Trunk asymmetry at children aged 10-15 years: relation between amount of asymmetry and risk factors.

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Abstract

Objective: This study focuses on the possible associations between the trunk asymmetry (TA) and different risk factors, such as: Body Mass Index (BMI), place of residence (rural/urban area), the gender of the subjects and the level of the physical activity.

Methods: The data for this study was obtained from a cross-sectional survey of school children carried out in 2015 in Cluj-Napoca, Romania. In this study 487 pupils (260 boys and 227 girls) aged 10-15 years were included. The angle of trunk rotation (ATR) was obtained from scoliometer readings. The level of the physical activity was calculated from the Physical Activity Questionnaire for Older Children. The statistical analysis was carried out on the obtained mean values (independent sample t-test, paired-sample t-test, ANOVA), and the relation between variables was analyzed by the Pearson correlation coefficient.

Results: In case of subjects from urban area the degree of TA was 2.75º(±2.85º), and in case of those from rural area 2.09º(±2.23º), t= 2.813, p = 0.005. The TA was lower in subjects who live in rural area, in houses: 2.07º(±2.21), than in case of those who live in flats in urban area: 2.86º(±2.94), (p = 0.032). The level of physical activity in case of boys is higher than in case of girls (boys 2.82±(0.68), girls 2.62(±0.67)). The Pearson correlation test did not find any correlation between the angle of trunk rotation and the level of physical activity: r= 0.000, p = 0.998. The degree of TA is higher in case of girls, than in case of boys (girls 2.88º(±2.91º), boys 2.19º(±2.38º)), t = - 2.601, p = 0.010. However, we found small correlation between the BMI and the TA in case of boys who have a degree of trunk asymmetry ≥5º: r = - 0.289, p = 0.044.

Conclusions: The study revealed the lack of correlation between the TA and BMI, place of residence and the level of physical activity practiced. However, in case of boys we found a small correlation between the BMI and sever asymmetry.

Key words: *trunk asymmetry, scoliosis, children aged 10-15, physical activity.*

Rezumat

Scop: Acest studiu se axează pe investigarea unor relaţii posibile între asimetria spatelui (AS) şi diferiţi factori favorizanţi, cum ar fi: indicele de masă corporală (IMC), mediul de reşedinţă, genul subiecţilor şi nivelul activităţii fizice.

Metode: Datele acestui studiu transversal au fost obţinute în urma unui screening şcolar efectuat în anul 2015 în Cluj Napoca (România). În studiu au fost incluşi 487 elevi (260 băieţi şi 227 fete) cu vârste cuprinse între 10-15 ani. Asimetria spatelui a fost evaluată prin măsurarea unghiului de rotaţie al spatelui, cu ajutorul unui scoliometru. Pentru determinarea nivelului activităţii fizice a subiecţilor a fost aplicat chestionarul Physical Activity Questionnaire for Older Children (PAQ-C) elaborat în 1997. Datele înregistrate au fost analizate statistic prin compararea valorilor medii (testul t pentru eşantioane independente şi pentru un singur eşantion, testul ANOVA), iar relaţiile dintre variabile cu ajutorul coeficientului de corelaţie (corelaţie liniară Pearson).

Rezultate: AS la subiecţii din mediul urban a fost de 2.75º(±2.85º), iar în cazul celor din mediul rural de 2.09º(±2.23º), t = 2.813, p = 0.005. Mărimea asimetriei a fost mai mică la subiecţii care locuiesc în mediul rural la casă 2.07º(±2.21), decât la cei care locuiesc în mediul urban la bloc: 2.86º(±2.94), (p = 0.032). Nivelul activităţii fizice al băieţilor 2.82±(0.68) este mai mare, decât al fetelor 2.62(±0.67). Testul de corelaţie Pearson nu a găsit corelaţie dintre unghiul de rotaţie al spatelui şi nivelul activităţii fizice: r = 0.000, p = 0.998. AS este mai mare la fete 2.88º(±2.91º), decât la băieţi 2.19º(±2.38º), t = - 2.601, p = 0.010. S-a constatat că există corelaţie foarte slabă, între IMC şi AS în cazul băieţilor care au asimetrii ≥5º: r = - 0.289, p = 0.044.

Concluzii: Studiul a relevat lipsa de corelaţie dintre asimetria spatelui şi IMC, genul subiecţilor, mediul de reşedinţă sau nivelul de activitate fizică practicată. Totuşi, la băieţi s-a constatat o corealaţie slabă între IMC şi asimetria gravă.

Cuvinte cheie*: asimetria spatelui, scolioză, copii de 10-15 ani, activitate fizică.*

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Introduction

The trunk asymmetry is a common physical disability in school age-children[1].It's prevalence, as well as the deficiencies of the locomotor system depend on several factors, among which: accidents, genetic factors, nutritional factors, lifestyle, lack of physical activity, psychological problems, etc.[2],as well as gender, age, residence area or the physical activity level of the subjects [3,4].We should focus on this postural problem, because this is the strongest factor that indicates the presence or predisposition to a scoliotic curvature [5].This fact is demonstrated by several studies, that find correlation between the truncal asymmetry and the scoliotic curvature (>10 Cobb degrees) in childhood and adolescence [6].

In order to measure the back trunk asymmetry several different methods were developed, but the most commonly used is the clinical examination using a scoliometer, especially when a school screening program is performed [7]. This type of examination method has multiple advantages: 1) the scoliometer is easy to use, 2) it is a cost effective tool and screening method[8]; 3) the evaluation can be performed in a relatively short time on a large sample, 4) it is not necessary for the examiner to have a medical qualification, 5) the method provides relatively reliable results [9].

The purpose of this study was to identify associations between trunk asymmetry and other various factors, such as body mass index (BMI), residence area (rural / urban), gender of the subject and physical activity level.

Materials and methods

Subjects

The study was conducted between March and May 2015 in three schools: one in Sălajcounty (rural school) and two in Cluj county (urban schools). The sample included 487 children age 10-15 years, 227 girls (46.7%) and 260 boys (53.3%). The sample was selected using the convenient non-probabilistic sampling method.

The children who were included in this study were examined during a school screening of scoliosis.The trunk asymmetry was quantified by measuring the angle of trunk rotation at mid-thoracic (T_4-T_8), thoraco-lumbar (T_{12}-L_1) and at the lumbar (L_2-L_5) regions of the spine.

Instruments and the measuring procedure

The Physical Activity Questionnaire for Older Children (PAQ-C) developed by Kowalski, Crocker and Faulkner was used to determine the level of physical activity, suitable for pupils age 10-15 [10].

To obtain additional information on the socio-demographic data of the subjects, the questionnaire was completed with seven new questions. The time required to complete the questionnaire was between 15-20 minutes. Respondents were rated by the same person.

Measurements of waist, body mass and trunk asymmetry were performed using Secatalimeter, Beurer BG 17 digital scale and a GIMA scoliometer, which is an instrument designed and introduced in practice by Bunnell in 1984, to limit the subjectivity of the forward bending test (Adam's test) [11]. It is used for rapid quantification of the angle of trunk rotation. The angle of rotation should be measured at three levels of the spine: at thoracic vertebrae T4-T8, at the limit of the thoracic and lumbar region T12-L1 and at lumbar vertebrae L3-5.

The recorded results were statistically analyzed using the Statistical Package for Social Sciences (SPSS-v.20). The Pearson linear correlation test was performed, and the mean difference between the average values was tested with the t-Test and ANOVA.

Results

Measurements performed with the scoliometer revealed that symmetry is present in 44.5% of subjects, mild asymmetry in 45.6% and severe asymmetry in 9.9% of those evaluated.

More than 70% of the boys and 69% of the girls show symmetry in the thoracic region of the spine in standingforward bending position. The thoracolombar region is symmetric in 67.3% of the boys and in 60.3% of the girls (Table I).

Severe asymmetry in the thoracic region was found in 0.5% of boys and 6.9% of girls. In the thoracolombar region, severe asymmetry was found in 3.0% of boys and 10.3% of girls, also in the lumbar region the percent of asymmetry was 2.0% in boys and 4.6% in girls.

**Table I. -** Frequency of trunk asymmetryi n boys and girls

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

In the case of the urban sample, the meanasymmetry is 2.75º (± 2.85º) and in the rural sample 2.09º (± 2.23º), the significance test result is t = 2.813, p = 0.005. Similarly, the girls were found to have higher values of trunk asymmetries (2.88º ± 2.91º) than boys (2.19º ± 2.38º), t = - 2.809, p = 0.005.

Table II. The distribution of the subjects according to age

Boys

Age [years]	Number of ex. Subjects	Percent [%]	Cumulative percent [%]
10	23	8.8	8.8
11	41	15.8	24.6
12	52	20	44.6
13	57	21.9	66.5
14	67	25.8	92.3
15	20	7.7	100

N = 260

Girls

Age [years]	Number of ex. Subjects	Percent [%]	Cumulative percent [%]
10	35	15.4	15.4
11	46	20.3	35.7
12	45	19.8	55.5
13	38	16.7	72.2
14	49	21.6	93.8
15	14	6.2	100

N = 227

Figure 1. - Correlation between BMI and severe asymmetry in boys, r (47) = - 0.289, p = 0.044.
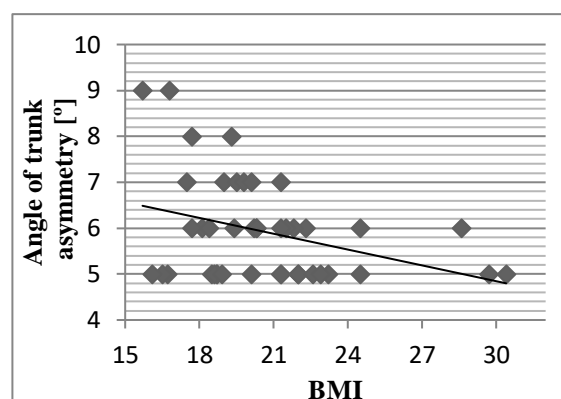
Of the children examined, 10.3% are left-handed and 89.7% right-handed. According to Holder [12], the proportion of left-handed and right-handed persons varies according to culture and geography. The number of right-handed persons is always higher, reaching 70% -95% of the population. Our study shows that in the case of the left-handed subjects, the mean asymmetry is 2.08º(± 2.25), while in the case of the right-handed subjects is 2.56º (± 2.71). According to the *t-testfor independent samples*, this difference is significant: t = 2.812, p = 0.006.

The distribution of the sample depending on the age and gender is presented in the Table II. The mean age of the subjects was 12.94 (± 1.45) years: 13.12 (± 1.41) years for boys and 12.73 (± 1.48) for girls.

One of the questions included in the questionnaire was how pupils travel to school (by personal car, by public transport, by bicycle, on foot, or by other devices: skateboard, roller, etc.).

The Tukey post-hoc test revealed that the value of the trunk asymmetry is significantly lower in the subjects who are going on foot to school (2.09º, p = 0.043) compared to the subjects who are going with personal cars (2.91º). No significant difference was found between subjects who go to school with cars and those using other means of transport (p = 0.461 for bus users, p = 0.999 for cyclists, p = 0.997 for skateboarders and trotter users).

The average physical activity score at the examined sample is 2.73 (± 0.68). Boys have a higher physical activity score (2.82 ± 0.68), than girls (2.62 ± 0.67), t = 3.258, p = 0.001. A value between 1 and 2 *is a mild physical activity*, between 2 and 4 *moderate*, and over 4 *intense physicalactivity*[10].

To determine the relationship between trunk asymmetry and physical activity level, the Pearson correlation test was applied (Table III). According to this test, there is no correlation between these variables: $r = 0.000$, p = 0.998. The results of the statistical analysis are similar, if we analyze separately the results of boys or girls. In the case of boys the result of the test is: $r = 0.055$, $p = 0.376$, and for the girls $r = - 0.014$, $p = 0.831$.

Table III. - Association between the trunk asymmetry and BMI, place of residence, physical activity level and the gender of the subjects

Dep. variable	Indep. variable	N	Pearson Corr.	Level of sign.
	BMI		- .085	.061
Trunk asymmetry	Place of residence	487	- .118	.009
	Level of Physical Activity		.000	.998
	Gender of the subj.		.128	.005

Regarding the relationship between trunk asymmetry and BMI, the analyses were performed at first on the sample of boys $r = - 0.085$, p = 0.169, then on the sample of girls $r = - 0.058$, p = 0.388, and finally on the whole sample $r = - 0.085$, $p = 0.061$, but no significant correlation was found between the investigated variables. A very low and negative correlation was found between BMI and trunk asymmetry, but only for boys with severe asymmetries (Figure 1), $r = - 0.289$, n = 47, $p = 0.044$. Between these two above mentioned variables there is no correlation in case of the group of girls: $r = 0.022$, n = 60, $p = 0.868$.

Discussion

The relationship between severity of trunk asymmetry and BMI was analyzed by the Pearson correlation test. No significant correlation was found between these two variables with the exception of boys with severe asymmetries ($\geq 5º$). A study [13] found that BMI has a significant and negative relationship with trunk asymmetry in both boys and girls,

meaning that smaller BMIs are associated with more severe asymmetry of the trunk. Other studies on this subject either confirm this relationship between BMI and asymmetry [14] or reject it [15].

The physical activity score at the evaluated sample is 2.73 (± 0.68), being significantly lower t = -5.222, p = 0.000, compared to the reported score (2.89 ± 0.64) by an other study [16]. At the same time, several studies also reported higher physical activity scores (3.1 (± 0.60), 3.2 (± 0.60), 3.05 (± 0.68))[17,18,19].

No significant correlation was found between physical activity score and trunk asymmetry $r = 0.000$, p = 0.998. Some studies confirm the relationship between physical activity and trunk asymmetry [20], others (including our study) do not confirm this hypothesis [21].

There is a relationship between the severity of the trunk asymmetry and the practice of certain sports or performance sports, rather than between the severity of the asymmetry and the level of general physical activity [22,23].

A study [21] concluded that „physical activity can be both a protective factor and a risk for postural changes. Possibly, factors such as the type of sport practiced, the volume of weekly training, time of practice and the way the activity is performed can influence the type of musculoskeletal response."

In our study, we found that the prevalence and severity of trunk asymmetry is significantly higher in subjects living in urban areas, than in those living in rural areas. This fact was also reported in 2012 [24]. They studied the influence of environmental and behavioral factors on the development and on the progression of idiopathic scoliosis in school-age children.

In the case of left-handed children, the severity of the trunk asymmetry is significantly lower than in right-handed children. Also, a study [3] found a relationship between trunk asymmetry and the handedness in children of Armenian, Albanian and Greek nationality.

Conclusions

Analyzing the results of this study, we can draw the following conclusions:

- There was a low correlation between severe trunk asymmetry and BMI in the boys group;
- In the case of subjects who travel to school on foot, the degree of asymmetry is lower than in those who travel by car;
- In subjects living in rural areas, asymmetry is lower than in those living in urban areas;

- In the sample included in the study, there is no correlation between BMI and the angle of rotation of the back, but if we analyzed severe asymmetry in boys, we found a significant correlation between the two variables;
- Although boys are more active in terms of physical activity level, however, neither in their case nor in the girls was any correlation between the level of physical activity and the severity of the trunk asymmetry;
- In the left-handed subjects the severity of the back asymmetry is lower than in the case of the right subjects.

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