International Journal of Human Movement and Sports Sciences 12(6): 1057-1065, 2024 http://www.hrpub.org
DOI: 10.13189/saj.2024.120617

The Influence of Sport on Team Sport Athlete's Postural Development

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Received October 3, 2024; Revised November 13, 2024; Accepted December 3, 2024

Cite This Paper in the Following Citation Styles

(a): *[1] Najada Quka, Marsela Shehu, Orkida Kosta, Rigerta Selenica, Dritan Sallaku , "The Influence of Sport on Team Sport Athlete's Postural Development," International Journal of Human Movement and Sports Sciences, Vol. 12, No. 6, pp. 1057 - 1065, 2024. DOI: 10.13189/saj.2024.120617.*

(b): *Najada Quka, Marsela Shehu, Orkida Kosta, Rigerta Selenica, Dritan Sallaku (2024). The Influence of Sport on Team Sport Athlete's Postural Development. International Journal of Human Movement and Sports Sciences, 12(6), 1057 - 1065. DOI: 10.13189/saj.2024.120617.*

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Abstract Athletes' posture development is a very important and complex issue that many researchers have recently focused on for a better performance. The purpose of our study is to determine the influence of sport on athletes' postural characteristics compared to those of non-athletes. In order to identify the postural parameters among the participants of the study, we used the "Posture Screen Mobile" software. Participants in our study were students from Sports University of Tirana aged 20±2 years (N=60 Bachelor's students; 52% males and 48% females). Based on the aim of our study, they were divided into two groups athletes (N=30; 60% male; 40% female) and non-athletes (N=30; 47% male; 53% female). The data were analyzed using IBM SPSS Statistics 20, focusing on a descriptive analysis and the Anova test. In our study, results show significant differences in postural curvatures between athletes and non-athletes (p-value < 0.05). Athletes reported higher scoliosis and lordosis curvatures, respectively forward lordosis with 3.2 ± 1.2 degrees and lateral curvature/scoliosis with 2.8 ± 1.2 degrees in their shoulders, compared to non-athletes (1.8 ± 0.9 and 2.1 ± 1.1 degrees). While between athletes, our results showed that basketball players *(3.1 (±1.2) hip/lordosis; 2.8 (±1.2) head/kyphosis)* exhibit higher sagittal plane curvatures for both lordosis and kyphosis compared to football players *(2.8 (±1.1) hip/lordosis; 2.6 (±1.1) head/kyphosis)* and volleyball players *(2.7 (±1.0) hip/lordosis; 2.8 (±1.2) head/kyphosis)*. Based on our findings and conclusions, the study underlines that when the movement model does not correspond to the proper action during exercise, muscle imbalance and incorrect postural behavior occur. Training with tasks that correct muscle imbalance has a direct impact on the postural deficits that athletes exhibit as a result of asymmetric exercises. The coach's obligation continues to control the strength at unilateral levels and compare them so that the indicators are comparable.

Keywords Athletes, Postural Parameters, Non-Athletes, Postural Characteristics, Sport

1. Introduction

Posture and how it develops among athletes are significant and complex issues that affect not just how well they might perform in sports but also their long-term musculoskeletal health. Also, a poor posture might be one of the risk factors of injury during sporting events [1, 2].

In this context, the importance of posture among athletes in mobility terms is well highlighted considering it as the mechanism that permits the alignment and orientation of the body in space during either its dynamic or static state. A mechanism is made possible by the intricate interactions between the skeletal, muscular, and nervous systems, which cooperate to maintain stability and balance [3, 4, 5].

In addition, in terms of sports performance, posture is determined as a neuromuscular reaction that, when combined with various internal and external components (morphological, physiological, biomechanical, metabolic, and environmental), maintains static and dynamic postural

stability, thereby optimizing sports performance, maximizing movement efficiency, stability, and injury prevention [3].

Because of these considerations regarding posture and its importance among athletes, evaluating athletes' postural development has recently become one of the most important areas of sports science garnering a lot of attention lately.

According to Asker et al [1], athletes are more likely to experience postural abnormalities as a result of *systematic and ongoing participation in specialized exercise programs*, particularly those athletes whose training routines include *asymmetrical motions*. Furthermore, among the most common postural deviations detected in athletes, they discovered *postural problems mostly affecting the shoulder and spine*. There is data that identifies postural concerns in sports as common today, emphasizing the *need for intervention in the training program adding postural exercises with preventive value* to ensure postural stability and muscle balance, both of which are the cause of not only postural deviations but also poor sports performance [2, 3, 6].

Many researchers have examined the impact of sport on the postural development of the athletes, focusing on the relationship between the movement specifics of sport and the developmental models of athletes' spines.

In this context, various researchers have detected that sports that rely heavily on repetitive motions above the head (tennis, volleyball) are more likely to cause rounded shoulders (kyphosis) [7, 8, 9]. Sports with asymmetric motions (basketball, football, volleyball, handball) are more likely to exhibit scoliotic tendencies due to muscular imbalances [7, 10, 11]. According to Watson [12], football influence lumbar lordosis tendencies with prevalence rates of 26.5% for mild lordosis and 51.9% for significant lordosis. Sports like gymnastics, football, and swimming can lead to hyper-kyphosis and hyper-lordosis particularly among teenagers with an immature spine who participate in intensive sports training for more than 400 hours per year [13, 14]. Cycling, which is characterized by prolonged forward posture, predisposes to the development of kyphotic habits [15]. Professional climbers, as opposed to non-professional climbers, have been demonstrated to exhibit kyphotic behavior as a result of training intensity and movement patterns [19]. Due to the asymmetric nature of handball, which is characterized by strong attacking and defensive actions, as well as the coordinated movements necessary to perform handball maneuvers [1, 10, 16], handball players are more likely to develop scoliosis tendencies [10, 17, 18].

Unfortunately, scoliotic behaviors are becoming more common in today's society, particularly among younger generations affected by a sedentary lifestyle, extended use of the technology, and longtime sitting position [20, 21, 22].

Knowing the frequency, cause, and effects of postural deviations in athletes and taking care about its development during training sessions is crucial in order to enhance sport performance by reducing the possible risk of injury and advancing overall health [1].

Including *postural exercises* in training program is crucial as long as it impacts athletes' ability to generate energy and transmit forces efficiently improving sport performance [24, 25, 26]; reduce the emergence of potential musculoskeletal injuries during sport events because of continued pressure on certain joints by an erroneous postural attitude influences [2, 20, 23] and secure musculoskeletal health & sports career longevity reducing the acceleration of tissue deterioration and its impact on the development of chronic musculoskeletal issues such as osteoarthritis as result of untreated postural pains and deviations [27].

Based on the foregoing, the aim of our study was to investigate the influence of sports on athletes' postural characteristics when compared to those of non-athletes, estimating and analyzing the differences of the postural parameters between athletes and non –athletes and between sports such as volleyball, basketball, and football players.

2. Methodology

2.1. Study Participant

This study involved Sports University of Tirana Students (N=60), from the first study cycle "Bachelor", aged ± 20.75 years. From 300 students in Sports University of Tirana, Bachelor study cycle, the sample of our study was 60 because of the selected criterion which was "students who participated systematically in sport and those who were not".

Based on this criterion the participants were divided into two groups:

a) athletes

N=30 students;

- 10 basketball players; 10 volleyball players; 10 soccer players
- 18 boys (60%)
- 12 girls (40 %)

b) non-athletes

N=30 students;

- 14 boys (47%)
- 16 girls (53%)

2.2. Instrument of the Study

To assess the postural shape of the participants we used the Posture Screen Mobile software, which is known for its effectiveness in assessing postural deviations. This application, which can be easily accessed from any Android electronic device, uses photography to identify study subjects' images from four different angles such as frontal plane (front/back) and sagittal plane (left/right)

allowing for a thorough postural analysis. This application is recommended to all of those who are interested in assessing and studying body posture/posture for various reasons:

1) it may be used anywhere as a result of its portability.
2) it is easy to use.

Participants first were informed about the objectives of the study and the procedures of the test, then they gave their permission to participate.

2.3. Procedure

Before the use of the Posture Screen Mobile software, participants were well informed by us about the clothing protocol and the process up until the final realization of the photographs in order to facilitate a more precise study of the postural posture of athletes and non-athletes.

In this contexts, participants were instructed to wear light clothes (topples and shorts for girls and shorts for boys, (photo 1 in order to maximize the visibility of anatomical landmarks and improve posture assessment accuracy.

They were also told to stand with their feet shoulder-width apart, looking forward, and their arms extend downward, keeping them close to their lower limbs, in a relaxed, anatomically neutral stance. Also, in the anterior view, they were told to face the camera with their hands facing the frontal plane (Photo 1).

After taking photos, the application provides a comprehensive report on the location of several body parts (head, shoulders, hips, and ankles) in relation to the sagittal axis after validating the photos by overlaying a grid on the images and ensuring the inclusion of anatomical reference points. One critical feature of the program is the determination of postural variables, which are the angles between anatomical reference points and the sagittal axis (Photo 2).

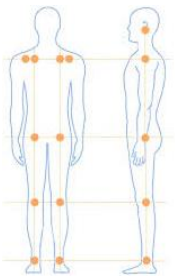
2.4. Statistical Analyses

The theoretical component of our study was carried out using the basic sectors of scientific research, such as Web Science, Research Gate, and PubMed for a comprehensive cognitive overview of the phenomenon explored in this study.

For the statistical analysis of the collected data, we used "IBM SPSS Statistics 20", respectively the descriptive statistical analysis, to describe and summarize data points in a constructive way so that patterns might emerge to fulfill every condition of the data, and the Anova test to compare and identify differences in postural characteristics between athletes and non-athletes and between athletes from different sports disciplines within the same age group.

(clothing and standing position during test)

Photo 1. Postural Test Protocol



Body region	Anterior Translation		Anterior Angulation	
Head	0.19^0 right	0.09^0 right	1.3^0 right	1.4^0 right
Shoulder	0.24^0 left	0.38^0 left	3.6^0 right	0^0
Ribcage	0.68^0 left	0.22^0 left	n/a	n/a
Hip/Pelvis	0.31^0 right	0.65^0 left	1.0^0 left	0^0
Total	**1.42^0**	**1.34^0**	**6.00^0**	**1.4^0**

Photo 2. Posture Screen Mobile' Report

3. Results

Table 1, provides a descriptive analysis of our research participants' demographics components including age, gender, and athletes or non-athletes.

Table 1. Descriptive Analyze about the composition of our study participants (age, gender, athletes and non-athletes)

Age	18-22 age group	±20.75	
Gender	N=60	26 male 24 female	52% male 48% female
Athletes	N=30	18 male 12 female	60% male 40% female
Non Athletes	N=30	14 male 16 female	47% male 53% female

Total N=60 students

(athletes /non-athletes)

Tables 2, 3, and 4 provide athletes' postural measurements in relation to the sagittal axis for volleyball, basketball, and football, with an emphasis on the evidence of their postural behaviors (scoliosis, lordosis, and kyphosis).

These tables, organized according to sports (volleyball, basketball, football), are concentrated on the analyses of the postural curves formed by the head, shoulders, and hips with respect to the sagittal axis. These curves are assessed in two different planes: the sagittal plane (lateral view in both left/right side) and the frontal plane (anterior-posterior view).

The results in Table 2, indicate that, in accordance with the plans, the **volleyball players'** most noticeable postural displacement is:

- in the frontal plane, the shoulders exhibit a lateral curvature of 2.5 ± 1.1 degrees, indicating the potential for scoliotic tendencies in volleyball players.
- In the sagittal plane, the head, shoulders, and hips are curled forward, backward, and forward, respectively, by 3.0 ± 1.2 degrees, 2.7 ± 1.0 degrees, and 2.8 ± 1.1 degrees, confirming the existence of kyphosis.

These curves are a result of repeated jumping and overhead motions in volleyball (dive, block, back serve, etc.), both with and without momentum [7, 8, 17].

The results in Table 3, provide the most detected basketball players' postural displacement, which, in accordance with the plans, are:

- in the frontal plane, basketball players have lateral curvatures of 3.0 ±1.2 degrees, 2.5 ±1.1 degrees in the head, and 2.0 ±1.1 degrees in the hips, indicating scoliotic behavior.
- in the sagittal plane, the shoulders, hips, and head curved forward at 3.5 ± 1.3 degrees, 3.1 ± 1.2 degrees, and 3.2 ± 1.4 degrees, indicating lordosis behaviors, and backwards at 3.0 ± 1.3 degrees, 2.9 ± 1.3 degrees, and 2.8 ± 1.2 degrees, indicating kyphotic behaviors, with values higher than scoliotic curvatures.

Table 3 shows that the most noticeable postural displacement is forward displacement, often known as lordosis behaviors. This clearly demonstrates how the particular demands of basketball, such as frequent hops and high shots, influence the development of lordosis habits.

Basketball players had higher frontal and sagittal plane curvatures than volleyball players, particularly in the shoulders and head [28, 29].

Table 4 shows that football players have considerable lateral curvature (2.8 ±1.2 degrees in the frontal plane, 2.2 ±1.0 degrees in the head, and 1.9 ±1.1 degrees in the hips), indicating a scoliotic posture. The forward displacement of the head, shoulders, and hips in the sagittal plane is 2.9 ± 1.2 degrees, 3.2 ± 1.3 degrees, and 2.8 ± 1.1 degrees, indicating football players' lordosis behavior. In addition, the backward displacement of the head (2.6 ±1.1 degrees), shoulders (2.9 ±1.2 degrees), and hips (2.7 ±1.2 degrees) shows that they exhibit kyphotic activity/tendency too.

The detected postural parameters measured on the football players are the result of the systematic and continuous induction of the specifics and movement techniques of this sport, mentioning long runs, throwing the ball and sudden changes of direction [12, 24, 25].

Table 2. Descriptive Analysis of Posture Displacement of Volleyball players

Posture Displacement	Head Angulation	Shoulder Angulation	Hips Angulation	Postural Behavior
Lateral Displacement *Frontal Plane* *(anterior –posterior view)*	2.0 (±1.0)	2.5 (±1.1)	1.8 (±1.0)	Scoliosis
Forward Displacement *Sagittal plane* *(lateral view in right-left side)*	3.0 (±1.2)	2.8 (±1.1)	2.7 (±1.0)	Lordosis
Backward Displacement *Sagittal plane* *(lateral view in right-left side)*	2.5 (±1.3)	2.7 (±1.2)	2.6 (±1.1)	Kyphosis

Table 3. Descriptive Analysis of Posture Displacement of Basketball players

Posture Displacement	Head Angulation	Shoulder Angulation	Hips Angulation	Postural Behavior
Lateral Displacement *Frontal Plane* *(anterior –posterior view)*	2.5 (±1.1)	3.0 (±1.2)	2.0 (±1.1)	Scoliosis
Forward Displacement *Sagittal plane* *(lateral view in right-left side)*	3.2 (±1.4)	3.5 (±1.3)	3.1 (±1.2)	Lordosis
Backward Displacement *Sagittal plane* *(lateral view in right-left side)*	2.8 (±1.2)	3.0 (±1.3)	2.9 (±1.3)	Kyphosis

Table 4. Descriptive Analysis of Posture Displacement of Football players

Posture Displacement	Head Angulation	Shoulder Angulation	Hips Angulation	Postural Behavior
Lateral Displacement *Frontal Plane* *(anterior –posterior view)*	2.2 (±1.0)	2.8 (±1.2)	1.9 (±1.1)	Scoliosis
Forward Displacement *Sagittal plane* *(lateral view in right-left side)*	2.9 (±1.2)	3.2 (±1.3)	2.8 (±1.1)	Lordosis
Backward Displacement *Sagittal plane* *(lateral view in right-left side)*	2.6 (±1.1)	2.9 (±1.2)	2.7 (±1.2)	Kyphosis

In table 5, the data of ANOVA test regarding the postural parameters recorded in volleyball, basketball, and soccer players, are shown for identification and comparison in both the frontal and sagittal planes. The findings demonstrate that:

- Compared to volleyball and football players, basketball players exhibit larger sagittal plane displacement for both kyphosis and lordosis.
- Basketball players exhibited more prominent sagittal and frontal plane postural displacement than volleyball players, primarily in the head and shoulders.
- Football players differ from volleyball players in that they have more noticeable kyphosis (backward displacement in the sagittal plane), primarily in the head and shoulders, and scoliosis (lateral displacement) in the frontal plane. If we compare the postural curvatures between football and basketball players, basketball players resulted in more pronounced curvatures both in the frontal plane (scoliosis) and in the sagittal plane (lordosis, kyphosis), as well as in the shoulders, head and hips.

The p-value of the ANOVA test ($p < 0.5$) shows significant differences in postural parameters between the sports (volleyball, basketball and football), identifying basketball players having more noticeable postural displacement.

In Table 6, the findings from the analysis of non-athletes' postural displacement in the frontal and sagittal planes showing that:

- In the frontal plane, the head, shoulders, and hips appear curved to the extent of 1.5 ±0.8 degrees, 1.8 ±0.9 degrees, and 1.3 ±0.7 degrees, respectively, indicating a slight lateral displacement of the spine relative to the sagittal axis (mild scoliosis).
- Likewise, the sagittal plane's curvatures (forward/lordosis; backward/kyphosis) also occur, demonstrating that non-athletes had less noticeable forward displacement and better postural alignment than athletes.

In Table 7, where the Anova test was applied, the postural parameters between athletes and non-athletes were compared. The findings show that scoliosis and lordosis curvatures are higher in athletes, specifically, athletes' shoulders have more forward lordosis curvature (3.2 ± 1.2 degrees) and lateral scoliosis curvature (2.8 ± 1.2 degrees) than those of non-athletes (1.8 ± 0.9 and 2.1 ± 1.1 degrees, respectively). The results indicate statistically significant differences in postural displacement between athletes and non-athletes, as indicated by the Anova test's p-value < 0.05.

These findings support the hypothesis of our research, indicating that athletes' postural development is influenced by sport differently than that of their counterparts who are not athletes.

Table 5. Comparison of postural displacement between Volleyball, Basketball and Football player ANOVA test (p< 0.5)

Postural Parameters	Volleyball	Basketball	Football	ANOVA (p-value)	Anatomical Planes	Postural Behaviour
Head	2.0 (±1.0)	**2.5 (±1.1)**	2.2 (±1.0)	0.045	Frontal Plane	Scoliosis *Lateral Displacement*
Shoulder	2.5 (±1.1)	**3.0 (±1.2)**	2.8 (±1.2)	0.052		
Hip	1.8 (±1.0)	**2.0 (±1.1)**	1.9 (±1.1)	0.038		
Head	3.0 (±1.2)	**3.2 (±1.4)**	2.9 (±1.2)	0.047	Sagittal Plane	Lordosis *Forward Displacement*
Shoulder	2.8 (±1.1)	**3.5 (±1.3)**	3.2 (±1.3)	0.053		
Hip	2.7 (±1.0)	**3.1 (±1.2)**	2.8 (±1.1)	0.042		
Head	2.5 (±1.3)	**2.8 (±1.2)**	2.6 (±1.1)	0.041		Kyphosis *Backward Displacement*
Shoulder	2.7 (±1.2)	**3.0 (±1.3)**	2.9 (±1.2)	0.046		
Hip	2.6 (±1.1)	**2.9 (±1.3)**	2.7 (±1.2)	0.039		

Table 6. Descriptive Analysis of Posture Displacement of Non –Athletes

Posture Displacement	Head Angulation	Shoulder Angulation	Hips Angulation	Postural Behavior
Lateral Displacement *Frontal Plane* *(anterior –posterior view)*	1.5 (±0.8)	1.8 (±0.9)	1.3 (±0.7)	Scoliosis
Forward Displacement *Sagittal plane* *(lateral view in right-left side)*	2.0 (±1.0)	2.1 (±1.1)	1.9 (±1.0)	Lordosis
Backward Displacement *Sagittal plane* *(lateral view in right-left side)*	1.8 (±1.1)	2.0 (±1.0)	1.7 (±0.9)	Kyphosis

Table 7. Comparison of postural displacement between athletes and non-athlete ANOVA test (p< 0.5)

Postural Parameters	Athletes	Non-athletes	ANOVA (p-value)	Anatomical Planes	Postural Behaviour
Head	2.2 (±1.0)	1.5 (±0.8)	0.032	Frontal Plane	Scoliosis *Lateral Displacement*
Shoulder	2.8 (±1.2)	1.8 (±0.9)	0.025		
Hip	1.9 (±1.1)	1.3 (±0.7)	0.041		
Head	3.0 (±1.3)	2.0 (±1.0)	0.038	Sagittal Plane	Lordosis *Forward Displacement*
Shoulder	3.2 (±1.2)	2.1 (±1.1)	0.029		
Hip	2.8 (±1.1)	1.9 (±1.0)	0.035		
Head	2.6 (±1.2)	1.8 (±1.1)	0.042		Kyphosis *Backward Displacement*
Shoulder	2.9 (±1.3)	2.0 (±1.0)	0.037		
Hip	2.7 (±1.2)	1.7 (±0.9)	0.034		

4. Discussion

In order to better understand how sport affects an athlete's postural development, we observed and compared the postural parameters of athletes and non-athletes between the ages of 18 and 22, taking into account the curvatures of the spine (head, shoulders, hips) as in the frontal (lateral curvature) and sagittal planes. The purpose of this study was to show if sport affects the athletes' postural parameters.

Our study's findings indicate a substantial variation in postural characteristics between athletes and non-athletes as well as between sports.

From the descriptive analyses of our study, volleyball players with forward head flexion and lateral shoulder flexion showed kyphotic and scoliotic tendencies. There are data emphasizing that this outcome was caused by specialized volleyball exercises such as repeated

movements above the head with momentum, without momentum "dives, serves"; volleyball jumping motions (dives, blocks) etc. [7, 8, 9, 11, 17, 24, 25].

Regarding the basketball players' postural parameters, results showed a tendency of the scoliosis (*lateral curvature of the shoulders in the frontal plane*), lordosis (*forward curvature of the hips*) and kyphosis (*backward curvature of the shoulder*). There are data that supports such postural forms in basketball players emphasizing that asymmetric movement and specific sports techniques such as dribbling, shooting, passing, and lay-up are responsible respectively for the scoliotic, kyphotic and lordosis tendencies among basketball players [7, 8, 9, 24, 25, 29].

In addition, our results showed moderate scoliosis, lordosis, and kyphosis tendencies among football players, respectively lateral curvature in the frontal plane and forward and backward curvature in the sagittal plane. These results are similarly detected even by some of our referred researchers considering these postural tendencies relatively expected because of the football specifics exercises (long runs, frequent changes in the direction of movement, close and far shots) and the asymmetry of movements [7, 12, 14].

Regarding the differences detected between postural parameters amongst sports (volleyball, basketball, and football) using the Anova test, our study identified the influence of sports on athletes' postural development. Respectively, the basketball players compared to football and volleyball players exhibited higher sagittal plane curvatures, indicating lordosis and kyphosis; basketball players compared to volleyball exhibited higher curvatures in the frontal plane, indicating scoliosis, while compared to football players resulted with higher curvatures in both, the frontal plane and the sagittal plane indicating scoliosis, lordosis and kyphosis attitude. In addition, football players compared to volleyball players resulted in more prominent lateral curvatures and backward curvatures in the shoulders and head, indicating scoliosis and kyphosis attitudes.

Regarding the differences detected among postural parameters between athletes and non-athletes, it is shown that athletes, regardless of sports affiliation, compared to non-athletes exhibit higher curvature of the spine in relation to the sagittal axis indicating scoliosis and lordosis tendencies. These results are supported by other homologous studies [7, 10, 11, 14, 19].

Postural parameters of the athletes are affected by the specifics of the sports while the light postural displacement detected among non-athletes is normal affected by a sedentary lifestyle, extended use of the technology, and longtime sitting position [6, 20, 21, 22].

Physical exercises have been shown to have a positive effect on postural development by strengthening and stretching the core muscles [6]; however, if they exceed the recommended amount in accordance with the young athlete's skeletal development phase, they can harm their skeletal system, negatively affecting its mechanical integrity and posture.

In this context, it would be better if coaches pay attention to growth and development principles while planning and designing training parameters (*intensity, frequency, volume, motor complexity, etc.*). Furthermore, if training tasks are designed due to muscular balance development, athletes' bad posture, as a result of asymmetric exercises, will improve allowing better performance. It is still the coach's responsibility to maintain unilateral strength control and compare them so that the metrics are similar. In this regard, it is crucial to incorporate postural strengthening into athletes' training regimens for both therapeutic and preventative purposes.

5. Conclusions

Our study revealed that sports have a negative impact on the postural development of team sports athletes due to their unique movement patterns. Soccer players exhibit moderate curvatures in all postural parameters, volleyball players exhibit scoliosis and kyphotic curvature, and basketball players clearly exhibit lordosis and kyphotic behaviors. The impact of sport on the postural development of team sports players was further demonstrated by the discovery that athletes have greater curvatures in scoliosis and lordosis when compared to non-athletes of the same age group.

The study recommends that training programs for athletes include education on proper posture, the use of posture assessments to track postural development, and a focus on improving muscular balance and postural stability. These measures can enhance athletic performance while promoting long-term musculoskeletal health throughout an athlete's career.

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