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STUDY ON TRUNK ASYMMETRY IN CHILDREN AGED 10-15 YEARS

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ABSTRACT. **Background**: A school screening for trunk asymmetries was performed in 2015, to assess children and teenage population the prevalence of these asymmetries. **Objectives:** To report the prevalence of trunk asymmetry in normal children and adolescents in Cluj-Napoca, by a cross-sectional study. **Methods**: The traditional Adam's forward bending test and scoliometer readings were used during the screening program to collect quantitative data. The angle of trunk rotation was measured to quantify the existing trunk asymmetry. A number of 373 subjects (199 male and 174 female) were screened, with a mean age of 13.0 ±1.48 (girls 12.73±1.51; boys 13.26±1.41). **Results**: The subjects were divided into two groups according to the severity of trunk asymmetry. In the first group, asymmetry was 1 to 6 degrees and in the second group was 7 or more degrees. The mean frequency of (severe) asymmetry of 7 or more degrees was 1.84% in boys and 7.28% in girls. The mean frequency of symmetric (angle of trunk rotation = 0 degrees) boys and girls was 70.5% and 66.7%, respectively. **Conclusions**: 47.7% of boys and 41.7% of girls were found to be absolutely symmetric in all regions of the spine. Girls are found to have a higher frequency of asymmetry than boys do. Right trunk asymmetry was more common than left. These findings are also supported by several studies from other European regions.

Keywords: trunk asymmetry, school screening, scoliosis, scoliometer measurement.

REZUMAT. **Studiul asimetriei trunchiului la copiii cu vârsta cuprinsă între 10-15 ani. Introducere**: În 2015 a fost efectuat un screening școlar pentru depistarea asimetriei trunchiului, cu scopul de a raporta prevalența acestei asimetrii la copiilor de vârstă școlară. **Obiective:** Raportarea prevalenței asimetriilor trunchiului la copiii și adolescenții sănătoși la Cluj-Napoca, printr-un studiu transversal. **Metode**: În cadrul acestui program de depistare au fost folosite testul Adam's – testul înclinării spre înainte - și măsurarea scoliometrică pentru a colecta date cantitative. Unghiul de rotație a trunchiului a fost măsurat pentru a cuantifica distorsiunile torsului. Au fost incluși 373 de subiecți (199 băieți și 174 fete), vârsta medie a elevilor fiind 13,0 ±1,48 (fete 12,73±1,51; băieți 13,26±1,41). **Rezultate**: Subiecții au fost împărțiți în două grupuri în funcție de severitatea asimetriei trunchiului. În primul grup au fost clasați cei cu asimetrii între 1 și 6 grade, iar în al doilea cei cu asimetria de 7° sau de la 7° în sus. Frecvența asimetriilor severe (7°≤) este de 1,84% la băieți și de 7,28% la fete.

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Frecvența spatelui simetric (unghiul de rotație a trunchiului = 0°) la băieți este de 70,5% și respectiv de 66,7% la fete. **Concluzii**: Din această cercetare reiese că fetele sunt mai afectate de asimetriile spatelui decât băieții. Asimetria toracică dreaptă este mult mai des întâlnită, decât cea stângă. Aceste constatări sunt susținute și de alte studii făcute în regiunile Europei.

Cuvinte-cheie: asimetria trunchiului, screening școlar, scolioză, măsurare scoliometrică.

Introduction

The purpose of scoliosis school screening is to detect back trunk asymmetry in children at risk to develop progressive scoliosis. Detection at an early stadium when the spinal deformity is likely to go unnoticed offers a unique opportunity for a less non-invasive (conservative) method treatment (Grivas, et al., 2007).

Currently, in Romania, there has not been any consistent or centralized preoccupation for scoliosis nor whatever type of physical deficiencies school screening. In the 1950-60,'s a periodical physical evaluation of the children was mandated by law and performed at the beginning of the school year (Ionescu, 1961). The deficiencies are often discovered through casual medical examinations, and in many cases the curves are far-gone progressed, so it is not possible to apply a conservative treatment, like physiotherapy and bracing.

In the last two decades, private and state associations organized some minor screenings, which aims to detect different kind of physical deficiencies (Avramescu-Oprițoiu, 2008; Câmpeanu, et al., 2013; Maroti, et al., 2001). In Romania, there are no studies with regard to scoliosis school screening.

The trunk asymmetry is a relatively known phenomenon and was found in numerous studies (Grivas, et al., 2006; Nissinen, et al., 2000; Willner, 1984) to correlate well with the prediction of future scoliosis in children and adolescents. During a scoliosis school screening, the amount of asymmetry of the trunk shape is considered the strongest indicator for referral and further orthopaedic assessment of the normal children and adolescent population. This asymmetry has resulted by the existence of a hump at the thoracic, thoracolumbar or lumbar area (Bunnell, 1984).

The most commonly used test for screening for scoliosis is the Adam's forward bending test and the scoliometer reading. The scoliometer was introduced in 1984 to limit the subjectivity of the forward bending test, it quantifies the trunk deformation by determining the angle of trunk rotation (ATR). Is it widely accepted that 7 degrees of ATR at any level of the spine is

the ideal criterion for referral (Bunnell, 1993). The reliability, the validity and the diagnostic accuracy of the scoliometer and Adam's forward bend test were evaluated in some studies. It was found that the use of this tool as a screening device is appropriate (Amendt, et al., 1990), at the same time the scoliometer and Adam's forward bend tests have adequate inter-examiner reliability for the assessment of thoracic curves (Côté, Kreitz, Cassidy, Dzus, & Martel, 1998; Murrell, Coonrad, Moorman, & Fitch, 1993).

The ideal age for scoliosis screening can vary, since it depends on the gender, age and the age of the menarche. The girls should be screened twice, at age 10 and 12, and boys once at age 13 or 14 (Labelle, et al., 2013).

Objectives

This cross-sectional study aims to report the prevalence of trunk asymmetry in normal children and adolescents from one of the largest cities in Romania, Cluj-Napoca, and to compare the obtained results with the results of other countries from Europe.

Materials and methods

In this study, 373 children (199 boys and 174 girls) aged from 10 to 15 years old were investigated, during a school screening program, between 2015 march and 2015 may. The scoliometer readings in standing forward bending position was performed and the trunk asymmetry was quantified by measuring the angle of trunk rotation at mid-thoracic (T_4-T_8), thoracolumbar (T_{12}-L_1) and at the lumbar (L_2-L_5) regions of the spine.

The scoliometer

The Bunnell scoliometer is a specially designed inclinometer that measures distortions of the torso. This device reveals children with a surface, mainly thoracic surface deformity. It does not reveal scoliosis per se. It was introduced in 1984 to limit the subjectivity of the forward-bending test. Is not sufficient to use this method alone for determining patient diagnosis and management, but based on a positive-frequency analysis the use of this instrument as a screening device would be appropriate (Grivas, Vasiliadis, Mihas, & Savvidou, 2007).

Traditionally, scoliosis screening is done either by Adam test or by using other optical techniques, while the radiographic measurement of Cobb angle is considered the golden standard (Patias, Grivas, Kaspiris, Aggouris, & Drakoutos, 2012). Although X-ray is the golden standard for diagnosis of idiopathic scoliosis, it is not used as a screening method because of the risk associated with radiation exposure (Kotwicki, et al., 2013).

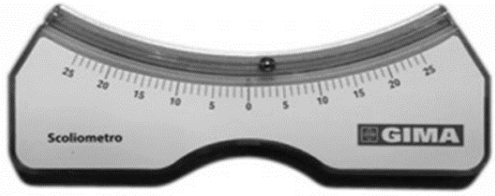

Figure 1. The scoliometer

The Adam's forward bending test

The subject was asked to bend forward, looking down, keeping the feet 15 cm apart, knees braced back, shoulders loose, hands positioned in front of the knees or shins with elbows straight, and palms opposed. The side of the hump determined the laterality of trunk rotation. Trunk asymmetry to the right side (higher hump on the right) was defined as right asymmetry and to the left (higher hump on the left) was defined as left asymmetry in each of the three mentioned regions and recorded in degrees. The scoliometer measurements were obtained successively at the same three areas of interest. Four rectangular lines on the floor of the sports court were drawn to help the subject in the positioning of their feet.

The examined children

The children were selected from two high schools from the centre of the city. The convenience non-probability sampling method was used to select the sample. The average age of the sample was 13.0 ±1.48 (girls 12.73±1.51; boys 13.26±1.41). 75% of the screened children come from the urban area and the remaining twenty-five percent from the rural area.

Scoliometer measurement equal to 0º was defined as symmetry at the particular level of the spine. Any other measured value was defined as asymmetry. According to the severity of the trunk asymmetry, the subjects were divided into two groups. In the first group, the scoliometer readings were less than 7º

and in the second group, the scoliometer readings were 7º or more. Right asymmetry was noted with a plus (+) and left asymmetry was noted with a minus (-). All subjects of the second group were referred to the hospital for further clinical and radiological examination.

Statistical method

For the statistical analysis, the SPSS-v.19 statistical package was used. Descriptive statistics were used to get descriptive information about the quantitative data. Were included the next statistical techniques: frequencies, mean, standard deviation. The frequency of symmetry, mild and severe trunk asymmetry for both boys and girls was quantified in standing forward bending position for the all examined regions of the trunk.

Results

In the investigated sample, it was found that greater part of the subjects have a mild or a severe trunk asymmetry. Mild asymmetry was present in 45.6% of subjects, however severe trunk asymmetry in 9.9% of the subjects.

Table 1. Prevalence of the asymmetry

	Symmetric	Mild Asymmetry	Asymmetry
Percent [%]	44.5	45.6	9.9

Forty-seven percent of boys and forty-one percent of girls were symmetric in the all regions of the back (ATR=0º) in standing forward bending position (FBP). If the three regions of the spine are separated and compared, there are differences between the regions and the two sexes. More than seventy percent of boys and sixty-nine percent of girls were symmetric in the thoracic region in FBP. For the thoracolumbar region, 67.3% of boys and 60.3% of girls were symmetric. 73.4% of boys and 70.7% of girls were found to be symmetric in the lumbar region, in the same position.

Mild asymmetry (ATR=1º - 6º) in the thoracic region was found in 28.6% of boys and in 24.1% of girls in standing forward bending position. In the thoracolumbar region, mild asymmetry was found in 29.7% of boys and in 29.3% of girls. In the last region, 24.6% of boys and 24.7% of girls were found to have mild asymmetry in standing position.

Table 2. Frequency of trunk asymmetry in boys and girls

Regions of the spine	Boys			Girls		
	Symmetric [%]	Mild asymmetry [%]	Asymmetry [%]	Symmetric [%]	Mild Asymmetry [%]	Asymmetry [%]
Thoracic	70.85	28.65	0.50	68.97	24.13	6.90
Thoracolumbar	67.30	29.70	3.00	60.34	29.32	10.34
Lumbar	73.37	24.63	2.00	70.69	24.71	4.60
Mean	70.51	27.66	1.84	66.67	26.05	7.28

Severe asymmetry (ATR ≥ 7º) in the thoracic region was found in 0.5% of boys and in 6.9% of girls. In the thoracolumbar region, severe asymmetry was found in 3.0% of boys and in 10.3% of girls. In lumbar region, severe asymmetry was found in 2.0% of boys and in 4.6% of girls in standing position.

The distribution of mild and severe trunk asymmetry – right or left – in standing forward bending position in the three examined regions of the spine in both girls and boys is shown in Table 2.

According to the severity of the trunk asymmetry, the subjects were divided into two groups. In the first group, the scoliometer readings were less than 7º and in the second group, the scoliometer readings were 7º or more. Right asymmetry was recorded with a positive sign (+) and left asymmetry with a negative sign (-).

All parents of the children and adolescence of the second group (ATR ≥ 7º) were informed by a letter of advice about their children condition. They were recommended to subsequently visit a hospital for further clinical and radiological examination.

Table 3. Frequency of asymmetry in *boys*.
Scoliometer readings at standing FBP

Regions of the spine	**Symmetric** [%]	**Asymmetric** [%]					**Severe asymmetry** [%]
		-2	-1	+1	+2	Total	(-2)+(+2)
Thoracic	70.85	0.5	9.56	19.09	0	29.15	0.5
Thoracolumbar	67.30	1.0	10.1	19.6	2.0	32.70	3.0
Lumbar	73.37	1.0	17.09	7.54	1.0	26.63	2.0
Mean	70.51	0.83	12.25	15.41	1.0	29.49	1.84

Table 2. and Table 3. show the difference in scoliometer readings between standing forward bending position at the three examined regions for boys and girls.

Table 4. Frequency of asymmetry in *girls*.
Scoliometer readings at standing FBP

Regions of the spine	**Symmetric** [%]	**Asymmetric** [%]					**Severe asymmetry** [%]
		-2	-1	+1	+2	Total	(-2)+(+2)
Thoracic	68.97	1.15	10.34	13.79	5.75	31.03	6.90
Thoracolumbar	60.34	1.15	8.62	20.70	9.19	39.66	10.34
Lumbar	70.69	2.30	13.79	10.92	2.30	29.31	4.60
Mean	66.67	1.53	10.92	15.14	5.74	33.33	7.28

The frequency of symmetry is greater in boys than in girls as shown in tables 2 and 3. The average score of symmetry in boys is over seventy percent while in girls is with four per cent less than in boys. The girls were found to dispose of a rather more severe trunk asymmetry than boys did, the ratio being four times greater in girls. The most affected part of the spine was the thoracolumbar part in both boys and girls. Mild asymmetry at this region was 29.7% in boys and 29.3% in girls, while severe asymmetry 3%, respectively 10.3% in girls.

Trunk asymmetry is more common in girls and almost in every region of the spine to the right side, with the exception of the lumbar area at mild asymmetries.

Discussion

This study respects the Bunnell's (1984) indications for a critical value of 7 degrees of the angle of trunk rotation in the scoliosis screening. Trunk asymmetries are found in normal children with no spinal curves because scoliometer measurements of 1º - 6º are considered associated with nonscoliotic spines. A spinal curvature is considered to be scoliotic if it is greater than 10º of Cobb angle. However, children with 5º - 6º of scoliometer measurements are good to be followed up clinically at a medical centre every 4-6 months (Grivas, et al., 2006).

We found that in the studied population, severe trunk asymmetry (which is associated with a possible scoliotic curve) is more common to the right side. This finding is supported by almost every study made on this topic (Grivas, et al., 2006; Grivas, Vasiliadis, Mihas, Triantafyllopoulos, & Kaspiris, 2008).

Seventy percent of boys and sixty-eight percent of girls were found to be symmetric in the thoracic region of the spine in the standing forward bending position. In the other two regions of the spine, we found the next values of symmetry for the boys and girls: thoracolumbar region 67% (boys) – 60% (girls),

lumbar region 73% (boys) – 70% (girls). In the screened population we found that the boys are more symmetric at all levels of the spine than girls do. These findings are supported by several other studies performed in Europe or in all over the world (Grivas, et al., 2008; Grivas, et al., 2006; Vercauteren, et al., 1982; Yong, Wong, & Chow, 2009).

At the all three regions of the spine 47.7% of boys and 41.4% of girls were found to be symmetric. A subject, whose spine was found to have asymmetry in one of his regions, was disposed to have asymmetry in all the three regions of the spine. The previous statement is more valid if the asymmetry is a severe one. The low proportion of the children to be symmetric is not an unusual fact. It is remarked in almost every study published on this topic, but a very extreme and low proportion of trunk symmetry is noted by Nissinen, Heliovaara, Ylikoski, & Poussa (1993). Only 8.3% of the children were found to be symmetric (thoracic hump between 0 – 2 mm) in the forward bending test.

It was found that severe trunk asymmetry is present in girls more than four times than in boys (7.28% – 1.84%, ratio = 3.96:1). Several studies show very similar ratios, but sometimes this gap between the female and male is greater. For example, Willner and Udén (1982) found in Sweden during scoliosis screening a total scoliotic incidence of 3.2% in girls and 0.5% in boys. The corresponding ratio was 1:3.6. Renshaw noted that the female to male ratio is 2:1 when Cobb angle is more than 10º; however, it reaches 5:1 or 6:1 when Cobb angle is more than 20º (Renshaw, 1988). The fourteen years old boys and the twelve years old girls were found to dispose of the most severe trunk asymmetries.

Conclusions

Overall, after a thorough analysis of the results of the school screening we might conclude that:

- the prevalence of back trunk severe asymmetry found in the studied population was 1.84% in boys and 7.28% in girls;
- the prevalence of back trunk mild asymmetry was of 29.24% in boys and 33.33% in girls;
- 47.7% of boys and 41.4% of girls were found to be absolutely symmetric in all regions of the spine;
- the most affected part of the spine is the thoracolumbar region in both boys and girls, but trunk asymmetries are more common in girls than in boys;
- it was found that severe trunk asymmetry (which is associated with a possible scoliotic curve) is more common to the right side;

- it seems that the 14 years old boys and 12 years old girls are disposed to have a higher prevalence of severe trunk asymmetries.

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