Original Article

Correlation between body mass index with thoracic and lumbar curves in female students at Jouf University

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ABSTRACT

Increasing body mass index (BMI) may affect the angles of the thoracic and lumber spines due to an increase in the load on spinal curvature and weakness of paraspinal muscles. This study aimed to detect the relationship between BMI with lumbar and thoracic curves and examined the relationship between waist circumference and lumbar curve in young females. Sixty-five female participants were recruited from Jouf University, ten participants were excluded. Age was between (18 and 25 years old) with a BMI (of 18.5–34.9 kg/cm2). Waist circumferences were measured using tape measurement. With a flexible ruler, the lumbar lordosis and thoracic kyphosis angles were measured from a standing posture. Body mass index had a non-significant correlation with thoracic kyphosis ($p = 0.966$) while, it had a moderate positive significant correlation with lumber lordosis ($p = 0.001$). Waist circumference had a moderate positive significant correlation with lumber lordosis ($p = 0.001$). The positive correlation of lumbar lordosis with BMI and waist circumference refers to changes in lumbar lordosis angle, while there was no correlation between BMI and thoracic kyphosis.

Keywords: Body mass index, Lumber lordosis, Thoracic kyphosis, Waist circumference, Female

Introduction

The kyphotic posture most commonly affects the thoracic spine which may lead to severe complications such as increase the incidence of degeneration process, spinal dysfunction, pain and may cause death [1]. Kyphotic posture had been related to the weakness in the extensor muscle group, decrease range of motion of the spinal extension, discomfort in the lumbopelvic region, abnormalities in the posture, deficiency of sensation, and changes in activation of muscles with improper scapular alignment [2-4]. The impairment in respiratory function and poor quality of life are caused by the kyphotic posture [5-9]. Furthermore, hyper-kyphosis compromises postural stability. It was reported that the main function of the thoracic spine in combination with the lumbar spine with other body parts can maintain the stability of the erect posture, provide kinesthetic awareness and maintain head stability [8, 10, 11].

Spinal curves from the sagittal plane, particularly lumbar lordosis, are required for successful weight bearing, increased paraspinal muscle efficacy, and sustained proper posture [12, 13]. Loading on the facet joint and disc increases as lumbar lordosis shifts to hypo or hyperlordosis, causing nerve root compression, disc and facet joint degeneration, paraspinal muscles' contraction, and paraspinal ligaments' sprain [14-16]. The risk of chronic low back pain can raise with higher lumbar lordosis due to changing the activation of back extensor muscles [17].

Anthropometric measurements have been favored for regular clinical usage due to their ease of assessment and inexpensive. For

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assessment of obesity and the distribution of fat, the circumference of the waist and body mass index (BMI) is often used [18].

In adults, BMI is used to describe the weight-to-height ratio (kg/m2) [19]. BMI from 15 to 19.9 kg/m2 is defined as underweight, BMI from 20 to 24.9 kg/m2 is defined as normal weight, BMI from 25 to 29.9 kg/m2 is defined as overweight, and BMI from 30 to 35 kg/m2 or above is defined as obese [20]. Variations in body composition can cause a variety of physical and physiological health issues, including postural issues. Causes include improper posture accompanied by the use of technology, an inactive lifestyle, and inadequate nutrition may change posture and spinal alignment in modern life [21]. BMI greater than the normal range may enhance the angles of thoracic kyphosis and lumbar lordosis, whereas BMI lower than the normal range may lead to scoliosis and improper spinal alignment [22, 23]. Other spinal disorders, such as lumbar and neck pain, may result from these changes in spinal alignment, resulting in a considerable increase in healthcare costs [24].

In previous studies, a significant relationship between BMI and lumbar lordosis has been found [25-27]. Furthermore, the degree of lumbar lordosis was found to have a weak relationship with the waist circumference while there was no relation with the waist-hip ratio [18]. The majority of research that has assessed the angle of lumbar lordosis in obesity has found a relationship between BMI and lumbar lordosis [18, 26, 28, 29]. However, previous studies didn't focus on the relationship between BMI and the thoracic spine or the relation of waist circumference with the lumber curve. So, the main aim of the present study is to detect the relation of BMI with thoracic and lumbar curves. In addition to the relation of waist circumference with the lumbar curve.

Materials and Methods

The present study is a cross-sectional study. Sixty-five female Participants were recruited from Jouf University, ten participants were excluded. Participants were to be between the ages of 18 and 25, have a BMI of 18.5–34.9 kg/cm2, be non-exercising, non-smoking, and have maintained their present body weight for the preceding three months. The exclusion criteria were participants with untreated diabetes mellitus, amputation or joint replacement surgeries, history of chronic low back pain for at least 4 months or pain during testing, spinal disorders and previous spinal surgeries, pregnant women, BMI <18.5kg/cm2, malignant tumors, ankylosing spondylitis, infection of the spine, progressive neurologic disorders, hemophilia, severe psychological disorders or positive straight-leg raising test indicating the severe degree of sciatica with and leg length discrepancy (>2 cm). The sample size was calculated by using the G*Power 3.1 program, with a power of 80%, an effect size of 0.291, α errors of 0.05, and. The required sample size was ٥0 patients. The period of study was from January to May 2022. Recruitment occurred through advertisements in the university. All participants signed the written informed consent. All the medical exams were done on the same day.

Procedures

Body height and weight were measured to the closest 1 kg using anthropometrics. The same supervisor measured the waist circumference twice using the world health organization technique (waist circumference was measured 3 cm above the anterior superior iliac spine) [18]. The umbilicus was used to measure the circumference of the waist as the reference point [30].

Thoracic and lumbar curves measurement

With a flexible ruler, the thoracic kyphosis and lumbar lordosis angles were assessed from a standing posture. The ruler conformed to the shape of the participant's thoracic and lumbar curves. Two markers with adhesive tape were applied to the spinous processes T-12 and S-2. The positioning of these markers made it easier to assess lumbar lordosis. Two markers were also applied to the skin of T-1 and T-12's spinous processes. The placement of these markers made thoracic kyphosis measurements easier. Twist-ties affixed to the flexible ruler were used to identify sites where the adhesive tape marking crossed. On a piece of paper, the outline of the curve was sketched, and markings matching the spinous processes were made along the contour of the curve for measurement of the degree of the curve. Two measurements were performed for each variable to allow an estimate of the reliability with 2-3 minutes of rest between the two measurements. The sticky points that were used to identify the spinous processes were replaced after the first examination by the new points before the second examination, the measurements were taken by the same examiner for all [25].

Statistical analysis

Quantitative variables were summarized using mean and standard deviation. Pearson correlation coefficient was conducted to investigate the correlation between BMI with thoracic kyphosis and lumber lordosis and between waist circumference with lumber lordosis. The level of significance was set at $p < 0.05$ for all statistical tests. The statistical package for social studies (SPSS) version 25 for windows was used.

Results and Discussion

Subjects characteristics

Fifty-five female subjects were included in the present study. The mean ± SD for age and BMI were 20.72± 1.17 years and 27.26± 5.54 kg/m² respectively. The mean ± SD for waist circumference was 82.45±10.02 cm. **Table 1** showed the participant characteristics.

Table 1. Participant characteristics.

	Mean ± SD	Maximum	Minimum
Age (years)	20.72± 1.17	23.00	18.00

Weight (kg)	67.29± 12.58	90.00	43.00
Height (cm)	158.03± 5.99	172.00	144.00
BMI (kg/m²)	27.26± 5.54	41.58	18.50
Waist Circumference (cm)	82.45±10.02	106.00	65.00

SD, Standard deviation

Correlation between BMI, thoracic kyphosis, and lumber lordosis

There was a non-significant correlation between BMI and thoracic kyphosis (p = 0.966) **(Figure 1)**. There was a moderate positive significant correlation between BMI and lumber lordosis (p = 0.001) **(Figure 2 and Table 2)**.

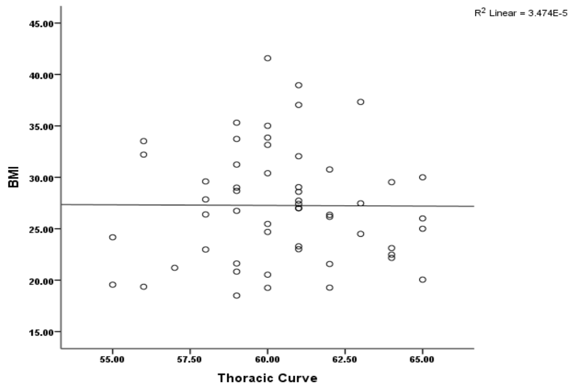

Figure 1. Correlation between BMI and thoracic kyphosis

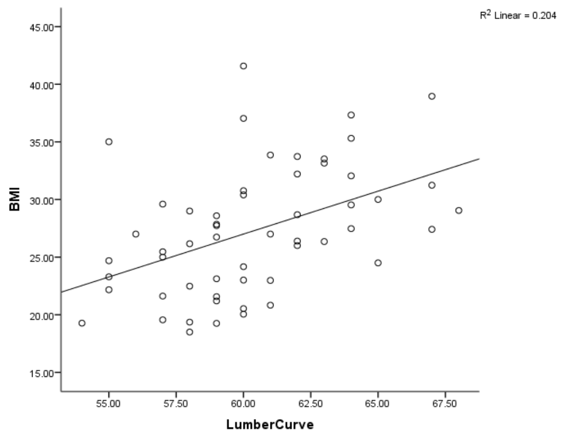

Figure 2. Correlation between BMI and lumber lordosis

Table 2. Correlation between BMI, thoracic kyphosis, and lumber lordosis

		r value	p-value
BMI	Thoracic kyphosis	-0.006	0.966
	Lumber lordosis	0.452	0.001

p-value, the Probability value

Correlation between waist circumference and lumber lordosis

There was a moderate positive significant correlation between waist circumference and lumber lordosis (p = 0.001) **(Figure 3 and Table 3)**.

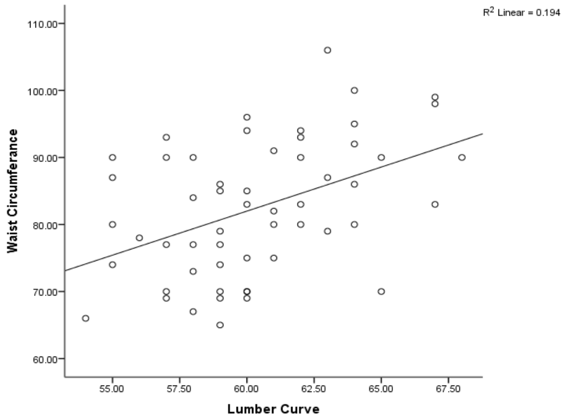

Figure 3. Correlation between waist circumference and lumber lordosis

Table 3. Correlation between waist circumference and lumber lordosis

		r value	p-value
Waist circumference	Lumbar lordosis	0.441	0.001

p-value, the Probability value

The present study assessed the correlation between body mass index, thoracic and lumbar curves, and the correlation between waist circumference with lumber lordosis between normal, overweight, and obese individuals. The results indicated that as the BMI increases there is an increase in the lumbar lordosis with no changes in the thoracic kyphosis while increasing in the waist circumference refers to changes in the lumbar lordosis.

The findings of the present study come following the findings of a study by Hoseinifar *et al.* who found that there was no significant relationship between BMI and thoracic kyphosis while there was a relation between BMI and low back discomfort [25]. However, there was a statistically significant relationship between BMI and lumbar lordosis. This result is due to the age of participants being between 18 and 25. So, they did not have degenerative changes in the lumbar area, nor they had a BMI of more than 25 kg/cm2. Vismara *et al.* found that obesity increases the anterior pelvic tilt angle as compensation for the anterior displacement of the center of mass, which increases the sacroiliac joint flexion [31].

In addition, Song *et al.* conducted a study on premenopausal females, aged 21-45 years [18]. The results found that BMI was substantially linked to lumbar lordosis. The BMI is assumed to reflect height and weight, which determine body form. After correcting the body weight, the significant relation was lost. Obesity-related changes in body form may have an impact on mechanical structure such as different musculoskeletal diseases.

In line with our results researchers found that increasing the body weight produces modification within the structure of the spinal curves which can afterward cause lumbar lordosis [32]. Moreover, an increase the body weight causes the gluteal muscles to be weak which allows the pelvic girdle to shift ventrally, increasing the inclination angle of the pelvis and inducing lumbar lordosis angle. The paravertebral muscles shorten with obesity as a result of continual contraction for maintaining an erect posture, pulling the spinal curve backward and increasing the lordosis.

Our findings are also supported by the results of Widodo and Wahyuni [33], who found a relationship between obesity and an increase in lumbar lordosis. Fifteen female and male individuals who were overweight and obese were included in the study. They found that the greatest depth of lumbar lordosis was found in the obese subjects with a depth rate of 54 mm. It occurs as a result of obesity that alters the line of gravity and weakens the muscular arrangement of the trunk, resulting in axial loads being received only by the spinal curves, particularly the lumbar curve. The torso's muscular organization is also compromised, particularly the ventrolateral abdominal muscles. The degree of lumbar lordosis is higher in females.

The waist circumference is related to lumbar lordosis in our finding which is consistent with the results of Song *et al.* who found a correlation between waist circumference and lumbar lordosis in obese females [18]. This is due to the altered body shape caused by obesity may have an impact on the mechanical structure and different musculoskeletal problems.

On the other hand, Taweetanalarp and Purepong [34] found that waist circumference did not have a relation with obesity. This may be due to the inclusion of obese participants only, rather than overweight participants. It's possible that the waist measurement isn't large enough to demonstrate a correlation.

Limitations

This study had some limitations including the inability to generalize the results of this study as it was done only on female participants and their age was from 18-25 years; all participants were students with sedentary lifestyles and small sample size. In addition, underweight students were not included in the study.

Recommendations

Further studies are recommended to be conducted on large sample size. Other studies are recommended to be done on male patients and to compare males and females. Future studies can be applied to another age group for example 30-40 years. Other methods can be used for assessment of the spinal curves, such as photogrammetry, X- ray, moire topography, or an electromagnetic tracking device [35].

Conclusion

In the present study, no relation was found between BMI and thoracic kyphosis while there was a moderate positive significant relation between BMI and lumbar lordosis, and between waist circumference and lumber lordosis. This indicates a direct effect of increasing BMI and waist circumference on the shape of lumber curvature.

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Conflict of interest: None

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Ethics statement: This study was conducted following the Declaration of Helsinki standards and approved by the research ethics committee Qurayyat Health Affairs, Jouf, Saudi Arabia (No: H-13-S-071).

References

1. Khakhali-Zavieh M, Parnian-Pour M, Karimi H, Mobini B, Kazem-Nezhad A. The validity and reliability of measurement of thoracic kyphosis using flexible ruler in postural hyper kyphotic patients. J Rehabil. 2003;4(3):18-23.
2. Katzman WB, Wanek L, Shepherd JA, Sellmeyer DE. Age-related hyperkyphosis: Its causes, consequences, and management. J Orthop Sports Phys Ther. 2010;40(6):352-60. doi:10.2519/jospt.2010.3099
3. Cheshomi S. The relationship between thoracic kyphosis curvature and subacromial space. WASJ. 2013;14(7):1072.
4. Ludewig PM, Reynolds JF. The association of scapular kinematics and glenohumeral joint pathologies. J Orthop Sports Phys Ther. 2009;39(2):90-104. doi:10.2519/jospt.2009.2808
5. Dolphens M, Cagnie B, Coorevits P, Vanderstraeten G, Cardon G, D'hooge R, et al. Sagittal standing posture and its association with spinal pain: A school-based epidemiological study of 1196 Flemish adolescents before age at peak height velocity. Spine (Phila Pa 1976). 2012;37(19):1657-66. doi:10.1097/BRS.0b013e3182408053
6. Kado DM, Huang MH, Barrett-Connor E, Greendale GA. Hyperkyphotic posture and poor physical functional ability in older community-dwelling men and women: The Rancho Bernardo study. J Gerontol A Biol Sci Med Sci. 2005;60(5):633-7. doi:10.1093/gerona/60.5.633
7. Di Bari M, Chiarlone M, Matteuzzi D, Zacchei S, Pozzi C, Bellia V, et al. Thoracic kyphosis and ventilatory dysfunction in unselected older persons: An epidemiological study in Dicomano, Italy. J Am Geriatr Soc. 2004;52(6):909-15. doi:10.1111/j.1532-5415.2004.52257.x
8. Sinaki M, Brey RH, Hughes CA, Larson DR, Kaufman KR. Balance disorder and increased risk of falls in osteoporosis and kyphosis: Significance of kyphotic posture and muscle strength. Osteoporos Int. 2005;16(8):1004-10. doi:10.1007/s00198-004- 2071791-2
9. Balzini L, Vannucchi L, Benvenuti F, Benucci M, Monni M, Cappozzo A, et al. Clinical characteristics of flexed posture in elderly women. J Am Geriatr Soc. 2003;51(10):1419-26. doi:10.1046/j.1532-5415.2003.51460.x

10. Moseley GL. Impaired trunk muscle function in sub-acute neck pain: Etiologic in the subsequent development of low back pain? Man Ther. 2004;9(3):157-63. doi:10.1016/j.math.2004.03.002
11. Minoonejad H, Barati AH, Naderifar H, Heidari B, Kazemi AS, Lashay A. Effect of four weeks of ocular-motor exercises on dynamic visual acuity and stability limit of female basketball players. Gait Posture. 2019;73:286-90.
12. Yamak B, İmamoğlu O, İslamoğlu İ, Çebi M. The effects of exercise on body posture. Electro Turk Stud. 2018;13(18).
13. Ambegaonkar JP, Caswell AM, Kenworthy KL, Cortes N, Caswell SV. Lumbar lordosis in female collegiate dancers and gymnasts. Med Probl Perform Art. 2014;29(4):189-92.
14. Barrey C, Roussouly P, Perrin G, Le Huec JC. Sagittal balance disorders in severe degenerative spine. Can we identify the compensatory mechanisms? Eur Spine J. 2011;20(5):626-33.
15. Murata Y, Utsumi T, Hanaoka E, Takahashi K, Yamagata M, Moriya H. Changes in lumbar lordosis in young patients with low back pain during a 10-year period. J Orthop Sci. 2002;7(6):618-22. doi:10.1007/s007760200111
16. Tsuji T, Matsuyama Y, Sato K, Hasegawa Y, Yimin Y, Iwata H. Epidemiology of low back pain in the elderly: Correlation with lumbar lordosis. J Orthop Sci. 2001;6(4):307-11. doi:10.1007/s007760100023
17. Shah J, Tanwar T, Iram I, Aldabbas M, Veqar Z. Effect of increased lumbar lordosis on lumbar multifidus and longissimus thoracis activation during quadruped exercise in patients with chronic low back pain: An EMG study. J Appl Biomech. 2020;36(6):436-43.
18. Song MY, Chung WS, Kim SS, Shin HD. Correlation between obesity and lumbar lordosis in obese pre-menopausal Korean females. J Korean Med. 2004;25(4):43-50.
19. Nuttall FQ. Body mass index: Obesity, BMI, and health: A critical review. Nutr Today. 2015;50(3):117-28. doi:10.1097/NT.0000000000000092
20. Rautiainen S, Wang L, Lee IM, Manson JE, Buring JE, Sesso HD. Higher intake of fruit, but not vegetables or fiber, at baseline is associated with lower risk of becoming overweight or obese in middle-aged and older women of normal BMI at baseline. J Nut. 2015;145(5):960-8.
21. Radzevičienė L, Kazlauskas A. Posture disorders and their causes in rural school pupils. Soc Welf Interdiscip Approach. 2016;1(6):118-25.
22. Fabris de Souza SA, Faintuch J, Valezi AC, Sant'Anna AF, Gama-Rodrigues JJ, de Batista Fonseca IC, et al. Postural changes in morbidly obese patients. Obes Surg. 2005;15(7):1013-6. doi:10.1381/0960892054621224
23. Lonner BS, Toombs CS, Husain QM, Sponseller P, Shufflebarger H, Shah SA, et al. Body mass index in adolescent spinal deformity: Comparison of scheuermann's kyphosis, adolescent idiopathic scoliosis, and normal controls. Spine Deform. 2015;3(4):318-26. doi:10.1016/j.jspd.2015.02.004
24. Sjolie AN. Associations between activities and low back pain in adolescents. Scand J Med Sci Sports. 2004;14(6):352-9. doi:10.1111/j.1600-0838.2004.377.x
25. Hoseinifar M, Ghiasi F, Akbari A. The relationship between lumbar and thoracic curves with body mass index and low back pain in students of Zahedan University of medical sciences. J Med Sci. 2007;7(6):984-90. doi:10.3923/jms.2007.984.990
26. Kamali N, Ahmadi MH, Kashami M. The effect of gender and obesity on lumbar lordosis. J Baboul Univ Med Sci. 2004;6:3-9.
27. Tüzün C, Yorulmaz I, Cindaş A, Vatan S. Low back pain and posture. Clin Rheumatol. 1999;18(4):308-12. doi:10.1007/s100670050107
28. Youdas JW, Hollman JH, Krause DA. The effects of gender, age, and body mass index on standing lumbar curvature in persons without current low back pain. Physiother Theory Pract. 2006;22(5):229-37. doi:10.1080/09593980600927864
29. Tizabi AT, Mahdavinejad R, Azizi A, Jafarnejadgero T, Sanjari M. Correlation between height, weight, BMI with standing thoracic and lumbar curvature in growth ages. World J Sports Sci. 2012;7(1):54-6.
30. Ray L, Lipton RB, Zimmerman ME, Katz MJ, Derby CA. Mechanisms of association between obesity and chronic pain in the elderly. Pain. 2011;152(1):53-9. doi:10.1016/j.pain.2010.08.043
31. Vismara L, Menegoni F, Zaina F, Galli M, Negrini S, Capodaglio P. Effect of obesity and low back pain on spinal mobility: A cross-sectional study in women. J Neuroeng Rehabil. 2010;7(1):1-8. doi:10.1186/1743-0003-7-3
32. Pratesya, LA, Mardianti D. Correlation between obesity and the depth of lumbar lordosis in obesity-typed women in internal medicine clinic Dustira Military Hospital Cimahi. In 12th Annual Scientific Meeting, Medical Faculty, Universitas Jenderal Achmad Yani, International Symposium on" Emergency Preparedness and Disaster Response during COVID-19 Pandemic"(ASMC 2021)) (pp. 42-44). Atlantis Press. doi:10.2991/ahsr.k.210723.011
33. Widodo WS, Wahyuni. Korelasi antara kegemukan dengan peningkatan kurva lumbal bidang sagital. J Kesehat. 2008;1(2):155-64.
34. Taweetanalarp S, Purepong N. Comparison of the lumbar spinal angle between normal body mass index and overweight young adults. J Physic Ther Sci. 2015;27(7):2343-6. doi:10.1589/jpts.27.2343
35. Samir S, Elshinnawy A, Elrazik R, Battesha H, Ali M, Gazya A. The long-term effect of smartphone overuse on Cervical Posture and range of motion in asymptomatic sedentary adults. JAPER. 2019;9(4):89-95.