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Upper Body Posture Investigation in Young Track and Field Athletes

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Abstract: Based on previous researches, it was identified how physical activity brings effects on the posture and physical development of a young body. The posture of the athletes is a large interest subject for the physical education and sports research field, mostly for the researchers who discovered that physical training affects body posture, even if there is no consensus on the direction of this effect. The main scope of the case study is to evaluate the anthropometrics variables and to evaluate the upper body posture using the APECS Pro version 6.2.0 developed by New Body Technology in young track and field athletes. The analysed group consisted of fourteen minor athletes (7 girls and 7 boys) with age between 11-13 years old. A minimum of two years of participation in athletics training, a frequency of 3 times/week training sessions, and participation on track and field contest at regional events, were criteria for inclusion in this study. Were assess anthropometric measurements (6 variables) and posture investigation (upper body posture in frontal plane – back view and sagittal plane, side view respectively). The results were performed by means, SD, and Independent Sample T-Test. Also, relationships between anthropometric variables and angular values of upper body posture in frontal and sagittal plane were analysed with Pearson correlation. Data analysis revealed asymmetry at the body alignment, head-neck, shoulder, scapulae, and axillae. It's recommended to perform exercise sets during the session training or individually to improve the strength and the balance of strength to be able to keep the best posture daily life.

Keywords: *interactive strategies; school performance; small groups; cooperation; critical thinking.*

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1. Literature review

The body posture and anthropometric evaluation "depends on many factors, including age, gender, race, somatic structure of the bone joints and muscles, mental status, lifestyle, and sport" (Wyszyńska et al., 2016; Latalski, 2013; Braganca et al., 2016). Grabara (2012) shows how "sport among children and adolescents is a very important stimulator for their development, both motor and physical". Also, "the participation in regular sports practice molds the character of a young person, improves one's motor and coordination capabilities, and significantly affects one's physical development and body posture" (Grabara, 2012; Grabara & Hadzik, 2009; Ischander et al., 2007). "Accurate, regular anthropometric assessments can help identify underlying medical, nutritional, or social problems in children and adults" (Kobel et al., 2022). "Participation in regular sports practice molds the character of a young person, improves one's motor and coordination capabilities, and significantly affects one's physical development and body posture" (Grabara, 2012). Children should be attracted to sport for well-being, better development and as factor in prevention and correction of postural or functional misalignments.

In order to avoid early specialization in events, which can affect future athletes, Kolman et al. (2019) divides training into three stages: basic training, sports skills development and performance maintenance.

Previous researches assessed the spine on different sports populations, such as: gymnasts (Ohlen et al., 1989), professional (Sainz de Baranda et al., 2001) and amateur football players (Wodecki et al., 2002), weightlifters (Lopez-Minarro et al., 2007), as well as other samples from other sports (Grabara, 2012; Boldori et al., 1999; Wasserman et al., 2018; Wojtys et al., 2000) and schoolchildren (Balko et al., 2017; Wyszynska et al., 2016; Kastan et al., 2017), in which changes in the structure of the spine, i.e. deviations in the position of the spine in the sagittal plane and lumbar pain, were found in a fairly high percentage. Thus in 2018 was published research on the evaluation of "the sagittal plane of the spine in 69 gymnasts in trampoline, mean aged 14.97 years old" (Castillo & Obregón, 2018) and found hyper kyphosis for the thoracic curvature and normal lordosis for the lumbar curvature when standing (de Baranda et al., 2009).

Matsuura et al. (2019) found an increased frequency of spinal changes in swimming events, which differed according to the style practiced. The target group comprised 488 swimmers with data for a total number of injuries for every part of the body, and "the most common injury site was the lower back, followed by the shoulder and knee" (Matsuura et al., 2019).

These data show that in the same sport gestures and technical positions imply differences in the sagittal profile of the spine. Sainz de Baranda et al. (2001) evaluated 78 professional football players and found normal values of sagittal spine angles, although maximum trunk flexion and stance positions indicated a kyphosis attitude. In other studies, comparisons have been made with spinal measurements in athletes who swim, play tennis, football, gymnastics, ballet, basketball or volleyball. These sports have had an impact on the morphology of the spine. Fewer cases of lordosis were found in football players and swimmers, and more cases of kyphosis in swimmers. Uetake et al. (1998) assessed the sagittal plane spine for a sample of 380 individuals from various sports. Comparing the groups, they showed that the group of "football players had a lower-than-average percentage of kyphosis, while the lordosis was within normal limits" (Radu et al., 2013).

Abricsson & Werner (2006) studied possible changes in spinal curvatures. After 5 years of study, they found 3 types of differences in the 15 subjects: highly significant differences between dorsal kyphosis and lumbar lordosis, significant and non-significant differences. Regarding their low back pain, seven of the subjects had no pain after the 5 years of the study, as they practiced complementary sports. Lopez-Minarro et al. (2008) compared spinal morphology in canoeists and runners. Runners had significantly higher values for dorsal kyphosis than canoeists, and there were no significant differences in lumbar lordosis between the two groups of athletes. The researchers concluded that it is necessary to carry out a postural exercise programme, in order to achieve a correct disposition of the spine and to ensure the harmonious growth of all structures, strengthening the spine. Firstly, special attention should be paid to the sitting position and secondly, the postural habits of the subjects should be known in order to improve postural hygiene.

The aims of the study were to investigate the upper body posture in two different planes: frontal (back view) and sagittal (side view), and the anthropometric variables of young track and field athletes, C1-C3 level of classification, in order to improve the body posture.

2. Methodology

Participants

The samples consisted of 14 young track and field athletes (7 boys and 7 girls) from AtletIS Sport Club from Iasi, Romania (11.36±0.63 years old, N=14; Boys=11.29±0.48 years; Girls=11.43±0.78 years). For admission to research group, the following inclusion criteria were applied: (1) to have

between 11 and 13 years old; (2) to have a minimum two years of sports experience; (3) to have a frequency of training sessions of 3 times/week; (4) to participation on track and field contest at regional events. Competitive level is categorized according to Romanian Athletic Federation in C1, C2, and C3 and corresponds to sports initiation period with participation in official competitions at a provincial, regional and national level. The data related to admission criteria was obtained from questionnaire filled out by subjects' care givers, and respected the research ethics prerogatives in accordance with the international guidelines. Also, a written consent was signed by parents according with ethical principles of human research.

Hypothesis

Hypothesis 1 – There are differences between anthropometrics variables in young track and field athletes categorized C1-C3 according to gender.

Hypothesis 2 – There are differences between variables of the posterior upper trunk symmetry (shoulder, axillae and scapulae alignment) in young track and field athletes according to gender.

Hypothesis 3 – There are correlations between body alignment and angular values measured from posterior and right side.

Procedures

To assess anthropometric characteristics of the human body (Kobel et al., 2022), it is essential to use validated and reliable methods and an experienced evaluator according with International Society for the Advancement of Kinanthropometry (Vaquero Cristóbal, 2017). All investigations for anthropometrics took place in Sports Medical Center from Iasi, where athletes going for two times on year for medical examination.

Body height (BH). To measure the height of a participant it is necessary to be barefoot in a standing position. The head is straight looking forward. The distance from ground level to the vertex is measured in cm.

Body weight (BW). Body weight is a very precise indicator of health status and of physical development. The subject, lightly dressed, steps on the weighing scale and the displayed value is read. The subject then steps off the weighing scale. The results are expressed in kg.

Arm span. We measure the distance between the tip of right and left medius from standing feet close together, arms stretched to the sides, face to the wall. The value is register in cm.

Thorax girth. The measuring tape is placed posteriorly under the lower shoulder blade angle and in the front under the mammary areola in

men, and at the level of the fourth rib joint with the sternum, in women; the assistant records the values at rest, inhalation and forced exhalation.

Thorax elasticity represents the difference between the chest perimeter in maximum inspiration and the chest perimeter in maximum expiration, measured in cm.

Biacromial breadth. From standing, hands on thighs and muscles relaxed, the two ends of the caliper are fixed on the left and right acromion; the result is expressed in cm.

Bitrochanteric breadth. From standing, the muscles relaxed the two ends of the calliper are fixed at the level of the trochanter left and right, the result is expressed in cm.

Upper body posture was assessed using the mobile application APECS v. 6.2.0. during standing from back side and right side. This app was specifically design for prevention, evaluation and correction posture (APECS; https://apecs.newbodytechnology.com/). Calculates the posture variables using markers detection on specific anatomical landmarks in relation with variables of interests. The device camera is used to take picture or to import picture from gallery from back, and right side. When taking the picture, the app shows a target that turns green when the cell phone is in a proper position to take a good photo. "This helps ensure each image is taken at a level and consistent angle. After the picture is taken, the user is directed to crop each picture at the subject's head and feet, giving a full view of the body" (Szucs & Brown, 2018).

Upper body posture – back view. Once photo is taken, the markers is put on the location indicated on the top of the app page (Table 1). To place a marker should press and hold with finger on the screen to pin the marker should press on the pin icon. The report showed us about detailed angle overview about: body, head, shoulder, axillae, scapulae, and torso alignment.

Table 1. Posture variables – back view

View	Variable	Markers
Posterior	Body alignment	C7, T5, superior end of intergluteal cleft
	Head	Lobus auricule left, lobus auricule right
	Shoulders alignment	Left acromion, right acromion
	Axillae alignment	Left and right posterior axillary folds
	Scapulae alignment	Left and right scapulae

Upper body posture – side view. For side view analyses following points were set on the photo: tragus, C7 vertebra, and acromion (Table 2). For

analyses detailed angle overview of body alignment, head and acromion were took in consideration.

Table 2. Posture variables – side view

View	Variable	Markers
Lateral	Body alignment	Tragus, acromion, trochanteric, malleoli
	Head	Tragus, C7
	Acromion	C7, acromion

Data analyses

The data were statistically analysed using SPSS, version 20.0. A descriptive analysis of each of the variables was performed (anthropometrics and angular values of upper body posture). The means were compared with Independent Sample t-test, and Pearson correlation coefficient were calculated to establish associations between anthropometrics measurements and angular values.

3. Results and data analysis

In order to answer to research aims a descriptive analysis were performed for each anthropometric variable. Results shows in Table 3 a total sample of 14 participants (7 girls and 7 boys). Group of girls obtained greater means of anthropometrics variables comparative with boys, but no significant statistical differences were found. We can observe similar results only for thoracic elasticity.

Table 3 Anthropometrics measurements – descriptive statistic

Variables	All (N=14) Mean±SD	Boys (N=7) Mean±SD	Girls (N=7) Mean±SD	p
Body height	151.57±9.84	150.00±8.67	155.14±9.02	0.295
Body weight	39.00±7.33	36.86±7.38	41.14±7.17	0.292
Arm span	152.36±12.09	150.71±11.31	156±11.39	0.340
Thoracic girth	70.00±4.83	68.14±5.30	71.86±3.80	0.158
Thoracic elasticity	7.29±0.99	7.29±0.95	7.29±1.11	1.000
Biacromial breadth	32.21±1.47	31.57±1.13	32.86±1.57	0.105
Bitrochanteric breadth	23.57±1.69	22.86±1.34	24.29±1.79	0.118

Testing Hypothesis 1: *There is differences between anthropometric variables related to genders in C1-C3 track and field athletes.* The differences are statistically insignificant at the significance level of 5% (two-tailed) and the 95% confidence interval. The hypothesis has not been confirmed.

Table 4 shows the summary of the angular values of both genders in upper body in two different views, back and lateral. As a general lateral view of the body, all feminine participants obtained front deviation of the body alignment. From back view, four subjects were evaluated with alignment deviation to the right and three subjects to the left. Similar with girls, boys have front deviation of the body alignment, respectively five to the right and two to the left.

In shoulder alignment, the mean was 1.37±0.59 (girls) vs. 0.60±0.25 (boys) with $p<0.05$, and the axillae alignment 1.51±0.52 vs. 0.65±0.31 with $p<0.05$.

Table 4 Upper body posture back and lateral view

	Back view										Lateral view			
Boys														
	Body		Head		Shoulders		Axillae		Scapulae		BA	H	A	Side
1.	1.9	R	1.6	R	1.7	L	0.5	L	0.5	L	3.6	32.0	3.0	F
2.	0.7	L	2.1	L	0.7	R	0.5	R	0.5	R	2.5	15.7	3.0	F
3.	0.4	R	0.5	R	0.5	L	0.8	L	0.8	L	2.5	15.9	1.5	F
4.	0.6	R	2.4	R	1.2	L	1.0	L	1.2	L	2.9	29.1	3.0	F
5.	0.7	R	2.1	R	0.7	L	0.5	L	0.7	L	2.4	19.6	2.1	F
6.	0.1	R	0.5	R	0.2	L	0.2	L	0.2	L	2.6	18.2	2.0	F
7.	0.3	L	L0.8	L	0.7	R	0.7	R	0.7	R	2.4	19.7	2.1	F
mean±SD	0.67±0.58		1.42±0.81		0.81±0.49*		0.60±0.25*		0.65±0.31		2.72±0.41	22.95±7.16	2.37±0.61	
Girls														
1.	2.2	R	1.7	R	0.4	L	1.2	L	2.1	L	3.6	31.3	2.7	F
2.	0.8	L	2.1	L	2.1	R	2.1	R	1.4	R	2.5	30.0	2.1	F
3.	0.3	L	2.5	L	1.0	R	2.6	R	2.4	R	3.0	37.0	3.7	F
4.	0.8	L	1.0	L	1.0	R	1.0	R	1.2	R	3.8	15.3	4.9	F
5.	0.9	R	2.3	R	1.7	L	1.0	L	1.3	L	2.7	33.6	2.0	F
6.	0.9	R	2.2	R	1.6	L	1.0	L	1.2	L	2.7	31.1	2.0	F
7.	0.8	R	2.4	R	1.8	L	0.7	L	1.0	L	2.8	24.7	3.7	F
mean±SD	0.95±0.58		2.02±0.52		1.37±0.59*		1.37±0.69*		1.51±0.52		3.01±0.49	29.00±9.09	3.01±1.11	

° - angle; BA – body alignment; H-head; A – acromion; R - right; L - left; F-forward;
*$p<0.05$

Testing Hypothesis 2: *There are differences between shoulder and axillae alignment in young track and field athletes according to gender.* The differences are

statistically significant at the significance level of 5% (two-tailed) and the 95% confidence interval. The hypothesis has partially confirmed.

In the figure 1 shows how we diagnosed the deviations from the normal posture to the right or to the left. The blue line shows the normal posture and the orange one the actual posture with deviation measured in angular values. In the frontal plane evaluation – back view, five parameters were assessed: (1) body alignment, (2) posture of the head, (3) shoulder alignment, (4) axillae alignment and (5) scapulae alignment.

Figure 2 shows similar investigation in sagittal plane for (1) body alignment, (2) position of the head-neck, (3) acromion position. Blue line indicates the good posture for every variable, and the orange one the current position in relation with identified markers with APECS app. The angular values were automatically calculated and represent the deviation of body from the ideal posture.

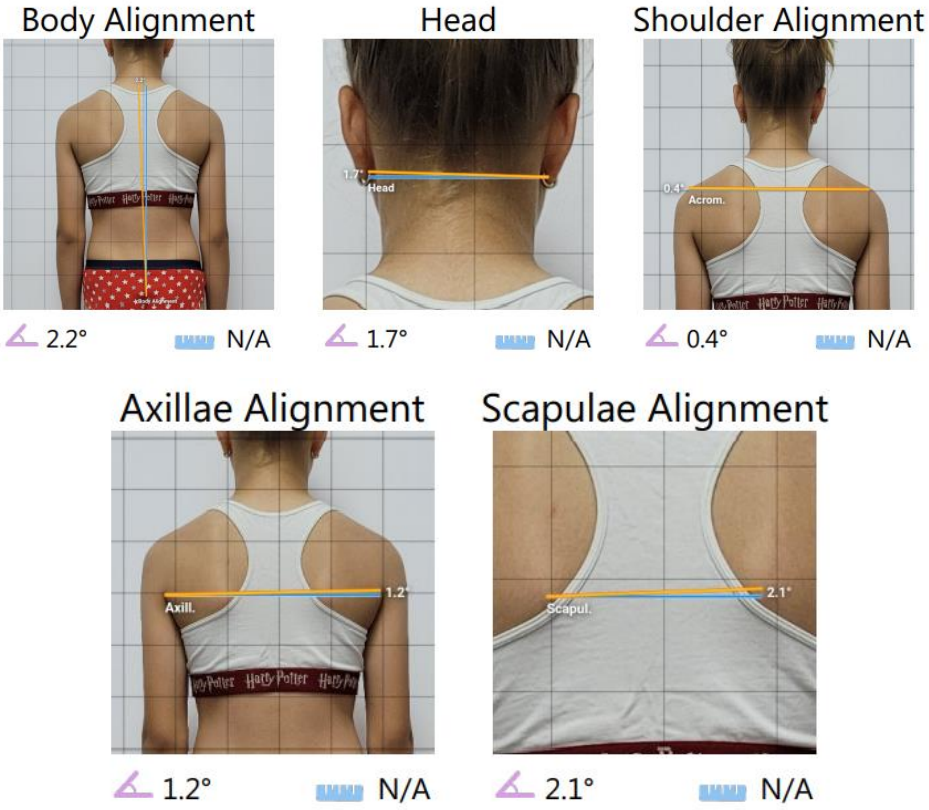


Fig. 1. Angle of the body posture – back view

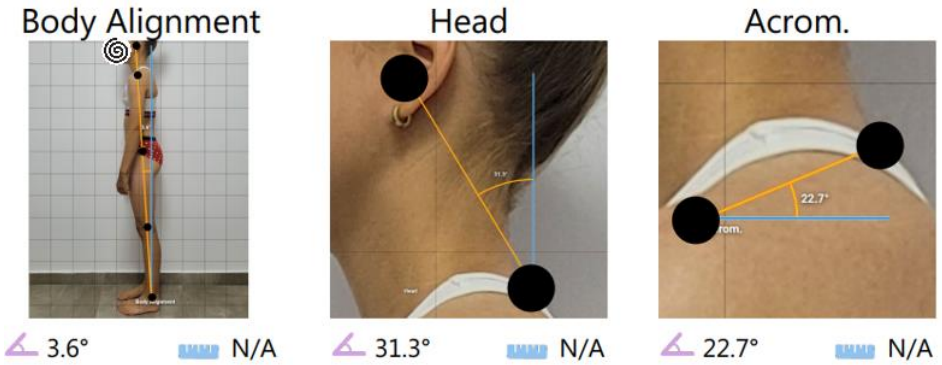


Fig. 2 Angle of the body posture – side view

From the statistical calculations (table 5) we can say that there are significant positive relationship between anthropometric variables, except thoracic elasticity. In this context it has been confirmed that there are positive relationships between anthropometrics variables in young track and field athletes.

Table 5. Correlations between anthropometric variables

Variables	W	AS	TG	TE	BiaB	BitB
Height	.951**	.964**	.811**	.320	.763**	.670**
Weight (W)		.918**	.841**	.264	.625*	.581*
Arm span (AS)			.787**	.432	.818**	.668**
Thoracic girth (TG)				.128	.592*	.544*
Thoracic elasticity (TE)					.269	.169
Biacromial breadth (BiaB)						.838**

*. Correlation is significant at the 0.05 level (2-tailed); **. Correlation is significant at the 0.01 level (2-tailed); BitB – Bitrochanterian breadth

The correlation analysis (table 6) shows positive and strong relationship between angular values of shoulder and axillae alignment (r=.851, p<,01), respectively head and shoulder alignment (r=.592, p<.05). The relationship is statistically significant at the significance level (two-tailed) of 1% and the confidence interval of 99%, respectively of 5% and the confidence interval of 95%. It has been confirmed that are correlations between body alignment and angular values, respectively between head position and shoulder alignment, and axillae-scapulae alignment in young track and field athletes.

Table 6 Correlation between upper body variables in frontal plane (back view)

Variables	H	SA	AA	ScA
Body alignment (BA)	.208	.215	-.036	.251
Head (H)		.592*	.431	.474
Shoulder alignment (SA)			.329	.161
Axillae alignment (AA)				.851**

*. Correlation is significant at the 0.05 level (2-tailed); **. Correlation is significant at the 0.01 level (2-tailed); ScA – Scapulae Alignment

In sagittal plane correlations (table 7) analyses showed strong and positive relationship between angular values of body alignment and head ($r=.677$, $p<.01$). It has been confirmed that there is correlation between angular values of body alignment and acromion (sagittal plane).

Table 7 Correlation between upper body variables in sagittal plane (side view)

Variables	Head	Acromion
Body alignment	.172	.677**
Head	1	-.077

**. Correlation is significant at the 0.01 level (2-tailed

4. Discussions and limits

The results of the body posture reported in this study may be used for prevention, for improvement of the muscle strength in order to prevent the back pain and to encourage a healthier posture for youth athletes. Often, asymmetrical physical exercise unique to a particular sport may result in the occurrence of body posture asymmetry, "particularly in the period of intensive growth. Some studies show that in many sports, especially those of asymmetric nature, disorders of the statics of the spine; trunk asymmetries; as well as disproportions of one's muscle mass occur in the training subjects" (Grabara, 2012; Kalata et al., 2020; Pakosz et al., 2021).

In the period of growth and development, it is important to focus the training to the harmonious development of youth bodies. Some factors may influence the upper body posture as behavioral habits, school and homework routine, time spend on mobile device, posture adapted to carry school bag (Cejudo, 2022; da Rosa et al., 2022; Popescu & Lee, 2020; Vaterlaus et al., 2021). Although sports training might have some disadvantageous effects on posture, it is essential to emphasize the positive

influence of physical activity on physical fitness of children and youth, which has been documented by numerous authors (Tomaczkowski & Klonowska, 2020; de Assis et al., 2021; Xing & Popik, 2020; Opala-Berdzig et al., 2021).

The identification or diagnosis of postural asymmetry during childhood and adolescence has a great importance in this phase of body growth and development. Shoulders, axillae and scapulae asymmetry by gender, report that girls has a high incidences of angle deviation comparative with boys. The imbalance of asymmetry is in relation to the subject's dominance side for all youth athletes. We can notice that the dominant side is lower up to one degree than to opposite for boys and between 1.37 and 1.51 degree for the girls in all three variables (shoulder, axillae and scapulae). Between genders, the girls reported higher angular values in upper body compared to the boys. Similar results for girls were suggests by Penha et al. (2005) in school age (7-10 years old). They point out that the difference is very small and may not be discerned clinically.

Sarro et al. (2022) showed that asymmetries are not expected in symmetrical sports and are not imperative related to the specific of the activity. The upper body asymmetry may be associated with lateral spine deviation, improper postural habits, muscle imbalance or lateral pelvic inclination. In elite volleyball, Wang & Cochrane (2001) conducted a research based on muscle imbalance, muscle weakness, scapular asymmetry and shoulder injury and suggested that posture depend by sport discipline played by an athlete. Grabara (2015) reported perfect posture for 6% of 50 children.

The present posture investigation it is not representative for youth track and field athletes and we cannot compare results of examination to previous investigations at this age. Also are a lack of sufficient reports in other sports at the same age in athletes.

Future research is required to investigate the effect of the correction exercises to improve body posture and to prevent risk injuries in the growth and development period. Therefore, it is important to notice that the training program not only aims at the outcome but also promote the harmonious development of the adolescent.

Conclusions

The analysis of the lower limb posture, of track and field youth athletes, illustrates that are not differences between anthropometric variables in relation with gender and are differences between shoulder and axillae alignment from back view. We can summarize as relationships that there are positive relationships between anthropometrics variables, and also there are

correlations between angular values of head-neck position and shoulder, respectively axillae and scapulae alignment in upper body symmetry of young track and field athletes categorized C1-C3 by the Romanian Athletic Federation.

The future investigation has been required to find out the effect of correction exercises on body posture in period of growth and development for young athletes.

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