Characteristics of sagittal curvature and mobility of the thoracolumbar segment of the spine in students specialising in physical dance

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Abstract. Aims: To understand the sagittal and mobility characteristics of the thoracolumbar segment of the spine in students specialising in physical dance. METHODS: Sagittal curvature and mobility of the thoracolumbar segment of the spine was measured in 35 standard dance students, 41 Latin dance students and 43 general university students using the Spinal Mouse spine electrometer. Results: (1) In the upright position, the sagittal curvature of the T9/10 to L4/5 segment was significantly less in standard dance-specific girls than in regular female university students ($p<0.05$). (2) The sagittal curvature of the T1/2~T5/6 and L1/2-L5~S1 segments in the upright position was significantly less than the spinal curvature in the shoe position for boys in the standard dance specialization ($p<0.05$, respectively); the sagittal curvature of the T1/2~T7/8 and L1/2~L5/S1 segments of the thoracic spine in the upright position for boys in the Latin dance specialization was significantly less than the spinal curvature in the shoe position ($p<0.05$, respectively); sagittal curvature in the T1/2~T6/7 and T11/12~L5/S1 segments was significantly less than the spinal curvature in the shoe-wearing position for girls in standard dance ($p<0.05$, respectively); sagittal curvature in the T1/2~T7/8 and T12/L1~L5/S1 segments was significantly less than the spinal curvature in the shoe-wearing position for girls in Latin dance in the upright position ($p<0.05$, respectively). curvature ($p<0.05$, respectively). (3) In the upright to maximum forward flexion position, sagittal mobility in the T1/2 to T4/5 segments was significantly less in the standard dance-specific male students than in the general male students ($p<0.05$). (4) In the upright to maximum posterior extension position, the sagittal mobility of the T1/2 to T5/6 segments of the thoracic spine was significantly greater in the standard dance-specific girls than in the general female university students ($p<0.05$). Conclusions: (1) In the upright position, the sagittal plane thoracic posterior convexity decreased and the anterior convexity of the lumbar spine increased in girls with standard dance specialties. (2) Reduced sagittal thoracic and lumbar spine curvature in the shoe position for students of the same gender in Latin and standard dance. (3) Standard dance specific girls have better spinal-thoracic stability and standard dance boys have less flexibility in the spinal-thoracic spine.

1. Introduction

The spine is an important pillar for supporting weight and maintaining a normal upright and seated posture. The sagittal morphology of the spine is important in maintaining a normal spinal mechanics. In clinical diagnosis, all manifestations of the coronal, sagittal or axial deviation of the spine from its normal position, where morphological abnormalities occur, are collectively referred to as spinal deformities [1]. Due to the excessive range of motor activity involved in dance movements, dancers may be more prone to abnormal sagittal spinal curvature postures (e.g. lumbar lordosis) [2], leading to hyperlordosis, lumbar spondylolisthesis, lumbar spondylolisthesis, and discogenic back pain [3].

The amount of training, the specific and repetitive movements, the type of exercise and the posture of each exercise are all related to the curvature and mobility of the spine. Body posture is one of the most fundamental criteria by which sports dancers are judged when competing, and sports dancers need specific training over time to maintain and develop proper dance posture [4]. Physical education dance girls wear high heels for long periods of time to perform large movements that often involve both chest, waist and hip movements, which may have an impact on the sagittal curvature of the spine. It is therefore important to clearly diagnose changes in the physiological curvature of the sagittal plane of the spine (pronation and kyphosis) and to assess the spinal health of students specialising in physical dance, in order to gain insight into the sport of physical dance.

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2. Subjects and methods of study

2.1 Study Subjects

The experiment was approved by the Ethics Committee of Sports Science Experiment of Beijing Sport University (approval number: 2022205H), and all subjects signed an informed consent form.

The G*Power3 sample calculation software was used to calculate the total sample size required for the test, giving a total test sample of 90 people.

Inclusion criteria: Age range 18-24 years old. Experimental group: (1) 18h or more training hours per week; (2) 2 or more years of training; (3) participation in municipal, provincial, national or international competitions in the last three years. Control group: no sports training experience.

Exclusion criteria: known spinal deformity, pregnancy or injury to any body part other than the lower back, history of back surgery; low back pain caused by herniated discs, slipped vertebrae, spinal fractures, etc.; subjects with other injuries or illnesses that prevent them from performing the test.

A total of 139 subjects were recruited, screened according to the inclusion and exclusion criteria, and 12 people with missing data were excluded, resulting in 119 people being retained for the experimental test. (Table 1)

Table 1. General information about the study population

	Standard Dance	
Gender	Male	Female
Number of people (persons)	17	18
Age (years)	20.35±1.66	20.06±1.98
Height (cm)	182.25±6.47	169.72±4.30
Body weight (kg)	69.29±9.13	54.31±3.12
BMI (kg/m^2)	18.91±0.90	20.82±1.68

Continued from Table 1

Latin Dance		General university students	
Male	Female	Male	Female
18	24	19	24
20.06±1.98	20.33±1.83	20.68±1.97	20.04±1.73
169.72±4.30	165.63±3.31	179.00±3.60	164.66±4.11
54.31±3.12	51.78±4.46	65.37±7.45	52.53±4.13
20.82±1.68	18.87±1.51	20.78±2.17	19.35±1.43

2.2 Research Methodology

2.2.1 Testing tools

The reliability and validity of measurements of sagittal curvature and mobility of the thoracolumbar segment of the spine have been confirmed in a number of studies using the Swiss-made Spinal Mouse spine electrometer [5-7]. (Figure 1)

Fig. 1. Spinal Mouse Spinal Electrometer.

2.2.2 Testing process

The subject must wear loose clothing while the test is in progress, remove the top of the shirt and pull the trousers down below the anterior superior iliac spine and caudal vertebrae, expose the entire back from the cervical 7 spine (C7) to the gluteal cleft (S3), disinfect the subject's back with an alcohol swab and mark each spine from C7 to S3 with a black marker.

The following poses were mainly tested:

Upright posture: The subject stands barefoot, hands at the sides of the body, eyes level in front of them, feet shoulder-width apart, standing upright. (Figure 2)

Maximum forward bending position: the subject bends forward as far as possible, head and hands naturally down, feet shoulder-width apart, weight between the feet, knees unbent. (Figure 2)

Maximum posterior extension position: the subject extends as far back as possible, hands can support the hips to maintain posture, feet shoulder width apart, knees should remain posterior and not bent. (Figure 2)

Fig. 2. Illustration of the test (quoted from the "Manual for the use of the Swiss spine measuring instrument")

Dance shoes posture: Students specialising in physical dance will stand naturally in their appropriate dance shoes according to the requirements of the programme, with their hands naturally placed at their sides, eyes level in front of them and feet shoulder-width apart. (See Figure 3)

Fig. 3. Dance Shoes

3. Results

3.1 Sagittal curvature of the spine

3.1.1 Sagittal curvature of the thoracolumbar segment of the spine in the upright position

Positive values of sagittal curvature in the upright position indicate a posterior convexity of that spinal segment, while negative values indicate an anterior convexity of that spinal segment.

In the upright position, there were no significant differences in sagittal and overall curvature of the thoracic and lumbar segments of the spine between the three groups of boys. This indicates that there were also no significant patterns or features of change in spinal morphology between the three groups of subjects.

The sagittal curvature of the spine was significantly greater in the T9/10-L4/5 segment ($p<0.05$) and not significantly different in other segments; the overall sagittal curvature of the lumbar segment of the spine was significantly greater in the standard dance segment ($p<0.05$); the sagittal curvature and overall curvature of the thoracic and lumbar segments of the spine were not significantly different in the Latin dance segment; and the sagittal curvature and overall curvature of the spine were not significantly different in the standard and Latin dance segments. There was no significant difference in the sagittal curvature and overall curvature of the thoracic and lumbar segments of the spine of the girls in Latin dance. This indicates that students specialising in standard and Latin dance have less posterior convex curvature of the lower thoracic segment and greater anterior lumbar convexity compared to the general college population.

($p<0.05$); # indicates Latin dance students of the same gender compared with ordinary university students, $p<0.05$; △ Standard dance students of the same gender compared with Latin dance students, $p<0.05$.

3.1.2 Sagittal curvature of the thoracolumbar segment of the spine in upright position in dance shoes for students specialising in physical education and dance

In the upright position, there was no significant difference in the sagittal and overall curvature of the thoracolumbar segment of the spine between standard and Latin dance specific boys when standing barefoot and in dance shoes. Compared to the barefoot standing position, the sagittal curvature of the T1/2-T5/6 and L1/2-L5/S1 segments of the spine was significantly smaller in the standard dance-specific boys when wearing dance shoes ($P<0.05$, respectively); the sagittal curvature of the T1/2-T7/8 and L1/2-L5/S1 segments of the spine was significantly smaller in the Latin dance-specific boys when wearing dance shoes ($P<0.05$, respectively); and the overall curvature of the thoracic and lumbar segments of the spine was significantly smaller in the standard and Latin dance-specific boys when wearing dance shoes ($P<0.05$, respectively). The overall sagittal curvature of the thoracic and lumbar segments of the spine was significantly smaller in Latin dance males when wearing dance shoes ($P<0.05$, respectively). It shows that compared to the barefoot standing position, both groups of boys showed less thoracic lordosis and lumbar lordosis when wearing dance shoes, showing a trend towards significant changes in chest and abdomen straightening and waist standing.

3.2 Sagittal ROM of the spine

3.2.1 Sagittal ROM of the spine in the upright to maximum forward flexion position

Upright to maximum forward flexion is expressed as A-F and reflects the flexibility of the spine, the higher the value the better the flexibility of the spine.

At upright to maximum forward flexion, the sagittal ROM of the T1/2-T4/5 segments of the spine was significantly smaller in the standard dance males compared to the general male university students ($p < 0.05$); there was no significant difference between the sagittal ROM and overall ROM of the thoracic and lumbar segments of the spine in the Latin dance males; there was no significant difference between the sagittal ROM and overall ROM of the thoracic and lumbar segments of the spine in the standard dance and Latin dance males. This indicates that the standard dance boys were significantly less flexible in the upper thoracic segment than the other two groups.

There were no significant differences in sagittal ROM and overall ROM of the thoracolumbar segment of the spine between the three groups of female students in upright to maximum forward flexion; sagittal ROM of the upper thoracic segment of the spine was lower than that of the general university students, and sagittal ROM of the lower thoracic and lumbar segments was slightly higher than that of the general university students in the standard and Latin dance specialties. The flexibility in the upper thoracic vertebrae was weaker than that of the average female university student, while the flexibility in the lower thoracic vertebrae and lumbar vertebrae of the spine was slightly better than that of the average female university student, but neither was significant.

4. Discussion

4.1 Sagittal curvature analysis of the spine

4.1.1 Analysis of the sagittal curvature of the thoracolumbar segment of the spine in the upright position

The normal human spine has an "S" shape in the sagittal plane, giving the spine a spring-like ability to cushion shocks [8]. Prolonged sports training may lead to sagittal imbalances in the spine, predisposing athletes to spondylolisthesis and consequent spinal curvature abnormalities [9].

In the present study, we found consistent changes in spinal thoracic and lumbar spinal curvature in the three groups of boys. This is similar to the findings of Kruusamäe (2015) [10]. This may be due to the fact that during the practice of physical dance, boys only undergo corresponding changes in spinal curvature under self-regulation and control according to the specific requirements of the movement gist.

Compared to the general female student population, the spine of standard dance girls had a significant flattening of the thoracic lordosis and a greater lumbar lordosis, while the thoracic and lumbar segments of the spine of standard and Latin dance girls were in close agreement. The occurrence of a flattening of the posterior convexity of the thoracic spine is largely consistent with the findings of foreign studies [10].

5. Conclusions and Recommendations

5.1 Research findings

(1) In the upright position, the sagittal thoracic curvature decreases and the anterior lumbar curvature increases in the sagittal plane for girls specialising in standard dance.

(2) Reduced sagittal thoracic and lumbar spine curvature in the shoe position for students of the same gender in Latin and Standard Dance.

(3) The spinal thoracic spine is more stable for girls and less flexible for boys in Standard Dance.

(4) In the two-person stance, the sagittal thoracic and lumbar curvatures become less in the standard dance-specific boys, and the standard dance-specific girls show negative values at the T5/6 segment and maximum negative values at the L2/3 segment.

5.2 Research recommendations

(1) It is recommended that the sample size be increased in future to provide a more accurate understanding of the spinal characteristics of students specialising in physical dance.

(2) The scope of the study could be expanded to include children, adolescents and the elderly who have had long-term physical dance training to further understand the effects of physical dance exercise on the spine in different populations.

(3) Increase the number of frontal spine tests to comprehensively assess the impact of physical dance on the spinal health of specialised students.

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