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Review Article

Importance of visual skills assessment and training module implementation in sports academies: A review

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Abstract

This review article explores the significance of visual skills assessment and training module implementation in sports academies to enhance players' performance. to assess the application of visual skills, vision training, and how the different visual skills play important roles in athlete performance. The main databases used to find openly accessible research articles on sports vision and the value of visual skills in sports were PubMed and Cochrane Library. Many studies have shown that visual skill enhances the athlete's performance but specific types of visual skills for different sports need to be asses. Also, summarizing the latest research, this review is a resource for researchers, educators, doctors, and anyone else who wants to understand how important visual skills are in sports. According to previous studies, players typically display better visual skills than non-athletes, including stereopsis, fixation, and response speed. Sports players must have strong visual skills because they have a big impact on how the game is executed. Studies have also demonstrated the value of both monocular and binocular vision in many sports. Additionally, Sports vision training methods have been effective in improving athletes varied visual skills and it highlights the significance of testing sports players' visual skills to maximize their performance potential. This review concludes that the visual skills assessment is essential to finding any areas that might need improvement. This in-depth examination highlights the value of visual training interventions for athletes and is a useful resource for understanding the requirements of visual skill analysis in sports.

Keywords: Visual skills, Sports vision, Sports player, Athletes, Vision assessment, Performance.

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1. Introduction

In vision development from infancy to puberty, there are several unique stages in the development of vision. Social functions develop before motor skills during infancy, when development begins in the middle and goes outward.[1-3] Following complete vision development, it turns to more skillful visuals like Sports Vision (SV), a new specialty that has garnered much attention in the last 20 years, particularly from athletes seeking to enhance their visual skills to perform better on the court.[4] Sports vision training (SVT) is now utilized to improve athletes' performance. Sports vision training can help any athlete improve their visual processing and reaction time, regardless of skill level, which are the only factors that distinguish an exceptional performance. The agonists are distinguished by their physical strength, speed, cognitive abilities, and endurance required to play. The College of Optometrists and many studies have outlined the 17 visual skills/abilities necessary for performing daily tasks including Visual acuity, eye movement control, eye coordination, focusing ability, peripheral vision, depth perception, colour vision, visual memory, visual-spatial skills, visual form perception, visual closure, visual discrimination, visual figure-ground, visual sequential memory, visual synthesis, visual attention, and visual tracking. Wendy Beth Rosen lists 22 visual skills that have an impact on our daily lives in her book the hidden link between vision and learning.[5-11] In comparison to less accomplished players or non-players, more accomplished players are good enough to identify perceptual cues, efficiently make eye movements, and perform well enough on processing speed tests and concerns, according to several

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studies.[12-15] These skills differ with different sports and the particular requirements of every sport.[16] Labby et al. offer a pyramidal structure-based paradigm to explain the visual function in motor response (**Figure 1** and **Table 1**). In this concept, the pyramid metaphor is used to emphasize the principle that each level of a stable, long-lasting pyramid must be constructed on solid foundations. In the case of a geometric pyramid, the pyramid will be unstable and ineffective if one of the lower levels is weak or has less breadth. The two core monocular visual skills, contrast sensitivity and visual acuity, are represented at the base of the pyramid in the visual system model. The previous monocular abilities are completely required for the binocular visual function of stereo vision. The binocular function cannot be at its greatest unless each monocular ability is at its peak. The next phase in the sports vision pyramid involves making a "go" or "no-go" decision based on the now binocular visual information. Finally, the motor effector level of the sports vision pyramid is placed above the decision level.[17] The effectiveness of this motor action will be intimately related to the information supplied by lower levels of the pyramid, stressing the relevance of the pyramid's earlier binocular and monocular layers. Each level below the summit of the pyramid must work optimally for successful sports performance.[12-15,17] These skills differ with different sports and the particular requirements of every sport.[16] (**Table 2**).

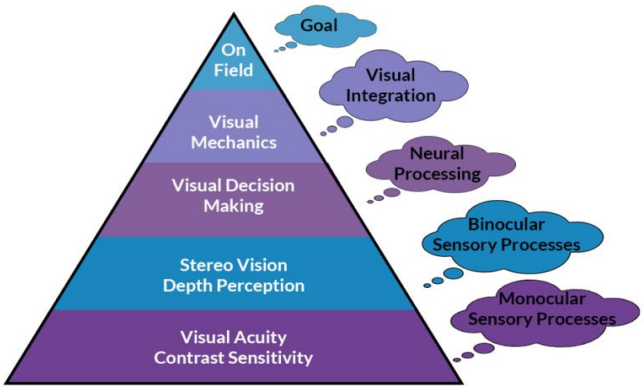

Figure 1: Labby proposed the pyramidal framework to describe the functions of visual motor reactions (Kirschen and Laby, 2011).[17]

In the past, a lot of studies have attempted to define and explain how vision affects how the body responds to an external stimulus.[12,20-25] Thus, we can say visual skills are very important aspects of sports, for example, hand-eye coordination, depth perception, etc. However, a successful sports performance necessitates the precise functioning of the visual system and the visual skills required throughout the game vary greatly depending on the sports discipline.[26]18 This review provides a better understanding of how visual skills are very important and that they need to be made compulsory evaluations of sports training programs. Competitive sports necessitate a wide range of psychological and physical skills.[27] Sports players/athletes and trainers/coaches always try or put effort into improving all these skills and visual motor skills are frequently in demand in sports training programs due to the perceptually demanding nature of sports.[28] So, the point here is that regular eye examinations or visual skills assessments and their implementation are essential to assessing the visual skills of athletes.

Table 1: Describe the importance as well as functions of visual motor reaction based on pyramid levels[18]

Level	Description	Importance
Level 1	Visual acuity & Contrast sensitivity	Foundational monocular visual abilities
Level 2	Binocular visual function (stereo vision)	Dependent on optimal functioning of Level 1
Level 3	"Go" or "no-go" judgment based on binocular visual information	Decision-making stage
Level 4	Motor effector level	Execution of motor movement
Overall	The success of the motor movement is tied to lower levels of the pyramid	Prior levels influence motor performance
Overall	Optimal functioning at each level leads to successful sports performance	The pyramid functions optimally when all levels are functioning at their best

Table 2: The different visual skills for different sports[19]

Cricket	Anticipation (bating) and Hand-eye coordination (fielding)
Football	Foot eye reflex time and peripheral awareness
Archery	Visual acuity and Glare
Sailing	Glare recovery, Ocular Motility and Peripheral awareness
Table Tennis	Motility and Hand-eye response
Snooker	Depth perception and Vergence facility
Netball	Stereopsis and Peripheral vision
Skiing	Contrast sensitivity and Dynamic visual acuity.
Hockey	Dynamic visual acuity and Hand-eye coordination

2. Materials and Methods

To find out the relevance of the visual skills importance in athletes articles for this review, used an electronic search across several databases, including Google Scholar, PubMed, the Cochrane Database of Reviews, and Science Direct, to find the academic literature. Visual skills were given

particular weightage in the inclusion criteria, emphasizing their value, assessment, and function in sports vision. However, Limitations were set on the selection of articles, excluding from this review that focused on other aspects of sports vision, such as sports-related eye injuries, psychological factors, visual impairment, neurological disorders, and studies that did not address sport-specific contexts, training regimes, or performance evaluations. Only articles written in English were taken into consideration. The search area found 183 articles but this review only included the 56 most relevant articles that focused solely on the role of visual skills in sports, by following the inclusion and exclusion criteria on the searched articles.

The following keywords were used to find the articles in this review "Visual Skills" AND "Sports", "Development of Visual Acuity", "Vision" AND "Sports OR ADHD", "Vision" and "Motor Development" OR "Eye Coordination Problems" OR "Visual Skills for Kids", "Vision" and Sports Performance" OR "Sports Vision Training" OR "Visual Acuity in Sports" OR "Binocular Vision in Sports" OR "Specific Visual Skills in Sports" OR "Eye Dominance and Sports", "Vision Assessment in Athletes" OR "Ocular Activity During Performance". The goal of the search was to compile a range of academic publications to learn more about the visual abilities needed for sports performance. A thorough analysis of the topic was ensured by compiling an extensive overview of the literature using many databases. The search procedure was reduced to concentrate solely on publications that addressed the visual qualities needed by athletes to excel in their particular sports by using these stringent inclusion and exclusion criteria. Finding research on the value of visual skills, techniques for assessing them, and the overall function of these skills in sports vision was the aim of the search **Figure 2**.

This review article will result in a better understanding of the key visual skills of athletes/players, which will ultimately aid in the creation of efficient training regimens and treatments to improve their visual performance.

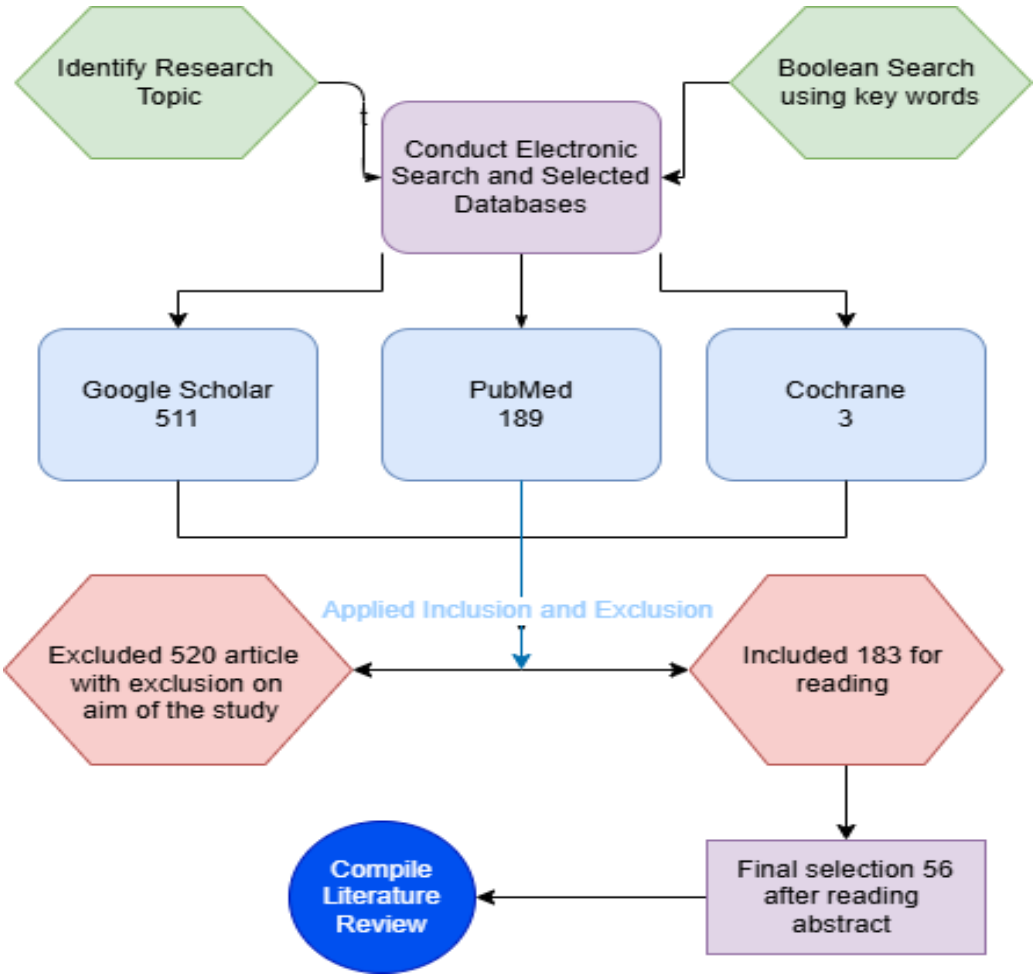

Figure 2: Flow chart of literature review

3. Discussion

This review summarizes the literature so far mentioned in **Table 3**, highlighting the role and importance of visual skills assessment and training modules in athletes' performance.

The sports visual demands satisfy the typical necessary parameters, an eyecare practitioner trained in measuring and improving athletes' excellent enough visual efficacy must undertake a minimum number of tests.[50] There are different types of visual skills required in different sports as shown in **Table 2**. In the routine examination of sports population or players visual examination is recommended, which includes an examination plan of primary visual skills that have a direct impact on the player's performance (**Table 4**). These sport-related batteries of tests might range from 90 minutes to two hours. Every type of athlete is subjected to fundamental skills procedures. Furthermore, supplementary talents enable doctors to select the qualities that are most significant to a specific activity.[29]

Table 3: Summary of included articles highlighting various visual skills and their significance in sports performance

S. No.	Topic	Reference	Focus
1.	Vision and Motor Development	12,29	Association of vision development with children's motor skills.
2.	Eye Coordination Problems	13	Impact eye coordination problems can have on reading and learning.
3.	Vision and Sports Performance	14-16,23,27,30	The role that vision plays in the athleticism of an individual, plus the benefits of sports vision training.
4.	Sports Vision Taining	17,20,22-24,31-33	Techniques of sports vision training and benefits for the athletes.
5.	Visual Acuity in Sports	34,35	Importance of static and dynamic visual acuity in sports.
6.	Binocular Vision in Sports	19,36-38	Role of binocular vision in sports performance, including potential vision dysfunctions of athletes.
7.	Specific Visual Skills in Sports	29,36,39-41	How different visual skills (peripheral vision, depth perception, color vision) influence specific sports performance.
8.	Eye Dominance and Sports	42,43	The possible effect of eye dominance on athletic performance.
9.	Vision Assessment in Athletes	44-46	Why is it important to evaluate visual function in various able athletes?
10.	Ocular Activity During Performance	47	Electrooculography is applied to assess eye movement during motor skills.
11.	General Sports Vision Resources	19,36,30,1,49	Books and journals regarding general ideas about sports vision, role played, etc.

Table 4: Describing the different visual skill and their importance

Visual Skill	Description	Importance in Sports
Visual Acuity	Ability to see minute details at a distance	It Affects control movement and performance; dynamic visual acuity is preferred for ball sports.
Binocular Vision	Maintaining eye alignment and stability, coordination of eye movements	Important for proper adjustments between opponents and teammates.
Stereopsis	Ability to perceive depth and accurately assess distances	Influences spatial localization decisions and performance in activities requiring depth perception.
Accommodative System	Ability to maintain clear vision when shifting focus between different distances	It provides good stability in visual information, especially under high levels of stress and exhaustion.
Dominant Eye	Assessment of motor and sensory dominance of one eye and its impact on coordination and performance	Affects eye-hand-foot synchronization, reaction time, and overall performance.
Peripheral Field of Vision	Ability to process visual information in the periphery.	Critical for motion detection and directing visual focus to other events.
Visual Memory	Ability to perceive and analyse visual information quickly and efficiently	Essential for processing and retaining information on the field.

Table 4 continued…		
Colour Vision	Ability to distinguish and perceive colours accurately	Important for recognizing and distinguishing players and other objects.
Eye Coordination with Body	Integration of eye movements with body movements for precise control	Play an important role in enhancing coordination and precise body responses to visual input.
Eye Tracking	Evaluation of eye movements during motor skill performance	It provides insight into how athletes manage their activities.
Visual-Motor Reaction Time	Time taken for retinal cells to transmit information to the visual cortex	Determines speed of motor response and coordination with visual input.
Speed of Recognition	Capacity to interpret visual information quickly.	It is very important for making quick visual judgments on the field.

Visual skills are crucial to performance in sports. Nascimento et al. and Gao et al. have emphasized the visual-oculomotor skills which is the time it takes for the retinal cells to transmit information to the visual cortex.[13] It assists in the achievement of optimal performance in several sports.[4] Their results are consistent with sport-specific studies such as cricket, badminton[33] and basketball.[38] This stream of studies focuses on how sports-specific activities demand visual skills from a person, especially dynamic visual acuity, depth perception, and binocular vision in serving precision and success in sport-specific competitive environments. Jorge J et al report that "Binocular Function Parameters in Elite Football Players" and found when compared to Caucasian athletes, Arab athletes have specific binocular function metrics that are better than the others. Binocular function in athletes appears to be better than in the general population when compared to reference studies. Eye movements during motor skill performance can provide valuable insight into how individual athletes manage their activities.[39] Senso Motoric Instruments, GmbH, and Falls Church, VA (Tobii Pro) are two businesses that sell comprehensive mobile eye tracking systems, which must be carefully chosen depending on the aim of the assessment, according to research.[44] Dynamic visual acuity allows a person to track moving objects accurately, while a better level of binocular vision enhances depth perception critical for spatial judgment.[46] The most unpredictable sense that affects sports performance is thought to be the vision.[32,45] It could be measured in different aspects such as static and dynamic visual acuity is how well individuals can see moving items.[51] When watching a moving object, visual acuity is required which is different and more demanding than when viewing a static object. Because ball sports need more speed from all competitors, dynamic visual acuity testing is preferable to static testing. In the case of visual refractive error best corrected visual acuity would be considered with correction of refractive error which helps a player to play their games without any obstacle related to the vision.[52] Convergence insufficiency and accommodation dysfunction are some of the vision deficiencies that have been widely studied. The core assumption is that an athlete's visual information is more stable when he or she has power and flexibility in their focusing capacity, especially when they are dealing with high levels of exhaustion and psychological stress. It has been hypothesized that rapid attentional focus in fast-paced sports is related to the visual decisions required.[50] How the conditions impact performance visually would not only affect how an individual perceives the visual environment but also the cognitive and behavioral levels. Other conditions that are linked to an underlying origin of vision problems include ADHD and academic challenges, therefore the need for early detection and intervention. According to Appelbaum and Erickson, vision training advancements have demonstrated targeted interventions meant to enhance visual performance.[40] These training programs rely on tailored exercises and technologies to address specific deficits within an individual and then offer promising solutions to athletes with vision-related challenges.

Burris et al. and Mazyn et al. have further explained the interface of vision with motor performance, especially in sports. These studies show how sensorimotor skills and stereo vision predict and enhance the acquisition of skills among athletes. Stereo vision will allow a certain degree of precision in depth perception, which is very important for activities that require hand-eye coordination.[41,53] Because many sports tasks demand spatial localization decisions, the relationship between the stereopsis abilities and sports player performance is a sensible one to investigate. Most of the studies have found that binocular vision can boost performance on specific activities when a comparison was done to single-eye player performance. Stereo vision's input to learning a natural interception job and concluded, the creation and utilization of depth compensating cues for people with weak stereopsis perception is not enough to deal well with confrontations under high temporal limitations, and this disadvantage cannot be mitigated by specific and intense training.

All these suggest the need for changing visual-oculomotor skills in different sporting environments Besides, Ceyte et al. mention that the very same skills require adaptability while applying visual-motor coordination demands of their sport.[31] In addition, research using magnetoencephalography (MGE) and functional magnetic resonance imaging (fMRI) shows that the dominant eye's primary visual cortex has a larger activation area.[54] With this

information in hand, the sports vision specialist can utilize visual training to generate coordination in dominance and a more functioning athlete. The system of movement with the body must be led & guided by the eyes. Time deviation in the ZBA test is distinguished from direction deviation by more statistically significant relationships with several PP markers.[1]

Visual information in association with an external attentional focus while motor tasks involving body movements through body projection were reported by Abdollahipour et al.[55] However, A series of orthotic exercises to improve binocular vision among the players with a positive effect on visual function after 8 weeks of training was also reported by Burris et al.[53] On the other hand, studies concluded the stereopsis level was significantly high up to 6 months after stopping training due to the adoption of a different method of measuring stereopsis i.e. at first the reaction time was evaluated at which the depth can be perceived and secondly, it was defined as the minimum distance at which the depth can be perceived.[56] New trends in sports vision research emerge advocating the use of advanced techniques and digital training methodologies.[30] Vera et al. and Kirschen and Laby outline virtual reality, and augmented reality, among other advanced tools implemented in vision training.[47,57] These evolutions shall assist athletes in achieving optimal performance through immersive, customizable training sessions. These methodologies, in addition, hold promises for applications beyond the treatment of vision-related deficiencies, such as rehabilitation and improvement of cognitive and motor performances.

Improving developments based on interventions, athletic performance, and vision-related issues across various contexts will be possible through integrative efforts that bridge developmental science, technology, and sports vision. Athletes, in particular, benefit from this integration process, but it is also more fundamentally important because of its role in understanding human performance and development.

In summary, visual skills play important, different, and specific roles in every sport as per the above table which shows the importance of evaluating visual skills as a part of sports training of the sports player for their esteemed sports.[19,42] To have a good understanding of the elements that affect performance, This is useful to categorize the assessment areas. In a sports vision consultation, a routine checkup is examined. This routine evaluation plan involves primary and secondary abilities that have a direct impact on sports performance. These skills are evaluated using a method that is directly related to the sporting talent that interferes, as well as the tools that are now on the market. Sports vision training techniques provide an additional opportunity for athletes to enhance their vision and other visual performance components that are essential to their sport. Given the importance of vision in the majority of sports, an eyecare practitioner should be skilled in testing and improving athletes' high-performance vision abilities.[58]

The correlation between expertise level and perceptual-cognitive competence was markedly influenced by many variables. This is unknown whether the fusion of cognitive and fitness exercises that comes from years of intensive sport improvement exercises also leads to higher performance, thus practical and theoretical consequences are addressed along with proposals for empirical research.[15]

4. Future Aspects

As with previous studies, the review highlights future aspects and much scope for research in this area, especially among athletes who are seeking new ways to improve their visual skills to achieve better performance on the court and implementation of sports vision training programs in sports academies.

5. Limitations of the Study

This review is limited to the unbalanced sample size of the recruited studies, which did not permit a meta-analysis. The literature survey of just one database could represent a constraint for potentially relevant studies. The included studies often enough have a sample number that is not statistically representative and not controlled and above all there is no standardized test such as scaling, systematic, or any meta-analysis and it is also limited to the Prisma strategy for reviewing a review article.

6. Conclusion

Both athletes and coaches depend heavily on their visual skills to perform at their best. To improve the performance of a player, it is also important to evaluate his visual skills. Different sports require different visual skills, which shows that every sport requires visual analysis which will help us to detect visual disability early which can be enhanced by vision training in different sports so that the players can perform well without any visual skill barrier and clearly shows that the implementation of sports vision training programs in sports academies. Also, it is found that to analyse the visual skills of players, there is no specific visual skill task analyser for different sports which can be important for any sport.

7. Source of Funding

None.

8. Conflict of Interest

None.

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