THE SHAPE OF ANTERIOR-POSTERIOR CURVATURES OF THE SPINE IN ATHLETES PRACTISING SELECTED SPORTS *

Curvatures of the spine in athletes

MAŁGORZATA LICHOTA, MAGDALENA PLANDOWSKA, PATRYCJUSZ MIL

The Josef Pilsudski University of Physical Education in Warsaw,
Faculty of Physical Education and Sport in Biała Podlaska, Department of Posture Correction

Mailing address: Małgorzata Lichota, Faculty of Physical Education and Sport,
Department of Posture Correction, 2 Akademicka Street, 21-500 Biała Podlaska,
tel.: +48 83 3428752, fax: +48 83 3428800, e-mail: malgorzata.lichota@awf-bp.edu.pl

Abstract

Introduction. Practising sport at the professional level brings about considerable spinal loads. As a result of an intensive effort, the adaptation abilities of vertebrae, intervertebral discs, ligaments and muscles decrease, which, in turn, influences the size of physiological curvatures of the spine and at the same time the quality of body posture. The aim of the work was to evaluate the shape of anterior-posterior curvatures of the spine and to define the frequency of occurrence of body posture types in athletes practising selected sports. *Material and methods.* The research was conducted among 46 athletes from the following sections: athletics, handball, volleyball and taekwondo. Inclination angles of the curvatures of the spine were defined with the use of a posturometer: α angle (upper-thoracic segment), β angle (thoracic-lumbar segment), γ angle (lumbar-sacral segment) as well as the level of thoracic kyphosis (χ) and lumbar lordosis (λ). Every athlete's body posture type was defined. *Results.* It was revealed that in the shape of anterior-posterior curvatures of the spine in the examined athletes the level of thoracic kyphosis was higher than the level of lumbar lordosis. In all the athletes the biggest values were observed in the inclination of the upper-thoracic segment, whereas the lowest ones (except for taekwondo competitors) in the inclination of the lumbar-sacral segment. The most common types of body posture were kyphotic and balanced types. No type-III kyphosis and type-III lordosis were observed. Athletes practising selected sports generally had a proper body posture. An improper posture, especially a wrong posture, was observed in few athletes. *Conclusion.* The specificity of movements performed during the training applied in a particular sport may influence the shape of anterior-posterior curvatures of the spine and thus the type of body posture.

Key words: body postures, curvatures of the spine, sport, BMI

Introduction

Physiological curvatures of the spine are shaped gradually at successive stages of posturogenesis. The level of the anterior-posterior curvatures depends on numerous factors, inter alia somatic type, gender, lifestyle and physical activity [1]. The undertaken physical activity influences the processes of ossification and shapes muscle strength and is one of significant elements shaping a body posture.

Practising sports professionally loads a musculo-skeletal system, especially the spine. Achieving a master level in sports requires performing hard physical exercises, frequently one-side exercises repeated many times in unnatural positions connected with a significant static-dynamic load. Intensive physical effort diminished adaptation abilities of not only passive elements of the spine but also active ones, i.e. muscles responsible for its proper shape [2, 3, 4].

Finding a connection between practising a particular sport and the shape of anterior-posterior curvatures of the spine arouses interest among numerous scientists [5, 6, 7, 8, 9].

---

* The work was prepared by the members of the Student Scientific Group "Corrective movement" acting in the Department of Posture Correction and was presented during the Conference of Student Scientific Groups, University of Physical Education in Warsaw 2009.

The aim of the work was to evaluate the shape of anterior-posterior curvatures of the spine and to define the frequency of occurrence of body posture types in athletes practising selected sports.

Material and methods

The research included athletes aged 20-24 doing athletics – sprint (A n=9), handball (H n=16), volleyball (V n=13) and taekwondo (T n=5) in a student sports club (AZS) who had been training for no less than 5 years.

During body posture examinations a non-invasive, electronic measuring-diagnostic device "posturometer-S" was used [10]. The measurement of a back medial body line with marked inclination angles of particular spine segments, i.e. upper-thoracic segment (α angle), thoracic-lumbar segment (β angle) and lumbar-sacral segment (γ angle) was done. The levels of thoracic kyphosis (χ angle), lumbar lordosis (λ angle) and the sum of angles (σ) which showed the size of anterior-posterior curvatures of the spine were defined. Types of posture were defined according to Wolanski typology and then a proper and improper body posture was defined according to the criteria of Zeyland-Malawka [11, 12]. The measurements were done in the pre-noon hours in April 2008.

Intrasubject error for the measured parameters was calculated from residual variance, which made it possible to accept the range $\pm 1^0$ as an error limit. The significance of differences between groups was defined with the use of t-Student test, while interdependencies of the analysed non-measurable features were set with the use of Chi-square test (χ^2). The level of the significance of differences with p<0.05 was accepted [13].

Results

Average values (±SD and range) of the body height, body mass and BMI set for the athletes practising athletics,

handball, volleyball and taekwondo are presented in Table 1.

The measurements of the examined students were oscillating at the level of 169.0-203.0 cm (body height) and 68.0-105.2 kg (body mass). BMI values remained within 18.8-32.1. BMI values between 20-25 kg/m^2 which are typical of proper weight-height proportions were observed in 34 students (73.91%), i.e. in all athletics competitors, 43.8% of handball players, 83.3% of volleyball players and 88.9% of taekwondo competitors. A bigger proportion of body mass (BMI 25-30) was observed in 11 athletes (23.91%), i.e. in 50% of handball players, 15.38% of volleyball players and in one taekwondo competitor. In the case of one handball player (2.17%) the value of BMI was higher than 30 kg/m^2.

The analysis of the collected material revealed considerable differences in the values of anterior-posterior curvatures of the spine in athletes practising selected sports. Thoracic kyphosis was more common than lumbar lordosis among the subjects. The biggest angle values were noted in the inclination of the upper-thoracic segment (α angle), significantly lower values in a thoracic-lumbar segment (β angle) and the lowest ones in a lumbar-sacral segment (γ angle) (Tab. 2 and Fig. 1, 2).

A detailed analysis revealed that the biggest values of α angle occurred in the group of volleyball players (15.2°) and handball players (15.1°), slightly lower values in taekwondo competitors (14.0°) and the lowest ones among athletics competitors (12.4°). Slightly different results were noted for β and γ angles.

A bigger inclination of a thoracic-lumbar segment (β angle) was observed in athletics competitors (12.6°) and volleyball players (11.3°), whereas the lowest inclination in the group of handball players (8.8°). The most pronounced inclination angle of the lumbar-sacral segment (γ angle) was noted in taekwondo competitors (14.0°), an intermediate level in athletics competitors (11.0°) and volleyball players (10.3°), whereas the lowest one in handball players (8.0°).

Table 1. Average values (±SD and range) of the body height, body mass and BMI of the examined athletes

Sport	N	Body height		Body mass		BMI	
		$\bar{x} \pm$ SD	Min-max	$\bar{x} \pm$ SD	Min-max	$\bar{x} \pm$ SD	Min-max
A	9	178.9±7.11	169-188.5	76.7±5.45	69.1-84.4	23.6±0.96	22.1-25.0
H	16	184.5±6.88	175-203.0	87.2±9.83	72-105.2	25.9±2.52	21.2-32.1
F	13	185.3±6.38	169.5-193.5	81.2±6.43	72.8-95.0	23.3±2.20	18.8-28.4
T	5	180.6±2.47	177.5-185	74.7±5.37	68-83.3	22.3±2.65	19-26.2

Key: A – athletics competitors; H – handball players; V – volleyball players; T – taekwondo competitors

Table 2. Average values (±SD and range) of particular spinal curvature angles in the examined athletes

| Sport	N	α angle – inclination of the upper-thoracic segment		β angle – inclination of the thoracic-lumbar segment		γ angle – inclination of the lumbar-sacral segment	
		$\overline{x} \pm$ SD	Min-max	$\overline{x} \pm$ SD	Min-max	$\overline{x} \pm$ SD	Min-max
A	9	12.4±4.85	6.0-22.0	12.6±4.03	8.0-19.0	11±5.22	4.0-20.0
H	16	14.9±5.81	3.0-22.0	8.5±3.12	5.0-12.0	7.7±4.16	1.0-14.0
V	12	15.2±4.26	7.0-21.0	11.3±1.92	8.0-14.0	10.3±3.91	5.0-19.0
T	9	13.7±4.97	8.0-22.0	10.4±3.00	9.0-11.0	12.7±4.95	7.0-22.0

Key: A – athletics competitors; H – handball players; V – volleyball players; T – taekwondo competitors
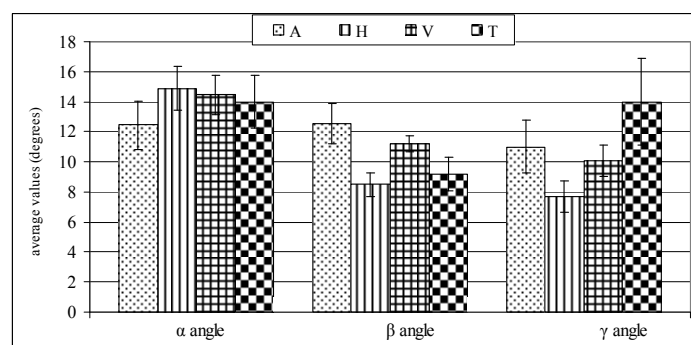
Key: α angle – upper-thoracic segment inclination; β angle – thoracic-lumbar segment inclination; γ angle – lumbar-sacral segment inclination; A – athletics competitors; H – handball players; V – volleyball players; T – taekwondo competitors

Figure 1. Average angle values (±SD) of inclinations of particular segments of the spine in athletes practising selected sports

The results of the research revealed that the value of thoracic kyphosis defined by the sum of angles α and β was the biggest in volleyball players (25.6°) and athletics competitors (25.0°) and similar but slightly lower in handball players (23.9°) and in taekwondo competitors (23.2°). A total value of physiological curvatures of the spine (σ angle) has similar values in taekwondo competitors (37.2°), slightly lower values in athletics competitors (36.0°) and volleyball players (35.7°), while in handball players it was significantly lower (31.8°) (Fig. 2). None of the analysed angles defining anterior-posterior shape of the spine differentiated the athletes significantly as far as the sport practised was concerned.
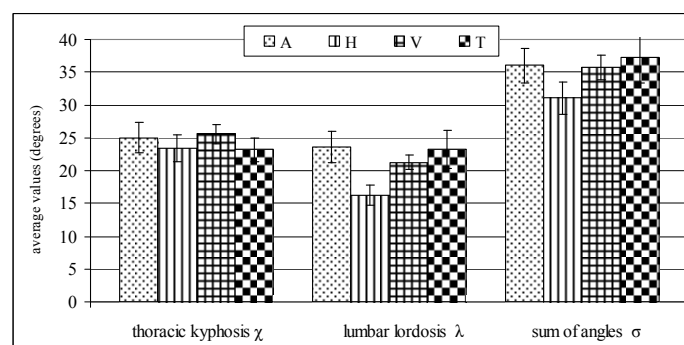
Key: A – athletics competitors; H – handball players; V – volleyball players; T – taekwondo competitors

Figure 2. Average angle values (±SD) of the curvatures of the spine in athletes practising selected sports

On the basis of the values of the angles of the spinal curvatures (α, β, γ) and their sums (χ, λ, σ), the body posture type of every athlete examined was defined (Fig. 3).
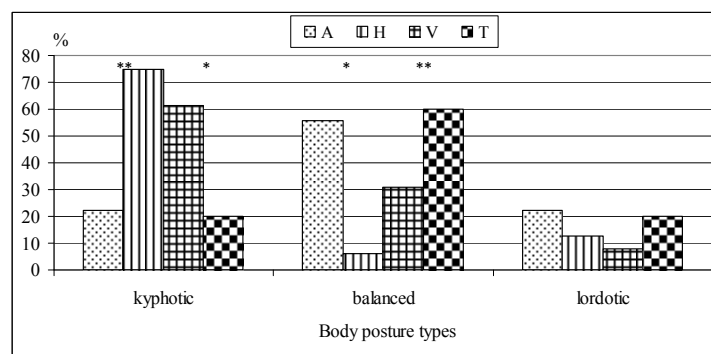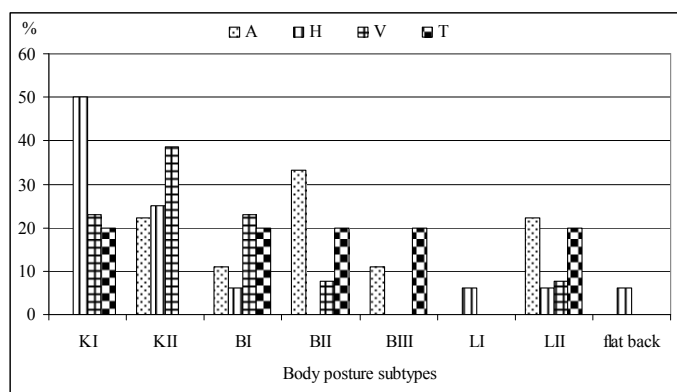

Key: A – athletics competitors; H – handball players; V – volleyball players; T – taekwondo competitors

Figure 3. Frequency of occurrence of body posture types in athletes practising selected sports

The frequency of occurrence of particular types of body posture differed depending on the sport practised. The types dominating in the group of handball and volleyball players were kyphotic types (75.0% and 61.5% respectively), while in the group of athletics and taekwondo competitors – balanced types (55.6% and 60%). Lordosis was observed the least frequently in all athletes regardless of the sport practised, especially in the case of volleyball players.

The analysis of particular sub-types made it possible to define the body posture of athletes more carefully depending on the sport practised. Figure 4 shows that the frequency of occurrence of different subtypes of body posture differentiates athletes practising selected sports. Among athletes practising athletics the most frequently observed subtypes were type-II balanced subtype and less frequently type-II kyphosis and type-II lordosis. Type-I kyphosis and type-I lordosis were not observed. In the group of handball players the dominating subtype was type-I kyphosis, while type-II and type-III balanced types were not noted. Flat back was noted in one handball player. Volleyball players most frequently had type-II kyphosis, less frequently type-I kyphosis and type-I balanced posture, while type-I lordosis and type-III balanced posture were not observed. Among taekwondo competitors type-I kyphosis, type-I, -II and -III balanced posture as well as type-II lordosis were noted with a similar frequency.
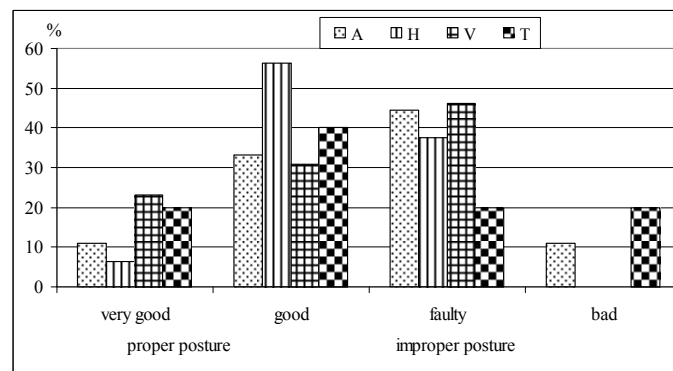

Key: A – athletics competitors; H – handball players; V – volleyball players; T – taekwondo competitors; KI – type-I kyphosis; KII – type-II kyphosis; BI – balanced type I; BII – balanced type II; BIII – balanced type III; LI - type-I lordosis; LII – type-II lordosis

Figure 4. Occurrence of particular subtypes of body posture in athletes practising selected sports

Type-III kyphosis and type-III lordosis, which are types of improper body postures, were not noted in any group of athletes.

Taking into consideration the criteria suggested by Zeyland-Malawka [11, 12], body postures of the examined athletes were assessed and defined as proper body postures (very good and good) and improper body postures (faulty and bad) (Fig. 5).

Key: A – athletics competitors; H – handball players; V – volleyball players; T – taekwondo competitors

Figure 5. Occurrence of proper postures (very good and good) and improper postures (faulty and bad) in athletes practising selected sports

In the athletes practising selected sports proper body postures were noted slightly more frequently than improper body postures. The best posture (good and very good) was observed in athletes practising handball and taekwondo, while an improper posture (faulty and bad) in athletics competitors.

Discussion

The results of the presented research confirm the influence of the oriented physical activity on the shape of anterior-posterior curvatures of the spine which is described by other authors. The collected data are consistent with the results presented by various scientific centres. Bieć and Demczuk-Włodarczyk [5] observed balanced types and postures defined as very good and good more frequently in taekwondo competitors. The results of observations carried out by Żurek et al. [14] also indicate the most frequent occurrence of balanced and kyphotic types (especially subtypes included in the group of very good and good body postures) among athletes practising judo. Barczyk et al. [15] noted that in athletes practising middle-distance runs a balanced type occurred most often, while in volleyball players a balanced and kyphotic type was more frequent. The research by Ślężyński and Rottemund [7] shows that volleyball players usually have kyphotic body posture with

a prominent thoracic kyphosis. Vojtys et al. [16] revealed the occurrence of big curvatures of the spine in athletes, especially in gymnasts and slightly lower ones in athletics competitors. Significant values of thoracic kyphosis in students frequently taking up physical activity are noted in the research done by Górniak et al. [17]. Zeyland-Malawka [18] noted relatively small values of thoracic kyphosis in weight-lifters and ice-skaters, while they observed big values in handball players and fencers. The author highlights the fact that the level of anterior-posterior curvatures is determined by taking up intensive, oriented physical activity; however, it does not have to be a decisive factor in shaping the spine [19].

Conclusion

The specificity of movements performed during the training applied in a particular sport may influence the shape of anterior-posterior curvatures of the spine and thus the type of body posture.

Literature

1. Kutzner-Kozińska, M. (Ed.) (2001). *The Process of Correcting Postural Defects*. Warsaw: AWF Warszawa. [in Polish]

2. Schiller, J.R. & Eberson C.P. (2008). Spinal deformity and athletics. *Sports Med. Artrosc. Rev.* 16(1), 26-31.

3. Janusz, W., Rutkowska E. & Markiewicz A. (1998). Spinal injuries in athletes. *Med. Sport.* 7-8, 67-70. [in Polish]

4. Dziak, A. & Tayara S. (1997). *Sacral pains*. Kraków: Wydawnictwo PH-U „Kasper". [in Polish]

5. Bieć, E. & Demczuk-Włodarczyk E. (2002). Body posture of athletes practising combat sports. *Fizjoterapia* 10(3-4), 32-36. [in Polish]

6. Gieremek, K., Stokłosa H. & Piekla D. (1992). Body posture of athletes practising shooting. *Wych. Fiz. Sport* 4, 45-52. [in Polish]

7. Ślężyński, J. & Rottermund J. (1991). Somatic indicators, body posture and foot arch of volleyball players. *Wych. Fiz. Sport* 35(4), 59-65. [in Polish]

8. Wood, K.B. (2002). Spinal deformity in the adolescent athlete. *Clin. Sports Medicine* 21, 77-92.

9. Zeyland-Malawka, E. (2000). Practising sports professionally as a factor determining the spine shape. In T. Mieczkowski (Ed.), *Positive and negative aspects of physical activity* (part I) (pp. 33-39). Szczecin: Wydawnictwo Naukowe Uniwersytetu Szczecińskiego. [in Polish]

10. Śliwa, W. (1997). Diagnostic-measuring device Posturometer-S, Orthopaedic-Prosthetic Engineering. In I Sympozjum IOP'97, 23-25 June 1997 (pp. 259-264), Białystok. [in Polish]

11. Zeyland-Malawka, E. (1999). Classification and assessment of body posture in the modification of Wolanski method and New York Classification Test. *Fizjoterapia* 7(4), 52-55. [in Polish]

12. Zeyland-Malawka, E. (1992). *Corrective Exercises*. Gdańsk: Wydawnictwo Uczelniane AWF Gdańsk. [in Polish]

13. Stupnicki, R. (2000). *Biometry, Short Outline.* Warsaw: Wydawnictwo MARGOS. [in Polish]

14. Żurek, G., Błach W., Ignasiak Z. & Migasiewicz J. (2005). The evaluation of the body posture of judo competitors in the light of photogrammetric method with the use of Moire's phenomenon. *Pol. J. Sports Med.* 21(4), 303-307. [in Polish]

15. Barczyk, K., Skolimowski T., Hawrylak A. & Bieć E. (2005). The shape of the spine in the sagittal plane in individuals practising selected sports. *Med. Sport.* 21(6), 395-400. [in Polish]

16. Vojtys, E.M., Asthon-Miller J.A., Huston L.J. & Moga P.J. (2000). The association between athletic training time and the sagittal curvature of the immature spine. *Am. J. Sports Med.* 28(4), 490-498.

17. Górniak, K., Popławska H., Lichota M. & Dmitruk A. (2006). The shape of anterior-posterior curvatures of the spine in physical education students with diverse BMI. In D. Umiastowska (Ed.), *Physical activity of people in different age groups* (part I) (pp. 242-247). Szczecin: Wydawnictwo Promocyjne „Albatros". [in Polish]

18. Zeyland-Malawka, E. (1977). The shape of anterior-posterior curvatures of the spine in handball players and judo competitors. *Sport Wyczynowy* 1, 48-59. [in Polish]

19. Zeyland-Malawka, E. (1992). Seeking the connection between the shape of the spine and intensive physical activity. In J. Ślężyński (Ed.), *Body posture of a human and methods of its assessment* (pp. 87-98). Katowice: AWF Katowice. [in Polish]