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ORIGINAL RESEARCH PAPER

POSTURE ASSESSMENT IN CHILDREN WITH AND WITHOUT DISABILITIES

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Abstract

Postural problems in children may lead to greater health problems in the musculoskeletal system as children grow. However, little is known about the variability of upright standing posture in children with various disabilities. This study aimed assessing the postural alignment of children (age 7 – 11 years) with intellectual, hearing, and visual disabilities. Postural alignment in standing was measured by using photogrammetry. The software ArchiCAD program was used to analyse data. Participants were 37 children (age 7 – 12 years) including 28 children with disability and 9 typically developed children. In the frontal plane, the asymmetry of posture and deviation of reference points was found in children with disabilities and also their peers without disability. Deviation of the posture from vertical axis was not found only in children with hearing disabilities. The most common deviation outcomes were lateroflexion of the head, asymmetry of shoulders, and scapulae, asymmetry of the pelvis, and asymmetry between ASIS and PSIS. In the sagittal plane the most common deviations were forward posture deviation, deviation of the head in relation to vertical and horizontal axis, the placement of the first vertebra and the manubrium against the horizontal axis, and pelvic inclination. The obtained results from this study revealed that postural deviations in children with mild and moderate disability are similar to those in typically developing children.

Key words: *postural alignment, children with and without disability*

Introduction

The most common health problems determined in preschool and elementary school age children in Latvia are related to posture, speech and language, and vision. According data of the Centre of Disease Prevention and Control of Latvia (2016) about 15% of children age between 15 – 17 years have posture problems. It can be explained by growth spurts occurring during elementary school age (7–11 years) that cause widespread alterations in body shape and dimensions, and affecting muscle tightness and flexibility (Bloomfield, Ackland, & Elliot, 1994).

Posture indicates relation between the spinal segments and environmental factors. Vertical posture is considered to be an important indicator of the musculoskeletal health. The ideal alignment in the vertical posture is related to the gravity line, which is an imagined vertical line passing through the center of gravity of the body. Previous research findings indicated that disability increases the risk of acquiring postural disorders in children with visual and hearing disabilities (Zwierzchowska, & Gawlik, 2007; Ray, Horvat, Croce, Mason, & Wolf, 2008) and intellectual disorders (Hill & Goldsmith, 2010). The Posture Committee of the American Academy of Orthopaedic Surgeons (1947) defined correct posture as “the state of muscular and skeletal balance which protects the supporting structures of the body against injury or progressive deformity, irrespective of the position (erect, lying, squatting, or stooping) in which these structures are working or resting”. While there is not standard approach to measure posture, the photogrammetry has been found to be reliable and cost-effective approach used in many studies (Claeys, Brumagne, Deklerck, Vanderhaeghen, & Dankaerts, 2016; McEvoy & Grimmer, 2005; Watson, & Mac Donncha, 2000). The progressive trend of postural deviations in children, including those with disability, followed by costly rehabilitation requires more evidence based research on posture variables in elementary school age children with disabilities. Therefore, this research aimed to assess posture in children with visual, hearing and intellectual impairments and their typically developed peers.

Materials and Methods

Participants in this study were 28 children with mild to moderate disability age from 7 – 12 years (8 with hearing, 8 with visual and 12 children with intellectual impairment) and 9 healthy children. Children with disability were recruited from special education programmes according to the Regulations of the Cabinet of Ministers No. 990 "Regulations on the Classification of the Latvian Education" (2008). The nine typically developed children were randomly selected from the general education program. The study received the Ethics Committee approval of the affiliated institution of the authors of this study. All participants and/or their parents/guardians provided written consent priori to the study. The photogrammetry method applied to obtain postural assessment data of all participants in the orthostatic position from the sagittal and frontal views.

The reference points cited by Kendall et al (1994) were used. Researchers used coloured circular stickers (diameter of 0.5 cm) to mark these points on each participant. The Ideal Postural Alignment (Normal posture) defined by Kendall et al (2005) was used to analyse obtained (Kendall, McCreary, Provance, Rodgers, & Romani, 1994; Васильева, 1996). The following reference points were marked in frontal plane: *mastoideus process, acromia and scapula, upper medial corners and shoulder blade (scapula) lower corners, iliac crest and posterior superior iliac spine (PSIS)*. Furthermore, in posterior plane following reference points were marked: *eye cavity outer canthi, iliac crest and anterior superior iliac spine (ASIS).* To assess posture deviation in the frontal plane, the following reference points were marked: *chin, manubrium and symphysis.*

In the sagittal plane, the following reference points were marked: *external auditory canal, the eye cavity outer canthus, manubrium, acromion process and axillary line, ASIS and PSIS.* To assess posture deviation in the sagittal plane, the following reference points were marked: *ear external opening, acromion, trochanter, lateral condyle, and lateral malleolus.*

A digital camera (Canon D5000) was positioned at a standard distance of 5.00m from the platform at a height of 1.20m. The camera's height was adjusted individually so that the imaginary lens axis would go through the centre of gravity of the participant (Galeja, 2015). The subjects wore bathing clothes and/or shorts and top. The pictures were taken from the anterior, and posterior directions (frontal plane) as well as from both sides (sagittal plane).

The obtained pictures were processed using computer programme ArchiCAD, analogous to computer programme MathCAD 14 (PTC, Needham, MA, USA) (Claeys, Brumagne, Deklerck, Vanderhaeghen, & Dankaerts, 2016). The posture characteristics in the frontal and sagittal planes were analysed by using angle measures between the reference points and its deviation from the horizontal and vertical axis. These angular measures have been previously used in studies investigating posture (Smith, O'Sullivan, & Straker, 2008).

Statistical calculations were performed by SPSS 19 and Microsoft Office Excel add-on programme Statistics 3.1. Descriptive statistics were used to check for normal distribution. Furthermore, nonparametric data analyses were used for further processing of quantitative study outcomes.

Results

In total seven reference points were assessed to analyse the body alignment of all participants in the frontal plane (Figure 1). For example, for the first reference point indicating the average deviation angle of the body from vertical was 1.04± .35^0 in children with visual impairment, .74± .17^0 in children with intellectual impairment, and 2.03± .42^0 in children without disability. However, none of children with hearing impairment did not present posture deviation from the vertical axis.

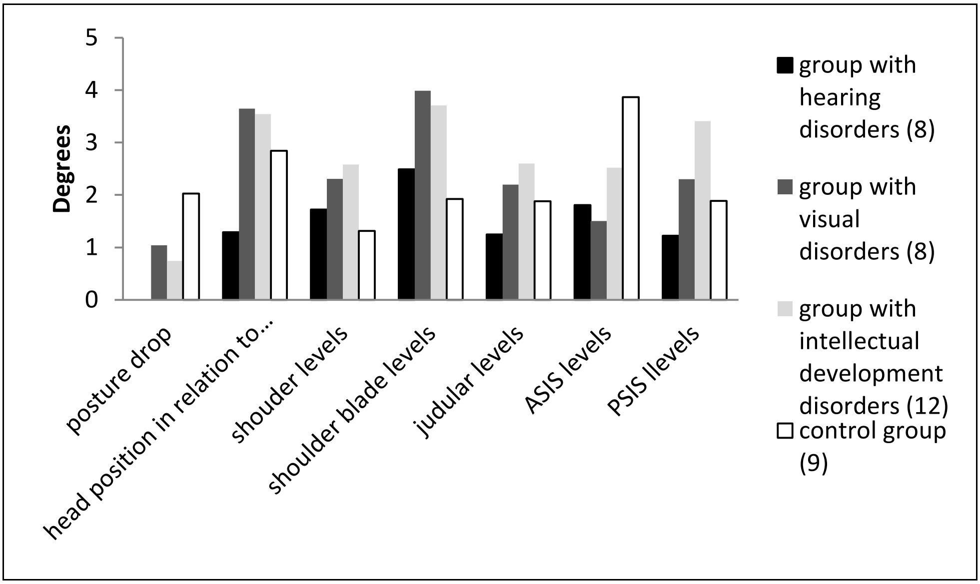

Figure 1. Mean results of the posture reference points in frontal plane

The average outcome results of the second reference point indicating the head position in relation to the vertical for children with hearing impairment was 1.29± .30^0, for children with visual impairment it was 3.65± .79^0, for children with intellectual impairment it was 3.55± .74^0, and for children without disability it was 2.84± .48^0.

The average outcome of the shoulder asymmetry measures in children with hearing impairment was 1.72± .59^0, in children with visual impairment it was 2.31± 0.41^0, in children with intellectual impairment it was 2.58± .42^{0,} while for children without disability it was 1.32± .31^0.

Analysing the measurement results of the reference points in shoulders (*scapula*) in relation to the Ideal Postural Alignment (Normal posture) defined by Kendall et al (2005), asymmetry in the right and left lower corner of the scapula was found in all participants. As illustrated in Figure 1 for children with hearing impairment the average deviation from Normal posture was 2.49± .50^0, for children with visual impairment it was

3.99±1.08^0, in children with intellectual impairment it was 3.71± .67^0, and in children without disabilities it was 1.93± .22^0.

Furthermore, analysing the measurement results of the reference points in pelvis the asymmetry of the the iliac crest in relation to the horizontal plane was found in all participants indicating deviation from the Ideal Postural Alignment (Normal posture) defined by Kendall et al (2005). The Figure 1 illustrates that the average asymmetry of iliac crest reference points in children with hearing impairment was 1.25± .41^0, in children with visual impairment it was 2.20± .62^0, in children with intellectual impairment it was 2.60± .54^0, and in typically developed children it was 1.88± .29^0. Also, measures of the placement of ASIS reference points revealed asymmetry between the right and left side in all participants. In children with hearing impairment the average asymmetry angle was 1.81± .54^0, in children with visual impairment it was 1.50± .25^0, in children with intellectual disability it was 2.52± .39^0, and in typically developed children it was 3.87± .91^0. Analyses of the PSIS reference points in relation to the Ideal Postural Alignment (Normal posture), the asymmetry was found in all participants. The average asymmetry angle in children with hearing impairment was 1.22 ± .35^0, in a group with visual impairment it was 2.30± .54^0, and in a group with intellectual disability it was 3.41± .68^0, and in typically developed children it was 1.89± .22^0.

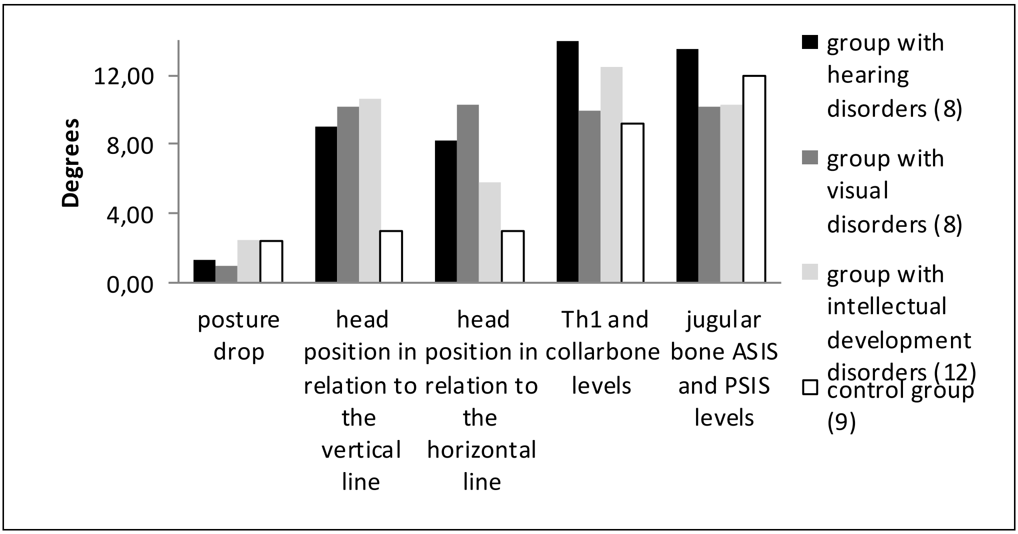

Figure 2. Mean results of the posture reference points in the sagittal plane

Analyses of obtained results for posture reference points in the sagittal plane, deviation from the Ideal Postural Alignment (Normal posture) was found in all selected parameters (Figure 2). For example, the mean results of the reference point indicating the angle of the body deviation from vertical indicated that all participants displayed forward posture deviation. In children with hearing impairment the average angle of forward deviation of the posture was 1.27± .28^0, in children with visual impairment it was .93± .36^0, in children with intellectual impairment it was 2.46± .43^0, and in children without disability it was 2.40±0.43^0.

Furthermore, for all participants the measurement outcomes of the head in relation to the vertical indicated deviation from the Ideal Postural Alignment (Normal posture). In the children with hearing impairment the mean deviation angle was 9.01± 2.02^0, in children with visual impairment it was 10.18±2.20^0 on the average, in children with intellectual impairment it was 10.67±2.31^0, and in children without disability it was 3.00± .58^0.

Also, the assessment outcomes for the head position in relation to the horizontal axis indicated deviation from the Ideal Postural Alignment (Normal posture). The mean deviation angle in children with hearing impairment was 8.2±2.2^0, in children with visual impairment it was 10.28±2.90^0 on the average, in children with intellectual impairment it was 5.79± .94^0 on the average, and in typically developing children it was 2.99± .65^0.

As in results described above, the study outcomes for the placement of the first vertebra and the manubrium against the horizontal axis indicated deviation from the Ideal Postural Alignment (Normal posture). The mean deviation angle in children with hearing impairment it was 13.97±2.11^0, in children with visual impairment it was 9.95±2.54^0, in children with intellectual impairment it was 12.46±1.38^0, and in typically developing children it was 9.23±1.77^0.

Analysing average study outcomes of the pelvis position in the sagittal plane described as reference points of ASIS and PSIS in relation to the horizontal axis had deviation angle over 5^0 indicating difference from the Ideal Postural Alignment (Normal posture). In children with hearing impairment it was 13.54±2.06^0, in children with visual impairment it was 10.20±1.97^0, in children with intellectual impairment it was 10.26±1.14^0, and in children without disability it was 11.92± .89^0.

Discussion

This study presented measures of posture reference points indicating that children with visual, hearing and intellectual impairments and their typically developing peers had deviations from the Ideal Postural Alignment (Normal posture). Also, other authors have presented similar results when assessing posture in children without health disorders (e.g., Claeys, Brumagne, Deklerck, Vanderhaeghen, & Dankaerts, 2016; Penha, Casarotto, Sacco, Marques, & João, 2008; Paušic, Pedišic, & Dizdar, 2010).

For example, Paušic et al (2010) found deviation of the head, shoulder and pelvis placement in boys (n=273) from 10 to 13 years of age. Furthermore, authors of previous studies have listed many factors causing the development of postural disorders where the most common factor is muscle imbalance (Kendall et al., 1994; Васильева, 1996).

Assessing the reference points in neck and shoulder in relation to the Ideal Postural Alignment (Normal posture) in the frontal plane, we found lateral flexion of the head and asymmetry in the shoulders in all participants. This outcome might be explained by the relationship between the curve of the head and neck in the frontal plane, which in turn, can be resulted from unbalanced tightening muscles on the right and left side of the neck (Almeida, Guimarães, Moc, Menezes, Mafort, & Lopes, 2013).

Also, out study revealed asymmetry in the lower corner of *scapula*. According literature this asymmetry in children can develop if the *scapula* is rotated medially which in turn can influence the muscle tone of the upper part of *m. trapezius* (Kendall et al., 1994; Васильева, 1996).

In the sagittal plane the obtained results of reference points revealed that all participants had retroflexion of the head. Also, deviation from the Ideal Postural Alignment (Normal posture) was found in reference points of first vertebra and the manubrium. The reason for deviations in the head, neck and the shoulder segments might be related to a weakness of deep neck flexor muscles and posterior shoulder muscles (Watson, & Trott, 1993; Jull, Barrett, Magee, & Ho, 1999; Placzek, Pagett, Roubal, Jones, McMichael, Rozanski, & Gianotto, 1999; Almeida et al., 2013; Galeja, 2015).

This study found that for all participants' measures of reference points in pelvis were deviating from the Ideal Postural Alignment (Normal posture). The pelvis placement in frontal and sagittal plane can be affected by imbalance between the lateral and frontal abdominal muscles, and pelvis muscles (Левит, Захсе, & Янда, 1993; Васильева, 1996). Also, authors have indicated that the abdominal front and lateral muscles form the abdominal wall protecting respiratory organs and making the intra-abdominal pressure, which in turn, provides stability in lumbar segments of the spine. These muscles also prevent pelvic inclination. People with decreased strength in abdominal muscles have increased lumbar lordosis (Васильева, 1996).

Moreover, authors have reported that *m. quadratus lumborum* affects lateral traction strength on vertebras of the lumbar part of the spine and provides intra-abdominal pressure. All together with deep core muscles it ensures the lumbar and pelvic stability. In case of the imbalance between the muscle strength and length, the pelvic position changes, for example, forming hip asymmetry, or iliac deviation (Oatis, 2009). Our study was in line with outcomes of other authors presenting hip asymmetry in all participants.

Overall, outcomes of the posture assessment in this study was in line with the literature reporting that there are reflector relations between the vertebrae of the spine segment, muscles that stabilizes the head, and the pelvic functional position. Any functional impairment, for example, movement restrictions, functional blocks, heightened muscle tone, in these body parts, will cause changes in the pelvic functional position (Левит et al., 1993).

Conclusions

The obtained results from this study revealed that postural deviations in children with mild and moderate disability are similar to those in typically developing children.

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