Assessing the Relationship between Body Composition and Spinal Curvatures in Young Adults

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Introduction

Nourishment is not only necessary for growth and life, but also protects the health. Insufficient or unbalanced nourishment is an important health problem, associated with many chronic diseases, which is predicted to be more often observed in the next decade. One of the groups at risk in terms of nourishment is young adults. Previous studies have reported that young adults were not sufficiently nourished in a balanced way [1,2].

One of the methods providing objective data about the nourishment status and habits of individuals is body composition analysis. In this method, which is routinely used in practice, the segmental and total fat, muscle and liquid percentages of individuals are calculated, thus providing clinicians with detailed clinical data [3]. Changes in body composition might lead to many physical and physiological health problems such as postural problems. In modern societies, reasons such as poor habitual posture together with technology, a sedentary lifestyle, and unbalanced nourishment might alter the posture and spinal alignment [4]. Body Mass Index (BMI) values above the normal level lead to an increase in thoracic kyphosis and lumbar lordosis, while values lower than normal might cause scoliosis resulting in a deterioration of spinal alignment [5,6]. These deteriorations in spinal alignment may cause future spinal problems such as lumbar and neck pain and thereby become a significant healthcare cost burden [7].

The studies in literature on the effects of body composition on spinal alignment are limited to BMI assessments, and thus there are many studies on this subject examining segmental...
and total fat and muscle distribution in detail. Therefore, the aim of this study was to examine the effects of the body/total, fat/muscle ratios and visceral adiposity in addition to BMI, on lumbar and thoracic spinal alignment in young adults.

Materials and Methods

Subjects

This cross-sectional study was conducted in the Physiotherapy and Rehabilitation Department of School of Health Science, Dumlupinar University. The study included 67 young adults aged 18–25 years, who met the inclusion criteria. These inclusion criteria were defined in order to minimize the effects of age at the time of spinal curvatures. Any participants with systemic disease and/or spinal pathology, a previous diagnosis of a musculoskeletal systemic problem, a history of spinal and extremity intervention, and those using ancillary equipment or orthosis were excluded from the study.

The researchers obtained required permissions from the Research Committee of Dumlupinar University. In accordance with the Helsinki Declaration, informed consent was obtained from all participants. The demographic data such as gender, height, exercise, and smoking habits were obtained using a form specifically prepared for this study.

Procedures

Body composition analysis

Body composition analyses of the participants were performed using Tanita Bc 418 Ma Segmental Body Composition Analyzer (Tanita, Japan). Tanita Bc 418 Ma is a single-frequency bio-impedance analyzer with 8 polar electrodes. This device allows the mass of different body segments to be determined separately. It computes the impedance, age, and height data and calculates the estimated fat and muscle mass for each segment. In this study, the BMI, visceral, body, and total fat percentages and body and total muscle ratios were determined. Body fat and muscle ratio means the fat and muscle ratios in the body except extremities.

Evaluation of spinal curvatures

The angle of thoracic kyphosis and lumbar lordosis were assessed using Spinal mouse® (Idiag, Fehraltorf, Switzerland) device. Spinal mouse is a non-invasive method examining the spinal angle and spinal deformities in the sagittal plane. With a manually controlled digital inclinometer, this device measures the distances and angles between the vertebrae by moving along the spinous process from the 7th cervical vertebra towards the 3rd sacral vertebra. These measurements are transferred using Bluetooth technology, and then monitored on the screen. Using the software of this device, the data seen on screen are used to examine the positional relationship between each of the vertebrae, to measure the angles between the vertebrae, and to calculate the angles of sagittal and frontal curvature [8]. In the present study, the thoracic and lumbar curvatures of participants were examined through the measurements in anatomic position (Figure 1), maximum trunk flexion (Figure 2), and maximum trunk extension (Figure 3). The kyphosis and lordosis angles were then calculated using the software.

Statistical analysis

The data obtained as a result of this study were analyzed using SPSS 20.0 statistics software. The mean values, frequency distribution, standard deviation and percentages of descriptive data were calculated. The relationships between the measurement parameters were analyzed using Pearson correlation analysis. In correlation analysis, the correlation coefficients between 0.00 and 0.19 were considered as “no relationship”, those between 0.20 and 0.39 as a “weak relationship”, those between 0.40 and 0.69 as a “mid-level relationship”, those between 0.70 and 0.89 as a “strong relationship”. 

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relationship”, and those between 0.90 and 1.00 as a “very strong relationship”. The level of significance in statistical analyses was set at 0.05.

Results

A total of 90 subjects were enrolled in this study and after exclusion of 23 who did not complete the assessments, the study was completed with 67 subjects. The mean age of the participants was calculated to be 21.59±1.45 years. The demographic data, body composition analysis data, and lordosis and kyphosis angle values of the subjects are presented in Tables 1,2.

There is no relationship between BMI and kyphosis angle (p>0.05) and no relationship with the lordosis angle (p>0.05). A statistically significant positive relationship was found between total and body fat ratio and kyphosis and lordosis angles (p<0.05) (Table 3) (Figures 4-7).

No relationship was found between the visceral fat and body muscle percentages and the angles (p>0.05). A negative, weak, significant relationship was found between total muscle percentage and kyphosis and lordosis angles (p<0.05) (Figures 8,9). The p and r values of these data are presented in Table 3.

Discussion

In this study, the relationship between body composition and spinal alignment was examined. It was concluded that kyphosis and lordosis angles have a positive relationship with total and body fat ratios and a negative relationship with total muscle ratio.

Studies have frequently reported a relationship between body type and composition and body posture [9,10]. Thus, it can be thought that different body types and compositions might affect spinal alignment. However, there are few studies in literature that have examined the relationship between body composition and the spinal alignment. In a study by Mauriciene and Baciuliene, of 405 adolescents aged between 10 and 13 years, the relationship between height, weight, fatty and fatless mass and lumbar lordosis and thoracic kyphosis curvatures was examined. Using the skinfold, the total fat ratio was calculated with Slaughter’s formula. Total fat percentage was found to have a weak positive relationship with thoracic kyphosis angle, while no relationship was found between the total fat percentage and lumbar lordosis [11]. In another study by Sanchez et al. (2014), of 36 participants aged under 40 years, the comparison spinal curvatures between normal weight and obese participants was investigated. Using the biplanar electromagnetic device, spinal curvatures was determined. They found that there were a significant difference in thoracic kyphosis between obesity and normal weight participants [12]. Similarly, in the current study, a positive relationship was found between total fat percentage and thoracic kyphosis angle. Furthermore, a weak relationship was also determined

\[\text{Table 1: The demographic data of the subjects.}\]

| Variables (n=67) | X±SD       |
|-----------------|------------|
| Age (years)     | 21.59±1.45 |
| Height (cm)     | 171.86±8.49|
| Weight (kg)     | 67.97±13.55|
| BMI (kg/m²)     | 22.88±3.44 |

\[\text{Table 2: Body composition ratios and spinal curvatures of the subjects.}\]

| Variables (n=67) | X±SD       |
|-----------------|------------|
| Total fat (%)   | 21.75±7.75 |
| Body fat (%)    | 20.95±7.33 |
| Visceral fat (%)| 2.35±2.10  |
| Total muscle (%)| 74.50±7.55 |
| Body muscle (%) | 54.70±4.13 |
| Kyphosis angle (°)| 41.50±7.97 |
| Lordosis angle (°)| 21.02±9.39 |

\[\text{Table 3: Correlation between body composition and spinal curvatures.}\]

| Variables       | Kyphosis angle (°) r/p | Lordosis angle (°) r/p |
|-----------------|------------------------|------------------------|
| BMI (kg/m²)     | 0.22/0.07              | 0.02/0.86              |
| Total fat (%)   | 0.33/0.00*             | 0.28/0.02*             |
| Body fat (%)    | 0.40/0.01**            | 0.27/0.03*             |
| Visceral fat (%)| 0.23/0.06              | 0.21/0.07              |
| Total muscle (%)| -0.33/0.00*            | -0.28/0.02*            |
| Body muscle (%) | 0.07/0.57              | 0.24/0.06              |

BMI: body mass index, kg: kilogram, m²: square meter, %: percent, °: degree, r: pearson correlation coefficient p: significant level
between lumbar lordosis and total fat percentage.

In this study, the more realistic and objective approach of the bio-impedance analyzer method was employed and the

total fat and muscle ratios were evaluated together. In addition to the fat ratio, a negative relationship was found between the total muscle percentage and the thoracic kyphosis and lumbar
lordosis. Accordingly, total fat percentage is an important parameter that should be examined. Therefore, in addition to the changes in total fat percentage, it is also thought that the changes in muscle ratio might affect the spinal deformities.

In body composition analyses, generally the total fat percentage is considered, while it has been frequently reported in literature that visceral adiposity might also cause spinal problems such as lumbar pain [13,14]. Souza et al., reported that in individuals with a high level of visceral adiposity, the lumbar lordosis angles might increase due to the anterior dislocation of the gravity line. In contrast to that study, no significant relationship was found between visceral adiposity percentage and thoracic kyphosis and lumbar lordosis in the present study. This might be because of the low level of mean visceral adiposity (2.35%) of the participants involved in this study. Further studies may re-examine this relationship in individuals with a high visceral adiposity level.

Deviation of spinal curvatures from the normal levels may alter the load on the spinal column. Especially in obese individuals, the increase in body weight or the deteriorated body composition increase the spinal load. Moreover, the increases in spinal curvatures also shorten the moment limb of the spinal muscles. This leads the muscles, which try to resist the increased spinal load, to be affected negatively [15]. For example, the increase in lumbar lordosis causes spinal hyperextension, in addition to laying the foundation for spinal disorders such as vertebral disc injuries, postural instability, and chronic lumbar pain by increasing the repetitive compression loads on the vertebra [16]. In the present study, it was also observed that the lumbar lordosis values increased as a result of increase in total fat ratio and decrease in muscle ratio. Therefore, individuals with a high fat percentage might be in a risk group and the body composition analyses should be considered while assessing these patients.

On the contrary, low BMI and fat percentage might cause scoliosis resulting in a deterioration of spinal alignment. In this regard, Clark et al. (2014) aimed to identify whether body composition analysis can be used for predicting scoliosis before the onset of clinically detected scoliosis. They showed a negative correlation between BMI and scoliosis reflecting of combination of reduced fat mass and lean mass and with a %20 reduced risk of scoliosis per SD increase BMI. Therefore, it can be thought that the measurement of spinal curvature and body composition analysis could be good parameters to detect and prevent injuries, and these measurements should be part of the anthropometric analysis [17].

According to previous researchers, increasing physical activity is an efficient method of decreasing the fat level. In literature, many exercise approaches have been reported to increase fat loss [18-20]. Considering the results of these studies, it can be stated that increasing physical activity might approximate the spinal alignment to the optimal levels by decreasing the fat ratio at the segmental level or in the entire body. From this aspect, to resolve spinal problems originating from spinal alignment deteriorations, exercises inducing fat loss and increasing the general muscle mass might be added into rehabilitation programs.

In literature, the studies examining the effects of body composition on spinal alignment have primarily used BMI. One of the strengths of the present study is the examination of the effect of total fat/muscle ratio on spinal alignment, which is more detailed than the use of BMI only. Another strong aspect of the study was the use of Spinal Mouse, which offers objective data, in examining the spinal deformities. Contrary to expectations, it was concluded that visceral fat and body muscle ratio values were not significantly related to spinal alignment.

Limitations of the present study were the low number of obese individuals involved and the low level of visceral adiposity. The authors did not analyze the correlation body composition and spinal curvature between genders, height, weight, BMI, exercise, and smoking habits. Further studies may investigate the effect of these parameters on the relationship between body composition and spinal curvatures.

**Conclusion**

In conclusion, this study revealed that spinal alignment might be deteriorated as a result of an increase in total fat ratio and a decrease in muscle proportion. Since the load on the spinal column might change as a result of the effects on spinal alignment, body composition analyses should be considered in the treatment of vertebra-related disorders and when necessary, the patients should be referred to a dietician or physician for regulation of dietary habits and to a physiotherapist to improve exercise habits. Therefore, physiotherapists should be included in a multidisciplinary team to evaluate body composition and spinal alignment and in the planning of preventive exercise approaches.

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