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Original Research Article

Selected lower extremity flexibility tests as an element of functional assessment for ballet school students – Preliminary observation

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ABSTRACT

Introduction: Muscles are a part of the human neuromusculoskeletal system, stabilizing the skeleton and allowing joint movements. Muscle characteristics include flexibility and contractility. Assessment of muscle flexibility includes flexibility tests. Dance teachers put special emphasis on their students' flexibility enhancement, applying muscle stretching techniques. Soft tissue injuries are very common in dancers. One of the elements of functional assessment of the musculoskeletal system are muscle flexibility tests.

Aim: The aims of this study are: (1) flexibility assessment of rectus femoris and hamstring muscles of both lower extremities; (2) evaluation of pain in the lumbar spine. The following research hypotheses are verified: (1) in ballet school students (elementary school) rectus femoris and hamstring flexibility tests results are within normal range; (2) there are no complaints of low back pain.

Material and methods: The study included 52 ballet school students, aged 11.64 ± 0.53 (mean ± standard deviation). Flexibility tests of rectus femoris muscle and hamstrings of both lower extremities were conducted and a numeric pain rating scale was used to assess low back pain.

Results and discussion: Shortening of rectus femoris muscle in both lower extremities, together with increased lumbar lordosis, were found in all subjects. It was observed that hamstrings of both lower extremities were stretched.

Conclusions: (1) Flexibility tests proved to be a simple tool for the assessment of flexibility of thigh muscles of both lower extremities. The results of these tests confirm muscle imbalance and relative flexibility in the lumbar spine. (2) Numeric scale is a simple tool for the assessment of low back pain. Among 52 students, 31 declared moderate pain sensations.

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1. Introduction

Muscles, as soft tissues, are components of the human neuromusculoskeletal system. They stabilize the skeletal system and enable joint movements. In physiological conditions muscles are characterized by flexibility and contractility. Flexibility is a passive property of muscles defined by the amount of force needed for the muscles to stretch.[1] To assess muscle flexibility, flexibility tests are applied.[2,3] Contractility of a muscle is a specific characteristics which allows muscle attachments to move closer and, in turn, enables movement in joint above which the very muscle is located. Dance teachers concentrate strongly on the enhancement of body flexibility of their students, using various muscle stretching techniques. Soft tissue injuries are common in dancers.[4,5] Therefore, functional assessment of the neuromusculoskeletal system in ballet school students, as an element of injury prophylaxis, seems to be rational. One of the elements of functional assessment of the neuromusculoskeletal system are muscle flexibility tests. For practical reasons, an attempt at assessment of the thigh muscles flexibility and detection of low back pain in the group of children attending ballet schools was made.

2. Aim

Given the significance of the issue, the following aims were formulated: (1) flexibility assessment of rectus femoris and hamstring of both lower extremities; (2) evaluation of pain in the lumbar spine. The following research hypotheses were verified: (1) in ballet school students (elementary school) rectus femoris and hamstrings flexibility tests results are within normal range; (2) there are no complaints of pain in the lumbar spine.

3. Material and methods

In total, 52 students of the Secondary Ballet School in Poznan, Poland, participated in the study. The average age of the subjects was 11.64 ± 0.53 years, the average body height was 151.10 ± 7.54 cm, the average body weight was 35.92 ± 5.41 kg and the average duration of education in ballet school was 2.17 ± 0.65 years. As an evaluation tool for the assessment of muscle flexibility rectus femoris and hamstrings flexibility tests were used.[3]

Flexibility test for rectus femoris muscle were conducted with the subject positioned prone and the investigator passively flexing their knee joint. The heel touching the buttock during passive flexion was considered to be a norm (Fig. 1).[3]

Flexibility test for the hamstring muscles were conducted with the subject positioned supine and the investigator passively flexing the hip joint with the knee extended.

Normal results included 90° of hip flexion (Fig. 2).[3]

Before the tests, all procedures were explained by the investigator, and results were documented in a customized form. A test for the rectus femoris and the hamstrings of both lower extremities was performed once. To define pain sensations of the lumbar spine, a numeric pain rating scale

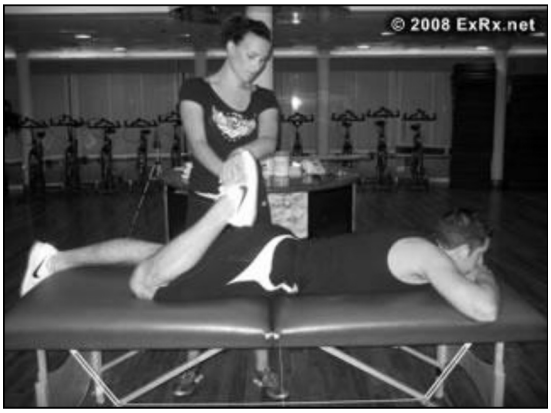

Fig. 1 – The rectus femoris muscle flexibility test.[18]

Fig. 2 – The hamstring muscles flexibility test.[19]

was used.[6] Students determined intensity of low back pain on a scale, where 0 indicated no pain, 1–3 small pain, 4–6 moderate pain, 7–10 most severe pain. The students declared no injuries of the musculoskeletal system. The study was conducted with the approval of the Local Bioethics Committee of Poznan University of Medical Sciences and with the consent of the subjects' parents or guardians. The results were presented graphically.

4. Results

Conducted flexibility tests showed abnormal flexibility of the rectus femoris muscle of both lower extremities together with increased lumbar lordosis (relative flexibility), in all subjects (Fig. 3). The failure to reach the norm is defined as muscle shortening. Assessment of hamstrings flexibility showed that the norm was exceeded in all members of the study group, which indicates muscle stretching (Fig. 3).

Among 52 subjects, 31 students (60%) declared low back pain. On a numeric scale, the pain was ranging from 4 to 6 and was classified as moderate (Fig. 4).

5. Discussion

The study has partially proved the research hypotheses. Abnormal flexibility test results for the rectus femoris muscle,

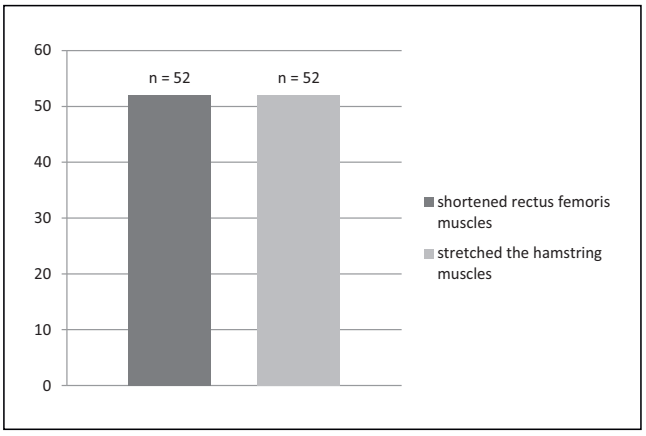

Fig. 3 – Flexibility tests for rectus femoris muscles and hamstring muscles at the subjects.

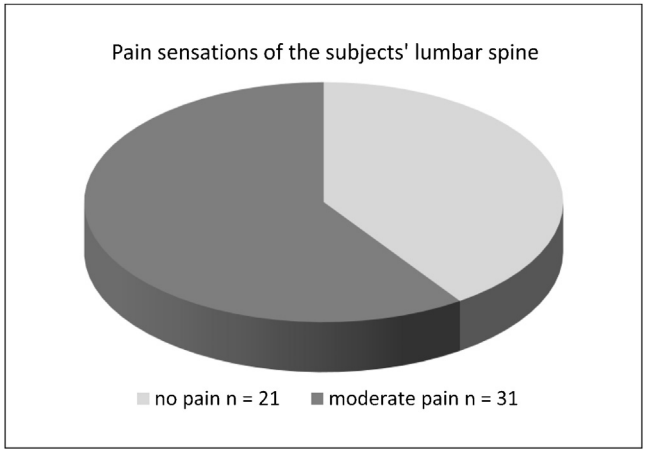

Fig. 4 – Pain sensations of the subjects' lumbar spine.

in both lower extremities, were found in all subjects (Fig. 3). This proves bilateral shortening of these muscles. Hamstrings flexibility tests showed exceeded norm in both extremities in all of the subject. The results of the flexibility tests proved that the muscles were stretched. Rectus femoris muscle and the hamstring muscle group are a two-joint muscles. When rectus femoris muscles are shortened, the pelvis is rotated forward, whilst shortened hamstring muscles cause the posterior pelvic tilt. The reason for muscle imbalance between the front and the back side of the thigh in ballet school students, who perform stretching exercises every day, remains unexplained. The cause of lower flexibility of the rectus femoris muscle might be a reduced number of the sarcomeres in this muscle.[7,8] When the number of sarcomeres is reduced, hyperplasia of connective tissue is observed.[9] The probable cause of the reduced muscle flexibility may also be the overgrowth of connective tissue in muscle fascia.[9] It is possible that lack of rectus femoris flexibility and its increased stiffness, might be a compensatory effect of insufficient mechanisms stabilizing a certain joint.

Relative flexibility of lumbar spine was observed in all subjects.[10] If the two muscles acting on the same joint cannot be fully stretched, they limit the normal range of movement, which must be compensated in the kinematic chain.[10] In the flexibility test for the rectus femoris muscle, in both lower extremities norm was not reached, and increased lumbar lordosis was observed. In contrast, flexibility tests for the hamstrings of both lower extremities showed the above normal flexibility, because the range of hip joint flexion exceeded the value considered as a norm for that test. Joint hypermobility may contribute to the occurrence of injury.[11] Muscle imbalance between the front and the back thigh muscle groups in both lower extremities may cause shortening of rectus femoris and lead to the lower crossed syndrome. Tightness of the rectus femoris muscle and the thoracolumbar extensors are observed in the lower crossed syndrome.[12] The study did not confirm the research hypothesis on lack of low back pain. Low back pain was observed in 31 subjects and it was defined as ''moderate'' (Fig. 4). It should also be mentioned that in other studies conducted by the author on the same study group ($n = 52$), 51 subjects had a strong risk factor for a weak lumbar spine susceptible to injury. The cause of pain in 31 subjects might be relative tightness resulting from lack of flexibility of the rectus femoris muscles of both lower extremities. The cause of back pain complaints may be shortness of hamstring muscles.[13] However, the study proved that in all subjects, hamstring muscles stretching was found in both lower extremities. The study by Witrouv et al. show that muscles with decreased flexibility and increased stiffness can be more prone to injuries.[14] Hamstring muscle group is often injured, especially the biceps femoris.[15] The imbalance between the thigh muscles can contribute to the occurrence of pain in the lumbar spine.[16] Combining physical rehabilitation with psychotherapy eliminates the sources of negative stimuli that lead to the dysfunction of motor organ or increase it.[17] Relative flexibility might also be the cause of low back pain in children. This work is an attempt to determine a research trend to explain why in ballet school students, despite the use of various muscle stretching techniques, there is no muscle flexibility and what is the cause of low back pain in such young subjects.

6. Conclusions

Flexibility tests proved to be an uncomplicated tool for the assessment of flexibility of front and back muscle groups of the thigh, in both extremities. The results of flexibility tests show muscle imbalance and relative flexibility in the lumbar spine.

Numeric rating scale is a simple tool for the subjective assessment of low back pain in children attending ballet school. Among 52 students, 31 declared moderate pain.

Conflict of interest

None declared.

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