Introduction

In recent years a significant increase in the incidence of body postural defects in children can be clearly noticed. The main factor contributing to this increase is civilization progress responsible for reduction of physical activity. The dominant sedentary lifestyle observed among children is a result of low health awareness and common ignorance of disease prevention principles in society [1, 2].

Preventive care is highly significant in prophylaxis and correction of body posture defects. Primary prevention is aimed at identification and elimination of harmful environmental influences and propagation of a healthy lifestyle. Secondary prevention aims at early detection of postural defects (e.g. more screening examinations would make it much easier to commence the corrective process early enough). Tertiary prevention is to curb the development of postural defects with the aid of specialist help (orthopedic and physiotherapeutic) to make the corrective activities a long-term process [3].

One of the most frequent postural defects affecting the lower extremities is genu valgum also known as knock-knees. It is a deformity where the knees angle in and touch one another when the legs are straightened [4]. Knock knees are characterized by hypertrophy of the medial condyle of femur, increased pressure on the lateral condyle of femur inhibiting the growth of bones and enhancing asymmetry; external shank rotation; ligamentous and muscular twisting consisting of a stretching of the medial collateral ligament and other medial knee muscles, and of a contracture of the fibular collateral ligament and other lateral knee muscles [5]. Due to these changes the knee loses its compactness, which may lead to its total dysfunction.

Scoliosis is an abnormal lateral curvature of the spine. The condition can be categorized as side-to-side (frontal plane), rotoscoliosis (horizontal plane) and sagittal plane spinal deformity. In the first degree scoliosis the Cobb angle (curvature angle) does not exceed 30° and the condition affects only the muscular and ligamentous system without any deformities of the bone tissue. Scoliosis is classified as a systemic disease affecting the locomotor, circulatory and respiratory systems and limiting the function of other internal organs [6].
The aim of the study was to examine force-velocity parameters of knee flexors and extensors in children with first degree scoliosis and knock-knees and compare them with those of healthy children. It was assumed that postural defects in children reduced the strength and endurance of lower limb muscles.

Material and methods

Material

The sample included 48 boys and girls aged 10–12 years. The subjects were divided into three study groups: Group I – children with first degree scoliosis, Group II – children with knock-knees, and Group III – healthy children. The subjects’ profile is presented in Table 1.

Table 1. Profiles of children under study (mean ± SD)

<table>
<thead>
<tr>
<th>Group</th>
<th>n (♀ + ♂)</th>
<th>Age (years)</th>
<th>Body height (m)</th>
<th>Body weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>19 (10 + 9)</td>
<td>10.89 ± 0.81</td>
<td>1.46 ± 0.09</td>
<td>37.29 ± 6.78</td>
</tr>
<tr>
<td>Group II</td>
<td>15 (8 + 7)</td>
<td>10.73 ± 1.10</td>
<td>1.49 ± 0.09</td>
<td>46.70 ± 12.04</td>
</tr>
<tr>
<td>Group III</td>
<td>15 (7 + 8)</td>
<td>10.92 ± 0.79</td>
<td>1.46 ± 0.12</td>
<td>36.33 ± 7.23</td>
</tr>
</tbody>
</table>

Group I – children with scoliosis, Group II – children with knock-knees, Group III – healthy children

Methods

The study was carried out in the Center for Function Tests (in conformance with the standard of PN-EN ISO 9001:2001 Certificate of Quality System) in the Faculty of Physiotherapy, University School of Physical Education in Wroclaw. In each group force-velocity parameters of flexors and extensors of the knee of the dominant leg were assessed with the aid of the Biodex System 3 dynamometer (Biodex Medical System Inc., USA). The dynamometer recorded the times of muscle force development in different conditions of muscle work (Fig. 1). The assessment was carried out in isokinetic conditions with different loads.

Each subject performed five alternate flexion and extension movements of the knee at developing angular velocities of 1.05 rad/s (60°/s), 3.14 rad/s (180°/s) and 4.19 rad/s (240°/s) [7–9]. During each movement subjects attempted to develop maximal muscle force in the shortest time possible. Before each test the dynamometer station was adjusted so that the dynamometer axis formed an extension of the knee axis of rotation. Each time the range of knee movement was determined (mean range of 1.76 rad/s (101°): 0° – maximal extension at the knee joint; 101° – maximal flexion at the knee joint). The subject’s thigh and pelvis were stabilized with dynamometer straps to eliminate any facilitating movements. Before the test each subject flexed the knee to the maximum and performed three submaximal flexion and extension movements at the knee joint to get acquainted with a given load [10].

Peak torque – Mm (N × m), total work – W (J) and mean power – P (W) were assessed during flexion and extension of the knee joint with consecutive loads. For each subject the relative muscle force was also calculated – Mm/mc (torque value per kg of body mass) (N × m/kg).

Results

Figures 2–5 present arithmetic means obtained for each group, parameter and load. The subjects from Group III obtained higher values of muscle torque, relative force, mean power and total work for knee flexors and extensors with almost all the loads. The results of children with knock-knees and children with scoliosis revealed no significant differences between Group I and Group II. Statistically significant mean differences be-
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Figure 2. Mean peak torque values $M_m (N \times m)$ of knee extensors (E) and knee flexors (F) in each study group (I, II, III) with the loads of $60^\circ/s$, $180^\circ/s$, $240^\circ/s$

Figure 3. Mean relative torque values $M_m/mc (N \times m/kg)$ of knee extensors (E) and knee flexors (F) in each study group (I, II, III) with the loads of $60^\circ/s$, $180^\circ/s$, $240^\circ/s$

Figure 4. Mean total work values $T_W (J)$ of knee extensors (E) and knee flexors (F) in each study group (I, II, III) with the loads of $60^\circ/s$, $180^\circ/s$, $240^\circ/s$
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Between Group I and Group II were noted primarily at a low and medium velocity of movement. Table 2 presents the Student’s t-test p values.

**Discussion**

The assessment of force-velocity parameters of large muscle groups determines the strength and endurance of the whole human body. The present study focused on the parameters of knee extensors as they constitute one of the largest and strongest groups of human muscles. A number of researchers have pointed to the fact that the assessment of the force and velocity properties of this muscle group reflects the strength and endurance of the whole body. Mameletzi et al. [8, 9] examined the relationships between the muscle strength of knee flexors and extensors and body composition in young swimmers. Suman et al. [11] assessed muscle strength in children with burn injuries before and after a 12-week exercise program, using the parameters of knee extensors. Horvat et al. [12] used the results of an isokinetic test of knee flexors and extensors in their analysis of peak muscle force and work in youth with and without mental retardation. It should be emphasized that isokinetic tests of knee muscles feature a high level of reliability and repeatability. In studies by Deighan et al. [13] and De Ste Croix et al. [14] the coefficient of correlation for peak force values obtained during two independent measurements amounted to 0.9–0.83 for knee extensors and 0.76–0.74 for knee flexors, depending on the load.

Children from Groups I and II achieved lower F-v values of knee flexors and extensors than their healthy counterparts. The biggest differences were noted at a low (60°/s) and medium (180°/s) angular velocity, i.e. with loads demonstrating the strength capability of these muscles. The decrease in the strength of muscles of the lower extremity in children with knock-knees (Group II) can be explained by muscular lesions charac-
teristic of this condition (stretching of the medial collateral ligament of the knee and contracture of the fibular collateral ligament) and changes in the osteoarticular system (asymmetry of the epicondyles of femur, stretching of the medial collateral ligament and contracture of the lateral collateral ligament). The lower F-v parameters in this group can also be attributed to the subjects’ larger body weight. The children with knock-knees were about 25% heavier than other children, while the body height differences were insignificant (Tab. 1). To make the obtained peak torque values independent of the subjects’ body weight, relative force was calculated for each subject and each load [15]. On the average, the healthy subjects’ values were 28% higher.

The results of peak torque, mean power and total work of knee flexors and extensors in Group I were similar to the results in Group II (children with knock-knees), i.e. also lower than results from Group III. The observed decrease in the F-v parameters of knee muscles cannot be rationally explained by ailments related to the postural defects. The observed reduced strength, power and work of the muscles of the lower limb can be caused by the low level of physical activities of children who are more prone to lead an “economical lifestyle”. This is additionally evidenced by the very low level of knowledge and awareness of postural defects in children among their parents. A study by Nowotny-Czuptyna et al. [16] revealed that among 77 parents of children with postural defects only 9 had a satisfactory knowledge about their children’s condition. Almost 40% of parents were not able to identify their children’s condition, and the majority of them could not enumerate situations and activities to be avoided by their children. More than 70% of parents admitted their children spent more than 10 hours a day in a sitting position.

Conclusions

1. Children with scoliosis of the first degree and knock-knees achieve significantly lower values of force and velocity parameters of knee flexors and extensors than their healthy counterparts.

2. Corrective exercise programs for children with scoliosis of the first degree and knock-knees should also involve strength and endurance training of muscles of the lower limbs.

References


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