Evaluation of Isokinetic Trunk Muscle Strength in Adolescents With Normal and Abnormal Postures

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Abstract

Objective: The aim of this study was to assess existing differences in the isokinetic trunk muscle strength in males and females aged between 10 and 11 years depending on body posture.

Methods: The study included 145 children (67 males and 78 females) divided into 2 age groups: 10-year-old males ($\overline{x}$ = 9.98 ± 2.34 years) and females ($\overline{x}$ = 9.85 ± 2.94 years) and 11-year-old males ($\overline{x}$ = 11.14 ± 2.22 years) and females ($\overline{x}$ = 11.15 ± 2.32 years). Posture in the sagittal plane was assessed by photogrammetry using the moiré projection technique. Based on a classification system, the participants were divided into subgroups of males and females with normal and abnormal postures. Trunk muscle strength was measured using isokinetic dynamometry.

Results: A high prevalence of abnormal posture in children aged between 10 and 11 years was observed, primarily represented by an excessive curvature of the spine in the sagittal plane. The males and females with poor posture recorded lower values in isokinetic trunk muscle strength.

Conclusion: The results of the study point to the need for the application of suitable physiotherapy treatment (corrective measures/exercises) to treat musculoskeletal disorders to compensate for the loss of trunk flexor muscle strength in children with improper posture. (J Manipulative Physiol Ther 2015;xx:1-9)

Key Indexing Terms: *Posture; Moire Topography; Muscle Strength*

The normal curvature of a neutral spine consists of a posteriorly convex curve in the upper back (thoracic) region and anteriorly convex around the lower back (lumbar) region. In this neutral position, the cervical and lumbar spine is slightly anteriorly convex, whereas the thoracic spine is slightly convex posteriorly. In an abnormal postural position, the pelvis may feature anterior, posterior, or lateral tilt. Such pelvic obliquity involves abnormal simultaneous movements of the back and hip joints.[1]

Generally, trends cultivated in modern society and the changes observed in how leisure time is spent have caused children to be considerably less physically active than in the past. This has led to adverse effects on the health, posture, and physical fitness of today's youth. Abnormal body posture has become a major issue of concern for parents, teachers, and health professionals.[2] This is especially so as correct posture is an important component of a healthy musculoskeletal system.[3] It allows for the body to be neutrally aligned without involving excessive muscular effort or overloading the supporting structures of the musculoskeletal system.[4]

Research on posture and the identification of the interrelationships between the positioning of various body segments by using a variety of measurement methods has been of core interest for many researchers.[2,5-11] One of the most frequently reported research methods is the use of radiography, with most studies focusing on the position of the pelvis and its impact on maintaining balance in an upright standing position.[5,6,8] Significant relationships

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were observed between the position of the pelvis and other body segments depending on sex and age.

Other studies used photography (photogrammetry) to assess posture by using surface markers to determine bilateral symmetry,[12] which was regarded as a determinant of correct postural alignment. The use of photography is considered to be a reliable and valid tool in assessing the posture of children in the sagittal and coronal planes[9-11] and, most importantly, does not expose children to any harmful radiation devices. Other authors have also emphasized that photography is applicable in assessing the shape of the spine in the anterior-posterior plane to areas such as diagnosing posture and also finding the incidence of normal/abnormal posture in a population.[7] Also noteworthy are studies presenting a body posture classification system based on photogrammetric research on large populations of children and adolescents.[7,13,14]

Apart from the aforementioned methods, an assessment of muscle function has recently come to the forefront as a diagnostic tool in evaluating posture. Measurement of muscle function has been previously used in a wide gamut of analysis in physiotherapy, physical education, and sports and also in monitoring the efficacy of therapy and training programs. Several studies have determined a significant relationship between the curvature of the spine in the sagittal plane and trunk muscle strength in a variety of cases as well as in individuals with musculoskeletal disorders[15-18] Today, one of the most reliable and accurate methods of assessing muscle function is considered to be by isokinetic dynamometry and has been subject to numerous studies.[15-20] However, both isokinetic dynamometry and the other various methods available for assessing muscle function have largely been carried out on adults, with little research available on children and adolescent populations.

In addition, no reports defining the relationship between body posture and trunk muscle function are available in healthy children at ages critical in the development of correct posture. From a biological standpoint, the age of between 10 and 11 years is considered to be an important stage in life as it marks the period when maturation begins, with the onset of puberty at approximately 10 years of age in females and around 12 years in males. There is nonetheless a wide age range when maturation begins due to genetically determined growth rate, environmental factors, and lifestyle.[21] However, studies have shown that musculoskeletal disorders may develop even before the initial phase of puberty.[10,22]

It is, therefore, necessary to conduct research that, alongside an assessment of posture, evaluates trunk muscle strength in regard to the different types of posture children can exhibit. Knowledge of these interrelationships can help identify early musculoskeletal irregularities and develop effective treatments. Therefore, the goal of this study was to evaluate isokinetic trunk muscle strength in a group of adolescents aged between 10 and 11 years in relation to posture.

Methods

Participants

The study was composed of 145 children (67 males and 78 females) aged between 10 and 11 years from randomly selected primary schools located in the city of Wrocław, Poland. The schools were located in close proximity to the city center and had similar educational and athletic facilities. All the children attending these schools and meeting the age requirement were selected for inclusion. All lived in the city boroughs belonging to each school's district.

A preliminary orthopedic examination was used to eliminate children with any discrepancies in leg length, scoliosis, exaggerated kyphosis or lordosis, or any musculoskeletal disorder.

Written parental consent was obtained for every participating child. The children who met the right criteria for participation were then divided into 2 groups: younger group, 31 males and 48 females aged 10 years ($\overline{x}$ = 9.98 ± 2.43 and $\overline{x}$ = 9.85 ± 2.94 years, respectively), and older group, 34 males and 32 females aged 11 years ($\overline{x}$ = 11.14 ± 2.22 and $\overline{x}$ = 11.15 ± 2.32 years, respectively).

The research was performed by the same group of researchers, at the same time of day (morning hours), and in similar conditions at each school. Due consent was obtained from the school districts, the participating children, and their parents. The study procedure was approved by the Ethics Committee for Scientific Research of the University of Physical Education in Wroclaw, Poland.

It was assumed that trunk muscle strength will depend on age and the anterior-posterior curvatures of the spinal column, where children with abnormal posture would record lower values of isokinetic trunk muscle strength due to increased thoracic kyphosis and lumbar lordosis when compared to children with right posture.

Postural Assessment

The participants' body height, weight, and body mass index (BMI) were measured.[23] Posture was assessed by photogrammetry using a projector/camera system[24] from CQ Electronic (www.cq.electronicsystem.com). This system is based on the moiré projection technique and topographically measures the curvature of the spinal column by having anatomical markers placed on the back. The moiré phenomenon is a type of optical distortion created by the "interference" of light waves, as if an image was refracted. A light is used to project a series of visible lines on the surface of the back, which, at different angles, are distorted depending on the distance of each anatomical marker from the projector, mirroring the shape of the back. A camera records the image, and the software is used to create a contour map of the entire observed surface, in effect providing a 3-dimensional coordinate image of the back.