exhibited an increased lumbar lordosis compared with control group and acute patients had an increased thoracic kyphosis and a forward head position compared with control group. There were different type of methods and position assessment in study by Christie *et al*. (1995). Jackson and McManus (1994) suggested that total lordosis was significantly less in the patients and was not age or sex-related in low back pain group and healthy subjects. This result also reported by Tsuji *et al.* (2001). Patients tended to stand with less distal segmental lordosis, but more proximal lumbar lordosis. Both groups had similar thoracic kyphosis (Jackson and McManus., 1994; Tsuji *et al*., 2001). Although there is controversy in this regard, because the result of majority of study was in accordance to this study, it may be concluded that there is no differences in lumbar lordosis and thoracic kyphosis between low back pain and healthy subjects.

Based on the other finding of this study, there was no correlation between thoracic kyphosis and BMI, but there was correlation between lumbar lordosis and BMI. Tuzun *et al.* (1999) demonstrated increase of both lumbar lordosis and sacral inclination with BMI. The results of Tuzum *et al.* (1999) were the same as this study. They found that lumbar lordosis was increased with high amounts of BMI and therefore there is association between BMI and lumbar lordosis in low back pain and healthy subjects. They also reported that there were no differences between two groups regarding lumbar lordosis and thoracic kyphosis. Kamali *et al.* (2004) showed that increase in body weight can increases lumbar lordosis. This result also reported by Ahey *et al.* (1997).

We did not find any correlation between lumbar lordosis and thoracic kyphosis with low back pain intensity. Tsuji *et al.* (2001) mentioned that visual analogue scale was significantly inversely correlated with lumbar lordosis. Although this finding is not completely in line with this study, but it may be concluded that lumbar lordosis and thoracic kyphosis are not considerable factors for pain intensity.

This study did not show any correlation between BMI and low back pain. Han *et al.* (1997) showed that there were no significant correlation between BMI and reporting low back pain symptoms in men, but women who are overweight or with a large waist have a significantly increased likelihood of low back pain. Yip *et al.* (2001) found no association between excessive weight, tall stature and an increased risk of low back pain prevalence in middle-aged women. This result also reported by Orvieto *et al.* (1994) and by Mirtz and Greene (2005). They concluded that there is a lack of a clear dose-response relationship between BMI and low back pain. The findings of above mentioned studies are in accordance to findings of our study regard to correlation between low back pain and BMI. In other studies, different results have been shown. Milgrom *et al.* (1993) and Garzillo and Garzillo (1994) believed that low BMI is a risk factor for lumbar pain and increased lumbar lordosis a risk factor for thoracic pain. In contrast, Sjolie (2004) investigated association between BMI and low back pain in adolescents and suggested that low back pain was associated positively with a higher than mean BMI.

The BMI above 25 kg m^{-2} (Youdas *et al.*, 2000) increases the risk of lumbar disc degeneration and overweight at young age seems to be particularly detrimental (Raty *et al.*, 1997; Liuke *et al.*, 2005). Also Toda *et al.* (2000) cited that trunk and lower extremity loss of muscle mass and central obesity may be risk factors for chronic low back pain as mentioned by Mogren (2006) and Rodacki *et al.* (2005). Different findings of above studies may be related to some differences in population, age and design of studies. In present study participants had age between 18-25 years old, thus they had not degenerative change in lumbar region and also, they had not over weight or BMI above 25 kg m^{-2}.

The results did not demonstrate relationship between low back pain and thoracic kyphosis with BMI. Risk factors of low back pain still remain unclear. Therefore, changes of BMI and spinal curves may be not only risk factors for low back pain. Thus, this study recommended that a longitudinal study will be done in this regard on subgroups of low back pain patients to compare and to investigate the relationship between the different variables such as lordosis, kyphosis, BMI and pain intensity.

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