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CHARACTERISTICS OF ANTEROPOSTERIOR CURVATURES OF THE SPINE IN SOCCER AND FUTSAL PLAYERS

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ABSTRACT
Purpose. The aim of the study was to determine differences in anteroposterior spine curvatures between futsal players, soccer players, and non-training students. The results may contribute to the development of present-day knowledge of posturometry, and its implementation in training can help reduce the risk of body posture disorders in athletes.
Methods. The examined group consisted of 48 athletes and 38 non-training college students. Body posture parameters were measured with the use of Posturometr-S. The normality of distribution was checked with the Shapiro-Wilk test, and the differences between the groups were measured with ANOVA and the Bonferroni post-hoc test. The level of statistical significance was set at $p < 0.05$.
Results. The analysis of α angle values revealed the widest and most similar measurements in the group of futsal players and soccer players. The analysis of variance proved statistically significant differences between the soccer players and futsal players ($p = 0.003$). The difference between the soccer players and non-training students was statistically significant. The highest γ angular value was measured in non-training students, followed by futsal players and soccer players. The statistical analysis revealed significant differences between the non-training students and futsal players, as well as non-training students and soccer players ($p < 0.001$).
Conclusions. A complex assessment of athletes' body posture is crucial in injury prevention. Training overloads may often lead to disorders of the organ of locomotion and affect the correct body posture in athletes. This, in turn, may result in pains and injuries.
Key words: spinal curvatures, futsal, training, athletes

Introduction

Futsal is a variant of association football (soccer), also called *futebol de salão*, big room soccer, or five-a-side football. As evidenced by significantly high numbers of people who play futsal on a regular basis, it has gained popularity in recent years. Unlike soccer, futsal involves time stopping at every dead ball, which means that a game played for two periods of 20 minutes may actually last up to 80 minutes [1]. Other significant differences between the two team sports are types of players' shoes and playing court surfaces. Soccer matches are played on a natural turf surface, whereas futsal is played indoors on flat, smooth, and non-abrasive artificial material. A futsal court thus differs from a soccer pitch. It is softer, more elastic and thus absorbs shocks better. In fact, the type of playing surface may affect the degree of the players' anteroposterior spine curvatures. Sport training exerts an impact on bone modelling and muscle strength, and contributes to the ontogenetic development of the players' body posture [2]. The general model of the players' morphological characteristics varies depending on their pitch position, which is related to the performance of different activities [3, 4].

Match video analyses reveal that, like soccer players, futsal players perform specific types of physical activities during a game: walking; low-, medium-, high-intensity running; sprinting; slide tackling; jumping; and standing. On the average, futsal players change the activity type every 3.38 seconds, and perform sprint runs of 1.95 seconds separated by 79-second breaks [5]. According to Hoff [6], soccer players perform maximum-intensity, 2–4-second efforts separated by 90-second breaks. However, Bangsbo [7] shows that the time between consecutive sprints performed by a soccer player during a match amounts to 55 seconds. These times

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are averaged, and the measurements provided by Hoff [6] and Bangsbo [7] should not be regarded as the only performance indices. Depending on a situation on the pitch, a player may perform several different phosphagen system activities during 1 minute, e.g. jumps, slides, sprints, and then continue jogging or walking for the next 2–3 minutes. The average distance covered by a futsal player during a match is 4313 m at the average speed of 7 km/h [8]. During a 90-minute soccer match, players can cover distances of 10–12 km [9]. The best physically trained players covered more than 130 m during 1 minute of a game, e.g. Henrikh Mkhitaryan: 137 m, Mario Götze: 136.1 m, Marco Reus: 132.5 m, Andrea Pirlo: 131.6 m, Jakub Błaszczykowski: 127.3 m [10].

Souza et al. [11] in their analysis of six consecutive soccer matches noted that players performed at the intensity of 82–91% HRmax, depending on their pitch position. Similar exercise intensities, i.e. 85–90% HRmax, in four consecutive soccer matches were noted by Wolański et al. [4]. Cometti [12] claims that in soccer, explosive exercises constitute only 5%, whereas low- and medium-intensity ones amount to 60% of the total playing time. According to Bangsbo [7], the heart rate in soccer outfielders amounts to 150–190 bpm. These observations clearly indicate that all high-intensity activities performed by futsal and soccer players, the contact nature of both sports, and the specificity of players' movements may, directly or indirectly, affect the players' anthropometric characteristics. Van Hespen et al. [13] and Ribeiro and Costa [14] indicate that the specificity of futsal exposes players to various injuries resulting from sudden and abrupt accelerations, stops, and turns during a game. The dynamic running direction changes in futsal contribute to the risk of ankle joint injuries, which in turn can have an impact on the function of different body parts, including the spine [15].

Sports training as a specific form of directional physical activity can exert a significant effect on the process of posture development of young men owing to high training loads and repeated unilateral exercises. Athletes participating in rigorous sports had higher risk of thoracic hyperkyphosis than sedentary people [16, 17]. The correct spine functioning and its flexibility are indispensable for each player and they co-influence sports results. The vertebral column connects the trunk with the limbs, which makes the natural spinal curvatures subject to overloads during games. Probably, the deepening of spine curvatures is common in sports in which base impact on lower limbs and hip joints is very strong [18]. Junge and Dvorak [19], in their study of 127 futsal matches, reported the incidence of 165 players' injuries. The majority of these injuries were caused by contact with another player, and 36% of them occurred during non-contact activities. Most injuries affected the lower extremity (70%), followed by head and neck (13%), upper extremity (10%), and trunk (7%).

According to Cole et al. [20], lumbar injuries and pains occur most often in gymnasts, soccer players, weightlifters, wrestlers, and swimmers. Ribeiro et al. [21] noted that body posture defects in futsal players may cause extra mechanical overloads of the osteoarticular and musculoskeletal systems. Injuries lead to training interruptions and increase the players' recovery time. Determinants of body posture include age, sex, physical activity, mental condition, and diet [22]. Human body functions in accordance with movement and posture patterns, developed by all parts of the body. Human spine and the musculoskeletal system adhere to the rules of mechanics as they are constantly affected by forces of gravitation. It should be remembered that particular regions of the spine never function separately but are integral components of the whole torso [23].

The aim of the present study was to determine differences in body build and posture between futsal players, soccer players, and non-training students. The results may contribute to the development of present-day knowledge of posturometry, and their implementation in training can help reduce the risk of body posture disorders in athletes.

Material and methods

Participants

The first study group comprised 22 male futsal players from the AZS AWF Wrocław sports club (mean training experience, 12.32 ± 3.15 years; body mass, 74.87 ± 8.16 kg; body height, 178.51 ± 5.01 cm; BMI, 23.55 ± 2.55 kg/m^2). The group included Polish Collegiate Futsal Championships medallists. The second study group consisted of 26 male soccer players (mean training experience, 15.5 ± 3.4 years; body mass, 80.1 ± 7.73 kg; body height, 184.03 ± 5.92 cm; BMI, 23.69 ± 1.29 kg/m^2). The non-training controls were 38 college students (body mass, 80.25 ± 7.75 kg; body height, 179.46 ± 6.51 kg; BMI, 25.11 ± 1.97 kg/m^2).

Procedure

The basic measurements included body mass, body height, and body mass index (Tanita, Japan). Body posture variables were measured with the use of the Posturometr-S non-invasive device [24]. Before the measurements, the spinous processes (C_7–L_5) were marked on the skin of each participant with a dermatograph pencil. During the measurements between the marked spots with the pointing stick of the device, a participant's lower extremities were evenly loaded and the head was held in the Frankfurt plane. The following angles were measured for particular spinal regions in the sagittal plane (Figure 1):

– alpha (α): upper thoracic segment,
– beta (β): thoracolumbar segment,
– gamma (γ): lumbosacral segment.

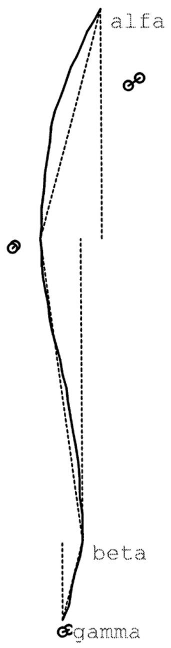


Figure 1. Sagittal plane

The thoracic kyphosis angle was calculated as the sum of alpha and beta angles ($\alpha + \beta$), and the lumbar lordosis angle as the sum of beta and gamma angles ($\beta + \gamma$).

The body posture analyses were performed in the pre-noon hours.

Statistical analysis

The results were presented as arithmetic means and standard deviations. Statistical calculations were carried out with the Statistica v. 12.0 software (StatSoft, USA). The normality of distribution was checked with the Shapiro-Wilk test, and the differences between the groups were measured with the use of ANOVA and the Bonferroni post-hoc test. The level of statistical significance was set at $p < 0.05$.

Ethical approval

The study was carried out in the Department of Physical Anthropology of the University School of Physical Education in Wrocław, Poland, by qualified staff. The participants were informed in detail about the study purpose and methodology. The study was conducted in accordance with the Declaration of Helsinki. All participants provided their informed consent to take part in the study.

Results

The comparison of anthropometric variables such as body weight and body height (Table 1) revealed that futsal players were lighter and shorter than professional soccer players and non-training students; according to the analysis of variance, the differences in body weight were statistically significant. As for body height, all the examined groups were statistically different.

The widest angles were noted in the upper thoracic curve (α), followed by the thoracolumbar curve (β), and the lumbosacral curve (γ). The analysis of α angle values revealed the widest and most similar measurements in the group of futsal players (± 14.77°) and soccer players (± 14.73°). In the group of non-training students, the mean α angle amounted to 13.39°. The widest mean inclination of the thoracolumbar curve (β) was found in the group of soccer players (± 11.08°). In the futsal players, the β angle amounted to 10.64°, whereas in the non-training group it was 9.82°. The mean γ angle in futsal players equalled 10.73°, in non-training students 8.66°, and in soccer players 7.23° (Figure 2). The analysis of variance revealed statistically significant differences between the soccer and futsal players ($p = 0.003$).

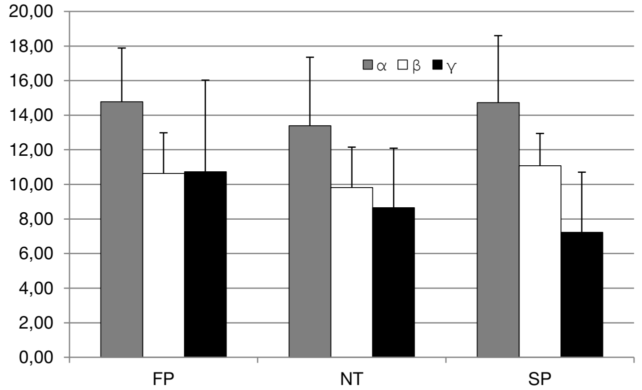
The mean thoracic kyphosis and lumbar lordosis angles are presented in Figure 3. The highest thoracic kyphosis degree was found in soccer players (25.81°), followed by futsal players (25.41°), and non-training students (23.21°). The difference between the soccer players and non-training students was statistically significant ($p = 0.021$).

The opposite was observed for the lumbar lordosis angle. The highest angular value was measured in non-training students (31.36°), followed by futsal players (21.36°), and soccer players (18.31°). The statistical analysis revealed significant differences between the non-training students and futsal players, and non-training students and soccer players ($p < 0.001$).

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

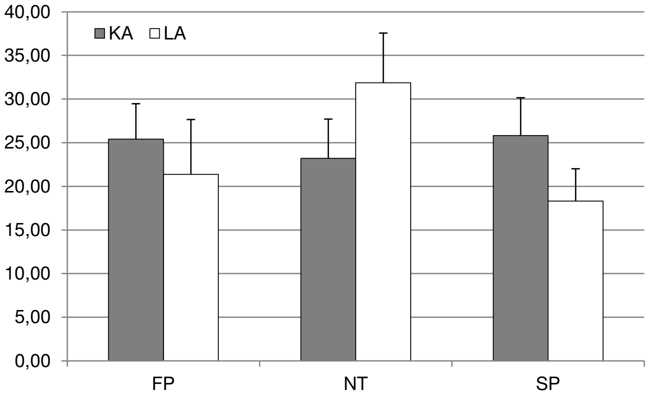
Variables	FP				SP				NT			
	N	$\bar{x} \pm SD$	Min	Max	N	$\bar{x} \pm SD$	Min	Max	N	$\bar{x} \pm SD$	Min	Max
Body weight (kg)	22	74.86 ± 8.16	58.6	87.0	26	80.10 ± 7.73	60.5	96.1	38	80.25 ± 7.75	62.0	94.5
Body height (cm)	22	178.77 ± 5.30	166.0	188.0	26	184.03 ± 5.92	172.5	196.5	38	179.46 ± 6.51	167.0	194.3
BMI (kg/m^2)	22	23.55 ± 2.55	18.5	28.6	26	23.69 ± 1.29	19.8	25.7	38	25.11 ± 1.97	22.3	30.8

FP – futsal players, SP – soccer players, NT – non-training students



FP – futsal players, NT – non-training students, SP – soccer players,
α – upper thoracic curve, β – thoracolumbar curve, γ – lumbosacral curve

Figure 2. Average values of particular spinal curvature angles in the examined groups



FP – futsal players, NT – non-training students, SP – soccer players, KA – kyphosis angle, LA – lordosis angle

Figure 3. Mean angles of body posture variables in the sagittal plane

Discussion

Body build is a key determinant in the selection of players for team games [25, 26]. Overall, the futsal players under study were shorter and lighter that non-training students and soccer players. Burdukiewicz et al. [3] revealed no significant differences in body build between futsal players and professional soccer players. The results of the present study do differ from those obtained by other authors. In a Croatian study, futsal players were, in fact, taller, which can be explained by differences in selection methodology between professional and amateur sports [27].

Assessment of spinal curvatures is a common research topic; however, very few studies of spinal curvatures in futsal players have been published so far. The shape of the spine is a crucial component of all body posture analyses and classifications. The spinal curvatures are characterized by a significant variability, associated with one's age, ontogenetic development, or practicing a specific sport for many years. A number of authors have attempted to find relationships between the shape of anteroposterior spine curvatures and the type and intensity of practiced sports [28–30]. According to Wojtys et al. [17], young people who commence intense training sessions with loads which are not age-adjusted are particularly exposed to the development of vertebral malformations. This is of special concern to young gymnasts, hockey players, and wrestlers. Long-lasting and intense training may lead to the development of excessive curvatures of the spine: hyperkyphosis and hyperlordosis.

The authors of the present study assessed the degrees of spinal anteroposterior curvatures in futsal players, soccer players, and students declaring low physical activity levels.

As for the physiological curvatures of the spine, the futsal players were characterized by slightly greater angles of thoracic kyphosis and lumbar lordosis than the non-training students. There was also a significant difference in the degree of lumbar lordosis between futsal and soccer players. Significant inter-group differences were not revealed in spinal regions, with the exception of the γ angle, which varied significantly between the futsal and soccer players. Ślężyński and Rottermund [31], in their study of volleyball players aged 18–34 years, showed that the measured curvatures of the spine clearly indicated a tendency towards kyphotic postures among the players, which can be explained by their frequent assumption of a forward leaning body posture with rounded shoulders and extended arms. The non-training male controls were characterized by more frequent lordotic postures. The α angle measured by Lichota et al. [32] in athletes practicing different sports was the widest in volleyball players (15.2°), followed by handball players (15.1°), taekwondo practitioners (14.0°), and track and field athletes (12.4°). The highest β angle was found in track and field athletes (12.6°), followed by volleyball players (11.3°), and handball players (8.8°). The γ angle was the lowest in team sport players. In the present study, the widest γ angle was observed in soccer players. The degrees of measured kyphosis and lordosis were similar in the present study and that by Lichota et al. [32]. Uetake et al. [18] noted most significantly increased spinal curvatures in sprinters, middle- and long-distance runners, and kendo practitioners, and only slightly wider ones in soccer players, rugby players, swimmers, and non-training individuals.

Zeyland-Malawka [33] noted greater lordosis degrees in athletes representing different sports (handball, hockey, fencing, judo, weightlifting, ice skating) than in non-training controls, as well as greater lordosis and the greatest kyphosis angles in handball players and fencers. Wodecki et al. [34] noted that boys who played soccer were characterized by smaller kyphosis and greater lordosis than their non-training counterparts.

Conclusions

Many earlier studies showed that the length and type of sport-specific training can affect the shape of anteroposterior spine curvatures and thus the body posture type in athletes. The results of the present study of spinal curvatures in male futsal and soccer players partially confirm this assertion. There is a tendency of increased kyphosis and decreased lordosis in futsal players. The postural differences between futsal and soccer players were insignificant.

Complex assessment of athletes' body posture is crucial in injury prevention. Training overloads may often lead to disorders of the organ of locomotion and affect the correct body posture in athletes. This, in turn, may result in pains and injuries.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

Authors state no conflict of interest.

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