RESEARCH PAPER

A Comparative Study of Contrast Sensitivity and Eye-Hand Coordination in Volleyball Players and Non-Volleyball Players

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ABSTRACT

Background: Volleyball is a fast-paced sport that demands visual processing and visuomotor coordination to perform the game efficiently. Visual skills, like contrast sensitivity and eye–hand coordination, are very important in the ability to follow moving objects, to react quickly to them and to execute the movements in the game.

Aim: The purpose of this study was to compare volleyball players and non-volleyball players in terms of contrast sensitivity and eye–hand coordination.

Methods: The study was a comparative cross-sectional study, consisting of 70 volleyball players and 70 non-volleyball players aged 20-26 years. With standardised illumination, the Pelli–Robson Contrast Sensitivity Chart was used to estimate contrast sensitivity. The Alternate Hand Wall Toss Test was used to measure eye–hand coordination. Data were statistically analysed using the Mann–Whitney U test: p-value <0.05 was considered statistically significant.

Result: Binocular contrast sensitivity and left-eye contrast sensitivity were significantly higher in the volleyball players than in the non-volleyball players ($p < 0.001$). There were also significant differences ($p < 0.001$) between volleyball players and non-volleyball players in their eye–hand coordination. These results suggest that volleyball players have better visual perceptual ability and visuomotor integration.

Conclusions: Volleyball players had significantly higher binocular contrast sensitivity and eye–hand coordination than non-volleyball players. Volleyball participation could improve visual processing efficiency and sensorimotor integration. Evaluation of the sports vision parameters could therefore be useful in athlete screening and performance enhancement programmes.

Keywords: Sports vision, Contrast sensitivity, Eye–hand coordination, Visuomotor integration, Athletic performance, Volleyball players.

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INTRODUCTION

Volleyball is a dynamic, fast-paced sport that involves the integration of visual, perceptual, cognitive and motor skills to perform optimally. In order to detect the trajectory, speed, and direction of the ball, players must respond quickly with appropriate motor responses during serving, passing, blocking, and spiking. The visual demands of volleyball are important, and visual performance skills and visuomotor coordination are of great value. [1,2]

Contrast sensitivity is one of the various visual functions that are important to sports performance and is considered a functional vision function. The contrast sensitivity is the ability of the visual system to distinguish the luminance of an object from that of its background in a variety of lighting and contrast levels. In contrast to regular visual acuity, which assesses the capacity to recognise high-contrast targets, contrast sensitivity offers details for visual performance in actual utilisation settings, exactly where contrast can be reduced, and it may help athletes see moving objects more effectively, as well as enhance spatial

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awareness and fast visual processing during sporting events. Previous research has shown that players involved in interceptive sports (IS) and fast-ball sports (FS) have greater visual skills than non-athletes [4,5].

Another important visuomotor skill developed is eye–hand coordination, which allows eye to coordinate with the hand to produce accurate and purposeful movement. Volleyball-specific activities require efficient eye–hand coordination for ball reception, setting, attacking and defending. Neuromuscular integration, reaction time, attentional processing, and motor precision have been reported to be enhanced in athletes after long-term sports participation, with volleyball players exhibiting improved reaction time and increased visuomotor processing compared to non-athletic people, respectively [6, 7, 8, 9].

The importance of visual and perceptual skills in sports success has been increasingly stressed in sports vision research. Although the visual attention, dynamic visual acuity, peripheral awareness and coordination have been found to be superior in athletes compared to sedentary individuals, very few studies have investigated these parameters specifically in volleyball players as compared to non-volleyball players, especially in the young adult population.[10]

The results of the present study could be useful in developing sports vision training programs, athlete assessment protocols, and performance enhancement strategies. The ability to detect superior visual skills among volleyball players could also help improve the understanding of the role of sport-specific training in the improvement of sensory and motor integration.

Hence, the purpose of the present study is to compare the contrast sensitivity and eye–hand coordination between volleyball players and non–volleyball players. The results of this study could add to the body of research in sports vision and further support the significance of visual performance assessment in athletes.

METHODOLOGY

Study Design and Participants

The present study was a comparative cross-sectional one which aimed to evaluate and compare contrast sensitivity and eye–hand coordination of volleyball players and non-volleyball players. The study sample consisted of 140 male participants aged 20–26 years. The subjects were 70 volleyball and 70 non-volleyball players.

The volleyball group consisted of people who had taken part in volleyball training and competitions for at least two years, with training sessions at least three times a week. The non-volleyball age-matched group comprised male participants who were not engaged in professional or competitive sports.

The Inclusion and Exclusion Criteria

The participants were those who had a best corrected visual acuity of 6/6 in both eyes. Ocular disease, ocular surgery, neurological disorders, binocular vision anomalies, musculoskeletal disorders, colour blindness and any systemic disease affecting the visual or motor function were contraindications to participation in the study. Participants who had not corrected refractive errors or used medication that could affect visual or neuromuscular function were also excluded.

Ethical Consideration

The study was approved by the Institutional Ethics Committee before the research was started. All subjects gave written informed consent, following an explanation of the study purpose and procedure. The study was conducted with respect to the ethical principles of the Declaration of Helsinki.

Preliminary Ocular Examination

Prior to the assessment procedures, all participants were given a thorough preliminary eye assessment. Information about the participants was collected, such as their sports history, age, and length of training. A LogMAR chart was used to assess visual acuity; then refraction and best correction was assessed. Eligibility for participation was also assessed for basic ocular health evaluation and binocular vision screening.

Assessment of Contrast Sensitivity

Standard illumination conditions in the room were used to assess contrast sensitivity with the Pelli–Robson Contrast Sensitivity Chart. The chart was placed at a distance of 1m from the participant at eye level. Participants were asked to use their normal glasses for the tests.

All participants read the letters one by one, starting from the top line of the chart, going to the right. All letters had the same size and had progressively reduced contrast. Testing continued until the participant got two or more letters wrong in a triplet. The contrast sensitivity score was measured in logarithmic contrast sensitivity (logCS) units on the standardised scoring system on the chart. [11]

Assessment of eye–hand coordination.

Eye-hand coordination was measured with the Alternate Hand Wall Toss Test. The procedure was performed with a standard ball and a flat wall surface. A line was placed 2 m away from the wall, and the subjects were asked to stand back from the line during the assessment.

The participant was instructed to throw the ball against the wall using one hand and catch it with the opposite hand alternately as quickly and accurately as possible. The time of test was kept at 30 seconds. One practice trial was given prior to the assessment to familiarise the participant with the procedure. The results of the number of catches made during the test period were tallied as the eye–hand coordination score. [12]

Statistical Analysis

The data collected were entered into Microsoft Excel and analysed using Statistical Package for the Social Sciences (SPSS) software version 20.0. All variables were calculated with descriptive statistics such as mean, median, standard deviation and range. Contrast sensitivity and eye–hand coordination were compared between volleyball players and non-players by using the Mann–Whitney U test. A p-value < 0.05 was considered statistically significant.

RESULTS

The total number of male participants in the study was 140, consisting of male volleyball players 70 and male non-volleyball players 70. The mean age (±SD) was 23.27 ± 2.66 years for volleyball players and 23.43 ± 2.12 years for non-volleyball players, which means that the volleyball players and non-volleyball players were of similar age.

Contrast sensitivity findings: There was no significant difference between the volleyball players and non-volleyball players in terms of contrast sensitivity in the right eye (median rank: players 69.73, non-players 71.27; Z = −0.26, p = 0.798). However, the contrast sensitivity was significantly higher in the left eye in volleyball players compared to non-players (median rank 89.56 vs. 51.44, respectively; Z = −5.58, p < 0.001). Likewise, the median rank of binocular contrast sensitivity was significantly higher for players (88.89) than non-players (52.11; Z = −5.39, p < 0.001), meaning that they had better contrast detection under binocular viewing conditions. (Table 1, Figure 1)

Result of eye-hand coordination: Volleyball players performed significantly better than non-volleyball players in the average performance in eye–hand coordination in three trials. For the first trial, players achieved a higher median rank (98.16) than non-players (42.84; Z = −8.11, p < 0.001). The second trial showed a similar pattern with players (median rank 95.07) outperforming non-players (median rank 45.93; Z = −7.17, p < 0.001). During the third trial, the performance of the players (median rank 88.89) was also higher than that of the non-players (median rank 52.11; Z = −5.39, p < 0.001). Overall, the volleyball player group had a significantly higher average eye–hand coordination score, with a median rank of 98.16 compared to 42.84 for the non-player group (Z = −8.11, p < 0.001). (Table 1, Figure 2)

Table 1. Comparison between a Volleyball player and a Non-Volleyball player

Variables	Group	N	Mean Rank	Z	Asymp. Sig. (2-tailed)
Contrast Sensitivity RE	Player	70	69.73	-0.26	0.798
	Non player	70	71.27		
Contrast Sensitivity LE	Player	70	89.56	-5.58	0.000
	Non player	70	51.44		
Contrast Sensitivity BE	Player	70	88.89	-5.39	0.000
	Non player	70	52.11		
Eye Hand Coordination 1st	Player	70	98.16	-8.11	0.000
	Non player	70	42.84		
Eye Hand Coordination 2nd	Player	70	95.07	-7.17	0.000
	Non player	70	45.93		
Eye Hand Coordination 3rd	Player	70	88.89	-5.39	0.000
	Non player	70	52.11		
Average	Player	70	98.16	-8.11	0.000
	Non player	70	42.84		

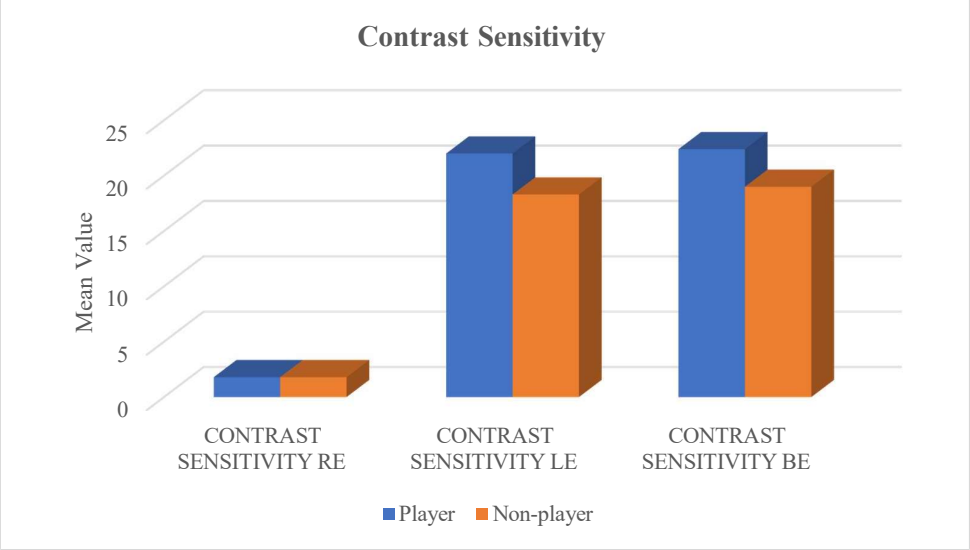

Figure 1. Contrast Sensitivity

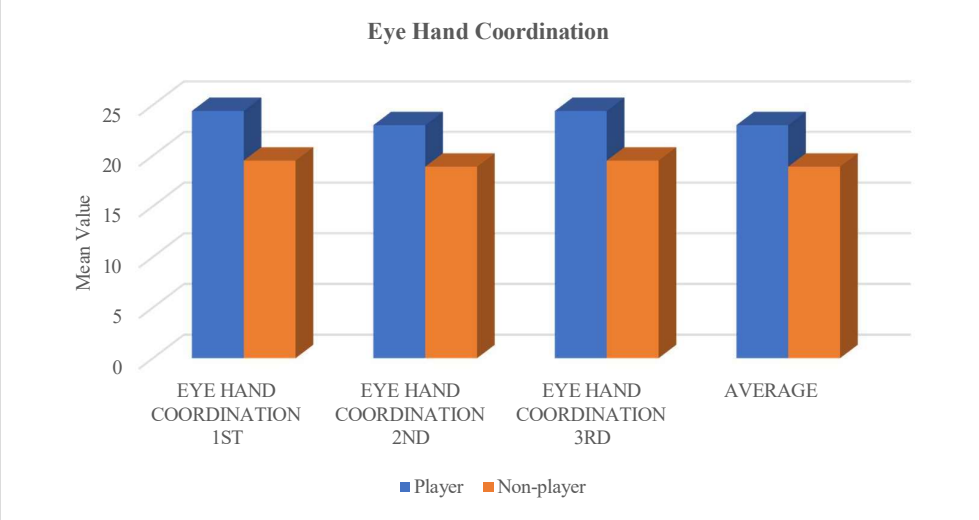

Figure 2. Eye Hand Coordination

DISCUSSION

The present study compared between volleyball players and non-volleyball players in terms of contrast sensitivity and eye–hand coordination, and it was found that the performance of volleyball players was significantly better than that of the other group in both visual and visuomotor performance. In volleyball players, there were significant gains noted in left eye and binocular contrast sensitivity, and all eye–hand coordination tests. These results indicate that extended volleyball exposure can have a positive effect on sensory processing, visual perception and visuomotor integration.

In the present study, there was no statistically significant difference between right eye contrast sensitivity among volleyball players and non-volleyball players. The contrast sensitivity of the left eye and binoculars, however, was significantly higher for volleyball players. Repeated exposure to rapid visual stimuli during volleyball practice might be due to the fact that it demands continuous tracking of ball trajectory, anticipation of movement and quick responses to changes in the environment. Sports in which interceptive actions are used have been shown to produce neurovisual adaptations and increased efficiency in sensory processing, which has been demonstrated as enhanced visual perceptual skills.[3,4]

The results of the present study corroborate previous research of improved visual performance in athletes versus non-athletes. The results of Laby et al. [3] and Poltavski et al. [4] suggest that sports participation can lead to adaptive changes in the mechanisms of visual processing, which in

turn could improve the performance of elite athletes in their visuo-oculomotor skills.

The very high binocular contrast sensitivity found in volleyball players in the present study might be clinically relevant because binocular vision is a key factor in depth perception, spatial judgment, and tracking of motion during sporting activities. Binocular visual input is constantly needed by volleyball players to receive serves, spike balls, and to react to opponents. Therefore, better binocular contrast sensitivity would likely aid in detecting low-contrast moving objects and help to promote quicker visuomotor responses when playing games. [13,14]

The present study also revealed that volleyball players exhibited significantly better eye–hand coordination performance in all testing trials. The mean coordination score for the volleyball players was always higher than for the non-volleyball players, suggesting that the volleyball players were more well-coordinated in terms of synchronising visual input with motor output. This enhancement could be a consequence of repetitive sport-specific training, which can be designed to promote motor learning, reaction times, anticipatory timing and neuromuscular coordination.

The results are consistent with recent research on volleyball players' visuomotor skills. Ningtyas and Amrulloh found that eye–hand coordination, reaction speed, and volleyball forearm passing performance had a significant relationship, emphasising the importance of visuomotor integration in the passing skill in volleyball [13]. Lima et al. showed that reaction time and eye–hand coordination in passing skills are important in volleyball, and reactive agility testing is reliable in volleyball players. [14]

The study pointed out the importance of visual attention, gaze behaviour, and quick decision-making in the volleyball game for expert volleyball players.[15] Furthermore, among youth volleyball players, Trecroci et al. found strong relationships between cognitive functions and sport-specific physical performance, a finding that indicates that sports participation has a positive effect on perceptual and motor functions. [16]

The increased eye–hand coordination found in the current study could be attributed to neuroplastic changes after repeated exposure to complex visuomotor tasks during training sessions. Under time pressure, volleyball demands fast visual assimilation and motor reactions, thus enhancing the efficiency of the sensorimotor pathways and coordination. Repetitive practice could also enhance attentional processing, reaction time, motor planning, and cortical visual processing.[3,6]

The results of the present study have relevance for sports vision and sports enhancement. Contrast sensitivity and eye–hand coordination assessment can be beneficial for athlete screening, talent identification, and sports-specific training program assessment. The use of visual training exercises in regular sports conditions could be useful to improve the athletic performance and visuomotor efficiency of volleyball players, as well.[17]

Although the findings of the present study, there were certain limitations. The sample comprised only male participants and may not be representative of female athletes and/or other age groups. Furthermore, the cross-sectional design does not allow causal inferences between volleyball training and enhancement of visual performance. More studies with larger and more diverse samples of young adults are recommended to further explore the impact of sports participation on visual and visuomotor functioning in the future, using a longitudinal design.

In conclusion, binocular contrast sensitivity and eye–hand coordination of volleyball players is significantly better than that of non-volleyball players. The results of this study were consistent with the existing studies, indicating that volleyball practice leads to improvements in visual perceptual skills and visuomotor integration.

CONCLUSION

The results of this study suggest that volleyball players have better visuomotor and visual performance than non-volleyball players, especially binocular contrast sensitivity and eye–hand coordination. The results indicated that continued involvement in volleyball could lead to greater functional vision as well as better sensorimotor integration, which are essential for good performance in interception sports. The results of these findings provide justification for the addition of contrast sensitivity and eye–hand coordination tests to sports vision screening for volleyball players. They also emphasise the possibility of the usefulness of vision training and visuomotor exercises for sports performance.

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