ANALYSIS OF BODY POSTURE BETWEEN YOUNG FOOTBALL PLAYERS AND THEIR UNTRAINED PEERS

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ABSTRACT

Purpose. The aim of this study was to analyze the body posture of young football players and their untrained peers. **Methods.** A group of 73 football players and 78 untrained boys, all aged between 11 and 14 years, were studied by measuring body posture indices with computer posturography (the MORIE technique). Spinal angles and curvatures in the sagittal plane and body posture asymmetry in the frontal and transversal plane were measured. Body height and mass and BMI were also determined. **Results.** Compared to the untrained boys, the group of football players had lower BMI. The position of pelvis in the frontal plane was more symmetrical ($p < 0.001$) in football players, but the alignment of the remaining measured parameters was similar between the two groups except for the horizontal symmetry of the waist triangles (a higher incidence of symmetry in some ages groups of football players) and the horizontal symmetry of the shoulder blades (a higher incidence of asymmetry in some ages groups of football players). A postural symmetry index that was created for this study did not find any differentiation among the studied groups. The spinal alignment of the football players featured a more flattened lumbar lordosis. **Conclusion.** Previously conducted studies on the body posture of young athletes are still not ample and complete, while the results do not clearly indicate the development of posture when subjected to sports training.

Key words: body posture, football training, adolescent, asymmetry

Introduction

Physical exercise is an important component of a healthy lifestyle for children and adolescents as well as fulfilling the natural human need for physical activity. However, special care should be given to young athletes when they take part in strenuous physical training in order to ensure their proper physical development.

Training for football, to a very large extent, develops lower limb strength and increases the endurance capacity of the muscular-ligamentous system. It was found that a football player during just one match runs a distance of over 10 km [1]. A too heavy training load can not only contribute to the risk of injury but delay meniscus, tendon and joint recovery, which as a consequence could lead to premature osteoarthritis. An estimated 5.5 million children and adolescents play football around the world and as many as 28% of young players (aged 5–14 years) injure themselves [2].

In order to become successful in football, a player ought to demonstrate a high level of speed, endurance, strength and agility skills. For young players, these skills share a significant correlation with growth and biological development, and as such, both body build [3] and body posture play an important role. An individual's body posture is dependent on both varied ontogenetic development and factors that stem from everyday life [4], such as lifestyle as well as how much and what form of physical activity is practiced. Correct body posture is characterized by symmetry in both the frontal and transverse places, the proper arrangement of various body parts, and the proper arrangement of the spine in the sagittal plane. Good posture also requires an individual to have properly developed motor skills as well as a well-functioning muscular and nervous system [4]. Various authors have studied the influence of sports training on body posture, finding that there exist both positive and negative aspects depending on the exercise performed for a given sport [5–19], with Zeyland-Malawka stating that "[…] physical activity – depending on what form and its intensity or even a lack of it can be incredibly important on the shaping of the spine" [15, p. 87].

Football is dominated by mostly asymmetrical lower limb movement (such as using the dominant leg for goal shots) [5] and symmetrical upper limb movement. Although top players can effectively use both legs in gameplay [20], the dominance of one leg over the other has been observed in games played at the international level [21]. Similar observations were reported by McLean and Tumilty, who on the basis of their own research, stated that most players feature leg dominance [22].

As such, the aim of this study was to focus on analyzing the body posture of young male football players and comparing them against their peers who were not physically active, with the following research questions:

1. Does the body posture of young football players significantly differ from their untrained peers in terms of body symmetry in the frontal and transverse planes?
2. Does football training have any influence on the formation of the spine in the sagittal plane?

These research questions were taken into consideration with the following hypotheses:
1. Young males who practice football have a higher incidence rate of symmetrical body posture than their untrained peers.
2. Football training does influence the formation of the antero-posterior curvature of the spine.

Material and methods

The study included two groups of young males aged 11–14 years: one was a group of football players ($N = 73$) and the other a control group of boys who did not participate in any form of sport ($N = 78$). Comparative analysis was performed by splitting the study sample into four age groups: 11-, 12-, 13- and 14-year-olds. The football players were recruited from a local football club in Katowice, Poland, which had the following training schedule: 11- and 12-year-olds trained three times a week while 13- and 14-year-olds trained five times a week. The training experience of the players was: two years for the 11-year-olds, three years for the 12-year-olds, four years for the 13-year-olds and five years for the 14-year-olds. Each practice session lasted 90 minutes, including a 15–20 minute warm-up, with the players training and practicing basic football skills, which included:
– increasing fitness potential according to the players' biological rhythm development;
– comprehensive mastery of various technical skills;
– mastering both individual and team tactics;
– practically developing technical and tactical skills during different game plays.
The subjects were assessed in early afternoon, with the football players examined before their training session in order to avoid the effects of postural muscle fatigue, which could have affected correct body posture. Body height was measured by a stadiometer (accurate to 1 mm) and body mass was determined by a Tanita electronic scale (accurate to 0.1 kg), with both measurements then used to calculate each subjects' body mass index (BMI).

Body posture was assessed by computer posturography (MORA 4, CQ Elektronik System, Poland) on the basis of the Moiré Shadow Technique, which is an objective, noninvasive method for screening body posture [23]. This method is able to spatially register an entire individual's back in three dimensions with a very short measurement time (about five seconds) which helps avoid postural muscle fatigue [24]. Body posture indices were marked on the vertebral processes (C_7–S_1), the anterior superior iliac spines (M_1, M_2), and at the bottom corners of the scapulas ($Ł_1$, $Ł_2$) before measurements were taken. The subject was then asked to stand with their back to the camera in a natural (habitual) posture.

Body posture analysis in the frontal and lateral plane included:
– The torso lateral inclination angle (KNT), determined by the deflection of the C_7–S_1 vertical line;
– The maximum deflection of the spinous process from the C_7–S_1 (UK) (mm);
– The symmetry of the shoulders in relation to each other (KLB) (mm);
– The symmetry of the shoulder blades based on their height (UL) and depth (UB) differences as well as the distance from the spine (OL) (mm);

Table 1. The criteria for assigning point values to the various postural elements of the body based on the synthetic index of postural symmetry (WSyn)

Calculated parameters	The number of points depending on the size of the deflection: provided in degrees (°) for KNT and KPT, and in mm for the remaining parameters						
	< 1	1–2	2.01–3	3.01–5	5.01–10	10.01–15	> 15
KNT	0	1	2	3			
UK		0		1	2	3	4
KLB			0		1	2	3
UL			0		1	2	3
UB			0		1	2	3
OL			0		1	2	3
TT			0		1	2	3
TS			0		1	2	3
KNM			0		1	2	3
KSM			0		1	2	3
KPT	0	1	2	3			

KNT – torso lateral inclination angle; UK – maximum deflection of the spinous process C_7–S_1; KLB – symmetry of the shoulders; UL – height symmetry of the shoulder blades; UB – depth symmetry of the shoulder blades in the transverse plane; OL – symmetry of the shoulder blades from the spine; TT – height symmetry of the waist triangles; TS – width symmetry of the waist triangles; KNM – pelvic lateral inclination angle in the frontal plane; KSM – pelvic torsion angle in the transverse plane; KPT – torso forward inclination angle.

- The symmetry of the waist triangles' height (TT) and width (TS) (mm);
- The pelvic lateral inclination angle (KNM) in the frontal plane and the pelvic torsion angle (KSM) in the transverse plane (mm);
- The torso forward inclination angle (KPT).

The size of the deflection in the frontal and transverse planes is presented in absolute values as the size of the deflection from a desired value of 0 (zero), but ignoring the direction of this deviation. In order to assess correct body posture by using symmetry as a deciding criterion, a synthetic index of postural symmetry (WSyn) was introduced to reflect the distribution of each measured postural component in the frontal and transverse planes by assigning point values to how much each component deviated from perfect symmetry (Tab. 1). For the shoulder blades (parameters UL, UB and OL), the maximum number of points that could be given was dependent on the one, most-asymmetrical indicator. Similarly, this was also how the waist triangles were treated (TT, TS).

In the sagittal plane the following measurements were taken:

- the C_7–S_1 line, drawn as a plumb-line indicating the torso forward inclination angle (KPT), whose size is presented as an absolute value
- the angular deviation from a plumb-line indicating the upper thoracic segment (α angle);
- the angular deviation from a plumb-line indicating the thoracolumbar segment (β angle);
- the angular deviation from a plumb-line indicating the lumbosacral segment (γ angle).

Statistical analysis was performed using Statistica ver. 9.0 software (Statsoft Inc., USA), which included calculating the means and standard deviations ($\bar{x} \pm SD$) of the values as well as comparing the results of both posture and other anthropometric parameters for the studied young football players and their untrained peers by means of the Student's t-test. The significance level was set at 5%. The values of those measurements that were statistically significant were highlighted and included the level of significance (p).

Results

The boys who played football did not differ from their untrained peers in terms of body height, however, their body mass index (BMI) was found to be significantly lower in all of the studied age groups (Tab. 2).

Absolute values were used to present the parameters that characterize posture in Table 3 and the KPT parameter in Table 4, otherwise the distance between left and right symmetry would have been naturally negative and positive, respectively. The differences between the boys who played football and their non-physically active peers in the frontal and transverse planes were as follows:

- the pelvic lateral inclination angle (KNM) was the only parameter to significantly differentiate among all the age groups. The football players were characterized by having an almost symmetrical pelvic lateral inclination angle;
- the pelvic torsion angle in the transverse plane (KSM) in the group of 12-year-old football players had significantly greater asymmetry in the shape of their pelvis in the transverse plane, but this value fit within the range of having moderate pelvic asymmetry;
- the width symmetry of the waist triangles (TS) was found to be more symmetrical in the group of football players, with significant differences found in both the 12- and 13-year-old groups of trained and untrained boys;

Table 2. Mean values (± SD) of the anthropometric parameters of boys practicing football (PN) and their untrained peers (C)

Parameter	Age group			
	11-year-olds		12-year-olds	
	PN (*N* = 19)	C (*N* = 20)	PN (*N* = 22)	C (*N* = 24)
Body height (cm)	145.74 ± 7.34	147.73 ± 7.9	151.09 ± 7.07	150.77 ± 6.75
Body mass (kg)	36.51 ± 6.8*	45.35 ± 13.49	40.09 ± 6.34	43.33 ± 7.79
BMI (kg/m²)	17.09 ± 2.29**	20.48 ± 4.37	17.48 ±1.75*	18.98 ± 2.6
	13-year-olds		14-year-olds	
	PN (*N* = 17)	C (*N* = 20)	PN (*N* = 15)	C (*N* = 18)
Body height (cm)	156.18 ± 5.21	156.65 ± 5.95	166.47 ± 9.51	166.72 ± 6.48
Body mass (kg)	43.41 ± 4.86	47.89 ± 9.41	52.33 ±10.17	57.72 ± 8.03
BMI (kg/m²)	17.71 ± 1.64*	19.41 ± 2.9	18.69 ± 1.81*	20.76 ± 2.67

 * significantly ($p < 0.05$) different from the control group
** significantly ($p < 0.01$) different from the control group

Table 3. Mean values (± SD) of the body posture parameters in the frontal and transverse planes
of boys practicing football (PN) and their untrained peers (C)

Parameters	Age group			
	11-year-olds		12-year-olds	
	PN (N = 19)	C (N = 20)	PN (N = 22)	C (N = 24)
KNT (°)	1.52 ± 0.9	1.1 ± 0.87	0.94 ± 0.76	0.86 ± 0.96
UK (mm)	3.98 ± 1.9	4.46 ± 2.83	3.68 ± 2.4	3.89 ± 2.06
KNM (mm)	1.64 ± 2.23***	7.27 ± 5.21	1.56 ± 1.39***	6.24 ± 4.36
KSM (mm)	7.76 ± 5.43	7.27 ± 5.21	9.89 ±4.06**	6.24 ± 4.36
TT (mm)	8.18 ± 6.64	8.84 ± 9.86	8.75 ± 5.95	7.06 ± 8.21
TS (mm)	11.21 ± 8.32	12.74 ± 8.87	5.72 ± 4.73**	10.49 ± 6.09
UL (mm)	7.98 ± 5.96	8.29 ± 7.74	5.84 ± 4.42	7.11 ± 5.28
OL (mm)	8.21 ± 6.64	12.24 ± 8.51	5.48 ± 4.14	7.51 ± 5.46
UB (mm)	15.79 ± 7.58	12.49 ± 10.3	18.36 ± 9.34**	10.77 ± 6.4
KLB (mm)	6.42 ± 5.27	5.11 ± 3.8	4.04 ± 2.99	4.04 ± 3.76
WSyn (pts.)	10.11 ± 3.05	10.6 ± 3.35	8.86 ± 2.56	9.42 ± 3.92
	13-year-olds		14-year-olds	
	PN (N = 17)	C (N = 20)	PN (N = 15)	C (N = 18)
KNT (°)	1.15 ± 0.96	1.41 ± 1.1	1.18 ± 0.66	1.05 ± 0.68
UK (mm)	5.1 ± 3.01	4.45 ± 1.98	4.74 ± 3.79	4.56 ± 2.06
KNM (mm)	2.36 ± 2.41***	6.48 ± 3.42	2.18 ± 1.82***	7.11 ± 4.97
KSM (mm)	7.56 ± 5.18	6.48 ± 3.42	10.08 ± 5.19	7.11 ± 4.97
TT (mm)	8.24 ± 3.8	10.92 ± 7.09	9.21 ± 7.14	10.34 ± 7.37
TS (mm)	7.09 ± 5.29*	11.08 ± 4.31	10.83 ± 9.02	12.65 ± 9.65
UL (mm)	8.13 ± 6.85	7.84 ± 4.73	8.82 ± 6.52	6.12 ± 4.97
OL (mm)	6.17 ± 4.24	6.65 ± 6.52	9.9 ± 7.57	7.47 ± 6.37
UB (mm)	15.71 ± 11.08	12.8 ± 8.86	21.96 ± 9.65*	14.07 ± 7.75
KLB (mm)	6.6 ± 6.15	7.33 ± 7	6.09 ± 3.74	6.12 ± 3.15
WSyn (pts.)	9.65 ± 2.85	11.55 ± 3.05	10.27 ± 2.4	10.22 ± 2.82

KNT – torso lateral inclination angle; UK – maximum deflection of the spinous process C_7–S_1; KNM – pelvic lateral inclination angle in the frontal plane; KSM – pelvic torsion angle in the transverse plane; TT – height symmetry of the waist triangles; TS – width symmetry of the waist triangles; UL – height symmetry of the shoulder blades; UB – depth symmetry of the shoulder blades in the transverse plane; OL – symmetry of the shoulder blades from the spine; KLB – symmetry of the shoulders; WSyn – synthetic index of postural symmetry;
  * significantly (p < 0.05) different from the control group
 ** significantly (p < 0.01) different form the control group
*** significantly (p < 0.001) different from the control group.
All mean values are significantly different from an expected value of zero.

– the depth symmetry of the shoulder blades (UB) among the group of young football players was found to be more frequent, with higher levels of having protruding shoulder blades, in addition, significant differences were observed between trained and untrained 12- and 14-year-olds (Tab. 3).

A deflection of the spinous process line above 10 mm, which points to spinal scoliosis, was found in 5.5% of the football players and in 2.9% of the control (untrained) group, while a deflection of 5–10 mm was observed in 22% of the football players and in 31% of the control group.

Differences between the group of football players and the untrained boys in the sagittal plane were as follows:

– the shape of the lumbar lordosis: statistically significant differences for angle γ, angle β and the lordosis angle (β + γ) occurred only in the group of 11- and 14-year-old boys. A small value of the lumbar lordosis angle was observed in football players (Tab. 4), while no differences were found in the thoracic kyphosis angle among the age groups.

Table 4. Mean values (± SD) of the body posture parameters in the sagittal plane of boys practicing football (PN) and their untrained peers (C)

Parameter	Age group			
	11-year-olds		12-year-olds	
	PN (N = 19)	C (N = 20)	PN (N = 22)	C (N = 24)
KPT (°)	2.67 ± 2.07	2.13 ± 1.6	2.76 ± 2.47	2.8 ± 1.97
α angle (°)	12.92 ± 4.2	14.94 ± 4.4	13.6 ± 3.68	12.88 ± 4.78
β angle (°)	12.93 ± 2.82	13.98 ± 3.16	14.14 ± 3.29	13.75 ± 2.61
γ angle (°)	12.02 ± 4.52**	16.94 ± 4.17	12.4 ± 4.61	13.77 ± 4.21
Kyphosis angle (α + β)	25.86 ± 6.17	28.93 ± 5.99	27.73 ± 4.57	26.63 ± 6.21
Lordosis angle (β + γ)	24.95 ± 5.12**	30.92 ± 5.98	26.53 ± 5.98	27.52 ± 5.74
	13-year-olds		14-year-olds	
	PN (N = 17)	C (N = 20)	PN (N = 15)	C (N = 18)
KPT (°)	2.42 ± 2.19	3.3 ± 1.82	2.01 ± 1.54	2.19 ± 1.87
α angle (°)	14.44 ± 4.67	14.54 ± 2.75	14.51 ± 3.4	14.62 ± 3.75
β angle (°)	13.92 ± 2.37	13.84 ± 3.34	12.85 ± 2.77*	14.7 ± 1.99
γ angle (°)	13.28 ± 5.14	14.14 ± 6.33	9.67 ± 3.13**	13.86 ± 5.03
Kyphosis angle (α + β)	28.36 ± 5.46	28.38 ± 4.58	27.36 ± 5.16	29.32 ± 4.53
Lordosis angle (β + γ)	27.19 ± 6.24	27.98 ± 7.18	22.52 ± 4.76**	28.56 ± 5.36

KPT – torso forward inclination angle
 * significantly ($p < 0.05$) different from the control group
** significantly ($p < 0.01$) different form the control group

Discussion

Increased physical activity of children and adolescents usually results in lower body mass and a lower body mass index, which was confirmed by the anthropometric measurements of this study. In turn, low physical activity promotes weight gains and obesity [25]. The fact that football players have less body mass than their peers was also reflected in other studies [3, 9]. Correct body posture, calculated on the basis of the pelvic inclination angle in the frontal plane, was found to be significantly greater in all the age groups of football players. However, this was the only measurement of stance that differentiated among all of the age groups. None of the remaining body measurements were found to differentiate between the trained and untrained groups, the only observed differences occurred between individual age groups. In addition, the synthetic index of postural symmetry found that the postural alignment of the various studied body parameters also did not differentiate among the studied groups. Through this index, it can be stated none of the groups had higher levels of symmetrical posture, with football training not significantly contributing to an improvement of body posture in terms of its symmetry.

Nonetheless, different conclusions were reached by other authors, who found that young male football players [9] as well as boys in sports-oriented middle schools [10] had better body posture. Other studies have argued that athletes have larger values of pelvic asymmetry, which could be associated with the predominance of using certain muscle groups during training, muscle groups which are responsible for the structure of the pelvis [26]. This in turn may largely depend on which sports discipline is practiced. For example, a higher incidence of trunk asymmetry was commonly observed in athletes who practiced sports that involved the asymmetric use of the shoulder, such as in handball players [11]. The incidence of asymmetric posture among athletes who practice team sports had also been examined by other authors [7]. Pietraszewska et al.'s research found that left-sided scoliosis occurs in 29% of football players [12]. It was noted in this study that the deflection in the spinous processes, which may indicate a lateral curvature of the spine, occurred in slightly less than 30% of the players, a value which was slightly less than in the untrained group of boys. Thus, individuals who practice sports that feature elements of asymmetry can be denoted with an asymmetric structure of various parts of their body.

Assessing the shape of the spine is even more difficult due to its variability, the different methods of measuring the inclination of individual spine segments and a lack of clearly defined assessment standards. In the present study, different shapes of the spine in the sagittal plane were observed in both studied groups. Generally, body posture in the sagittal plane was characterized by a smaller curvature of the lumbar lordosis, while no

differences in the shape of the thoracic kyphosis were found. A similar propensity of having a flattened lumbar lordosis was also noted for 14- to 16-year-old athletes [13]. However, other researchers have found that boys who practice football were, on the whole, characterized by a lower thoracic kyphosis and greater lumbar lordosis angles than their untrained peers [14].

This was not confirmed in the present study. In addition, research on the body posture of boys practicing fencing when compared to their untrained peers found no significant differences in the structure of anterior-posterior curvature of the spine [15]. Wojtys et al. [16] noted a significant correlation in the shape of the spine in the sagittal plane dependent on the duration of training (the longer the training period, the greater thoracic kyphosis and lumbar lordosis angles), as was found during measurements of individuals practicing different sports. These authors did not find a relationship between the size of the anterior-posterior curvature with age or sex [16]. Other studies confirmed a dependency between the structure of the spinal curve in the sagittal plane and the type of practiced sports. A greater curvature of the spine was noted in sprinters, medium- and long-distance runners, and kendo and shot-put athletes, while a smaller curvature of the spine characterized football players, rugby players, swimmers and those who did not practice any sport [17]. Zeyland-Malawka [18] examined the posture of athletes from various disciplines (handball and hockey players, fencers, judokas, weightlifters and skaters) and observed differences in the shape of the spine in the sagittal plane, namely, a larger lumbar lordosis angle in the groups mentioned above when compared to an untrained group, and a larger thoracic kyphosis angle in handball players and fencers. The author proposed that sports training is only one of several factors that affect the shape of the spine in the sagittal plane [18]. Research by Lichote et al. on athletes also confirmed a diversification in the formation of the curvature of the spine in the sagittal plane. These authors concluded that the specificity of sports training is one of the leading components that can affect the shape of the anterior-posterior curvature of the spine [19]. In addition to sports training, and as was previously mentioned, body posture can also be affected by a number of other factors. Studies on the posture of 8- to 13-year-old children revealed a significantly different shape of the spine in the sagittal plane depending on age and gender [27]. Other authors went as far to report on the relationships between the size of the anterior-posterior curvature on body build, which indicates that height, weight and BMI can influence the size of the thoracic kyphosis and lumbar lordosis [28–30].

In summary, previous studies on the body posture of young athletes are still not ample and complete, while the results do not clearly indicate the development of posture when subjected to sports training. From the results of the previously cited studies, the authors of this study feel that more research needs to be performed on young athletes over longer periods of time, which can more definitely point to the impact of sports training on body posture.

Conclusion

Through analyzing posture in terms of its symmetry, it was found that boys who practice football when compared to their untrained peers are characterized by a higher incidence of having the correct alignment of the pelvis in the frontal plane. In some age groups a higher incidence of having symmetry of the waist triangles was observed, as well as a frequent incidence of protruding shoulder blades and an asymmetry of the pelvis in the transverse plane.

An assessment of posture in the sagittal plane noted significant differences in the shape of the spine between the football players and untrained boys only for the lumbar lordosis and only in the group of 11- and 14-year-old boys, while the football players on the whole were found with smaller lumbar lordosis. It is difficult to confirm the original hypothesis of there being a connection between sports training and body posture, as the differences were not observed in all of the studied parameters as well not being significant in all of the age groups.

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