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RESEARCH ARTICLE

Screening of Refractive Errors and Ocular Disorders of Male Professional Soccer Players

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Abstract:

To improve their performance, many athletes already invest a significant amount of time and effort in training camps, personal trainers and equipment, while neglecting to invest in their vision. However, improving visual performance can help improve overall performance in a way that other training regiments cannot. Even for athletes without vision problems, improving visual performance - such as increasing dynamic visual acuity, decreasing reaction times and improving eye-hand coordination - is an integral component of improving overall performance. Fifty-four male elite Brazilian soccer players from a top club participated of study. To verify if the changes found in soccer players exceeded the 40% found in the literature. The athletes were all submitted to visual acuity (VA) tests without correction using the Snellen eye chart and the noncontact intraocular pressure (IOP) using to computerized tonometer. They also underwent a self-refraction examination through a self-refractor. Among the 54 athletes that presented to the screening (108 eyes) 93/108 (86%) had refractive errors following between one or both eyes. In 108 eyes there was 50 (46%) hyperopic eye with astigmatism; 19/108 (18%) of myopic astigmatism, 15/108 (14%) with myopia, 6/108 (6%) with hypermetropy and 15/108 (14%) were emmetropes. The prevalence of refractive errors was hyperopic astigmatism followed by myopic astigmatism (50 vs 19 cases). The left eye was the one that presented more hyperopic and myopic astigmatism in relation to the right eye, 52% and 58%, respectively. There were no differences in mean VA and IOP between in the right and left eyes, respectively. The changes verified in the screening of the present study exceeded 40% of ophthalmological alterations found in soccer players and contemplates the hypothesis of the study.

Keywords: Perception, Tax complexity and tax efficiency, Ethiopia

Introduction

The search out the association between visual competencies and sports overall performance has a long and rich record. The history of ophthalmology begins in the 18th century, however worries approximately the imaginative and prescient of athletes did now not stand up till the 20th century [1]. American ophthalmology took its first steps with the evaluation of baseball athletes, however, it was in 1970 that is, in reality, started out to increase this provider on a routine foundation at the sports field [2]. The Olympic games in Los Angeles and Athens had been like a large laboratory to make the mark of ophthalmology with a huge wide variety of athletes in numerous sports being evaluated [3]. From the effects found, the ophthalmology logo changed into established as an essential area of contribution to a game [3].

Sports ophthalmology experts believe that up to 80 percent of perceptual input in sports comes from the eyes [4]. We all understand that the physiology of athletic training for soccer is extremely important, but the sense of sight is fundamental to its tactical and technical performance. Vision care for athletes of all ages and skill levels should begin with the identification of visual factors that potentially contribute to peak performance [5]. Literature has mentioned that (i) athletes have better visual abilities than non-athletes and better athletes have better visual abilities than the poorer athletes [6], (ii) the visual abilities are trainable, and (iii) the visual training is transferable to the performance of the athlete [7]. These statements show that this is a field that should be highly valued in sport and soccer would be no different and justifies the present study [8].

The ophthalmology assessment is not yet part of the evaluation routine of athletes. Therefore, it is a gap of knowledge that needs to be addressed in the scientific and awareness-raising environment that should reach the professionals of this sport. Physical fitness is as important as adequate eye vision in high-performance sports [9,10]. Vision is the most dominant sense, with 70% of all sensory receptors in the eye and components such as visual skills, contribute up to 80% of information obtained [10]. Among the aspects of athletic conditioning in professional and amateur sports, vision care is also an important trait, as well as a much-neglected one. Even in elite groups, up to 40% have visual problems that are amenable to correction and improvement [11].

Soccer involves dynamic sensory-motor interactions and various sensory-motor systems directly influence an athlete's performance and achievements [12]. In this sense, the visual system is one of the most important sensory-motor coordinators, which is closely related to the proprioceptive and vestibular systems [13]. The player continuously and simultaneously sees and interprets the visual information in different positions on the soccer field. In this regard, spatiotemporal properties of the environment, a spatiotemporal performance of the visual system and contrast sensitivity may have important roles [14]. Most studies on ophthalmology in sports are related to traumatic eye injuries, but few studies routinely assess intraocular pressure and visual acuity disorders in soccer players [15].

Descriptive scientific studies published on VA and IOP in soccer players are scarce because ophthalmology is not yet routinely performed among athletes. In the present study, we hypothesized that the fact that the evaluated players had never undergone an ophthalmologic evaluation could represent the range of 40% of changes observed in athletes and that the risk stratification of eye disease promotes preventive action in soccer players particularly exposed. The purpose of the present study was to establish the prevalence of refractive errors and the most common ocular disorders found in soccer players utilizing intraocular pressure (IOP) and visual acuity (VA) assessment.

Materials and methods

Study design and participants

This is a cross-sectional study carried out in a single professional soccer club in Brazil. A total of 54 elite professional male soccer players, age 21.6±3.3 years old ranging in the age from 19-33, were enrolled in the study. Prior to the examination itself, a preliminary family history of myopia, amblyopia, strabismus, retinoblastoma, congenital cataract, metabolic or genetic disease was taken. The players were first division and participated in the main competitions in our country. The sample consisted of 22 midfielders, 6 goalkeepers, 6 fullbacks, 8 central defenders, and 12 strikers. The admission criteria included (a) being healthy; (b) participating in ≥ 10 hours of training sessions for athletes, (c) not taking any medication, (d) not having any known ocular pathology, (e) to be training in sports aiming to improve her performance to be formally performance and results, (f) to be actively participating in sports competitions, (g) to be formally registered in a local, regional or national sports federation, (h) to have sports training and competition as major activity (way of living) and devoting several hours in all or most of these days to these activities, exceeding the time allocated to other types of professional or leisure activities [16]. All athletes met the above criteria, as they were members of soccer teams and had been training for the past three years or longer, at least 5 days per week, and at least one competition per week. The average amount of experience with training and competitions in soccer was 6±4 years. They were high-level and were instructed to avoid alcohol consumption and vigorous exercise 24 hours before the ophthalmologic evaluation. To sleep, for at least 7 hours, not to consume caffeinated drinks or other stimulants in the 3 hours before the test and to follow the regular diet, but do not eat 1 h before the test. The same ophthalmologist physician performed all assessments and to eliminate the interobserver error. Ophthalmologic evaluations were performed before starting the competitive preseason. This study was approved by the University of São Paulo, School

Medicine Ethics Committee for Research on Human subjects (case # 1251/07), as following the recommendations of the Declaration of Helsinki for the study in humans.

VA is defined as the clearness of vision that depends on the sharpness of the retinal image and the integrity of the retinal and visual pathway [17]. VA may be alive of the patient's ability to resolve fine detail. It is the foremost normally used measuring of visual operation you may create. Distance VA is used to assess the adequacy of spectacle corrections and as a key indicator of ocular health. It is expressed because the angle subtended at the anterior focus of the attention by the detail of the letter or image recognized. The degree of uncorrected VA, seeing objects in the far distance, was performed using a range of static VA Snellen eye chart [11]. The pattern for measuring the eye to see the close distance is 33cm away and 6 m (20 feet). Players began reading rows of letters diminishing in size until the letters could no longer be accurately discriminated. VA was based on the number of correct responses. In the Snellen eye chart, the degree of VA is rated in feet, meter, or percentage (%). Individuals with the result of 20/20 feet (6/6 meter) have 100% of normal vision to see objects far away. Great vision in young adults with no impairment is usually between 20/16 feet and 20/12 feet, much better than 20/20 feet. Thus, 20/20 feet (i.e. 6/6 meters) vision has come to be interpreted as a limit (Figure 1). Snellen Eye Chart of "normal" vision with which an individual can cope well enough in school, sports or industry and hence does not require correction. Vision on the far side 20/20 feet is usually improved with corrective lenses. IOP is defined as the pressure within the eye relative to the constant formation and drainage of the aqueous humor [12]. An important quantitative relationship is provided below: (IOP = FC + PV) - Where F = aqueous fluid formation rate, C = outflow rate, PV = episcleral venous pressure [12]. These factors are those that drive IOP. Classification of severity of vision impairment based on visual acuity in the better eye. The World Health Organization (WHO) uses the following benchmarks to categorize visual impairment: (i) Normal: 20/10-20/25 feet; (ii) Near normal visual impairment: 20/30-20/60 feet; (iii) Moderate visual impairment: 20/70-20/160 (feet); (iv) Severe visual impairment: 20/200-20/400 (feet), or 11-20 degrees on visual field; (v) Profound visual impairment: 20/500-20/1000 (feet) visual acuity, or 6-10 degrees on visual field; (vi) Near-total visual impairment: Counting fingers, Hand motion, Light perception, or (vii) 5 degrees or less on visual field and (viii) Total visual impairment: No light perception [17]. A visual acuity conversion table is shown in Table 4 (AAO, 2020).

All participants were also evaluated for their IOP of no contact, which measures the force exerted by the aqueous humor in the anterior chamber (the space between the iris and the anterior surface of the posterior face of the cornea) of the eyeball, using a computerized tonometer no contact (TX-10, Canon®, USA). An autorefractor (R-30, Canon®, USA) was used for all measurements of refraction, which was converted to spherical equivalents calculated as the spherical value plus half of the astigmatic value. In the present study, we categorize cut-off points as non-significant and significant refractive errors: (1) non-significant: minimum value -0.25D spherical for myopia; +0.25D spherical for hypermetropy and + or - 0.25D cylindrical for astigmatism and (2) significant: minimum value -0.75D spherical for myopia; +1.5D spherical for hypermetropy and + or - 1.00D cylindrical for astigmatism.

Statistical analysis

Quantitative variables were presented in terms of their values of central tendency and dispersion measurements. Thus, the data are presented as mean and standard deviation (SD). The normality and homogeneity of variances among eyes were obtained by using the Kolmogorov-Smirnov and Levene tests, respectively. Paired t-tests were used to test for the difference between VA and IOP in right and left eyes. Refractive errors were shown by relative frequency distribution and prevalence among positions. The statistical significance was set at $p < 0.05$. All statistical analyses were conducted using SigmaStat statistical analysis software, version 3.5 (Sigma Stat 3.5, Systat Software Inc, Ashburn, VA, USA).

Results

A total of 54 men soccer players (108 eyes) aged 19-33 years old participated in the study. The soccer athletes examined had never had an eye examination. The results were described as mean and standard deviation. Tables 1 and 2, summarizes by athlete the degree of alteration larger or smaller refractive error noted in male soccer players in this study. The frequency of refractive error was quantified by repetition percentage. Among total the players, 93/108 (86%) had refractive errors in one or both eyes. In 108 eyes there was 50 (46%) hyperopic eye with astigmatism; 22 (20%) of myopic astigmatism, 15 (14%) with myopia, 6 (6%) with hypermetropy and 14 (13%) were emmetropes (Figure 2). Of the 54 players that presented refractive errors 47% (22), 11% (6), 11% (6), 15% (8) and 22% (12) were a midfielder, goalkeeper, fullback, central defender and striker, respectively (Table 1). The prevalence of refractive errors was hyperopic astigmatism followed by myopic astigmatism (50 vs 19 cases). The prevalence of hyperopic astigmatism was higher in midfield players, 20% in the right eye and 22% in the left eye (Table 1). The left eye presented more hyperopic and myopic astigmatism compared to the right eye, 52% and 58%, respectively (Table 2). In all athletes hypermetropy lower ≤ 1.00D was considered light (Table 2). When categorized the significant myopia (-0.75D spherical) and astigmatism (≥1.00D cylindrical), in the right and left eyes, myopia showed (4/54=7%) in both eyes and astigmatism showed (7/54=13%) in RE eye and (8/54=15%) in LE eye, respectively. However, when compared the different values for stigmatism (RE: 2.18 ± 1.6D vs. LE: 1.31 ± 0.3D, no difference was observed ($p = 0.156$). For myopia (RE: 1.31±0.65D vs. LE: 1.19± 0.37D, no difference was noted ($p = 0.752$). The results of statistical evaluation of IOP and VA were normal. Comparing RE and LE, there was symmetry in the distribution of vision levels for all refractive errors, with no statistically significant difference (Table 3). About 21% of players were found to have a significant refractive error for an athlete of which 7% were myopic and 15% were astigmatism (Table 2). Analysing each athlete separately, four had a VA of 20/30 feet (i.e. 6/9 meters) with 91.4% equivalent efficiency and one athlete in one eye 20/200 feet (i.e. 6/60 meters) equivalent to only 20% of visual efficiency or peripheral vision is very poor. The use of corrective lenses was indicated for athletes who exhibited anisometropia due to a large diopter difference in the gradation of both eyes. Thus, the dimension of anisometropia can be considered according to the number of diopters that differed from eye to eye (Table 2).

Discussion

The major highlight of the ophthalmological alterations found in professional soccer players in this study were more than 80%, surpassing the 40% found in high-performance athletes [15]. For a high-level athlete, as is the case with a professional soccer, the visual demands are enormous and need to follow motor demands with great efficiency. A healthy vision is a critical factor in sports performance because visual information is the dominant sensory system when performing practically any perceptual-motor task [9]. This study aimed to describe the implications of refractive errors in soccer players. In this screening, rather than the mean values, the individual values show more significant changes among athletes. Measurement of VA using Snellen's chart should be adopted in soccer teams because it is an easy and low-cost method associated with low indices of untestability. The medical staff can be trained in to this routine [37,38].

Similar to our findings, a study in the US found that 25% of athletes competing at a high-level had never had a completed eye examination, although 29% had visual symptoms and 28% had less than 20/25feet (i.e. 6/7.5 meter) VA [13,17]. Prevalence of uncorrected refractive errors and visual complaints reject the common belief that athletes have fewer uncorrected refractive errors [18]. Furthermore, the results of some other studies suggest that low degrees of blurred vision have no adverse effects on sports performance. Even mild myopia results in blurred vision, while oblique astigmatism causes optical aberrations that distort athletes' distant vision. However, in soccer players, these changes can reduce accuracy and decrease technical performance during the match. In addition, it can cause eye discomfort and headaches.

Sports such as soccer where reaction time and depth perception are altered will affect performance as it will result in distractions, loss of focus, and visual challenges increasing the time to react quickly. In athletes with myopia, it will be difficult to see far. In athletes with astigmatism (eg. goalkeepers) at night, he will see the ball shaded. In hyperopia, if it is small, not so much, but it can cause headaches and take the athlete's concentration off [19]. Athletes with normal vision admit that they often have difficulty keeping an eye on the ball. This gets worse as the field gets dusty and when the lights change from natural to artificial. Refractive errors occur when the shape of your eye prevents light from properly focusing on the retina (a layer of light-sensitive tissue at the back of the eye) according to the American Academy of Ophthalmology [20]. Therefore, one can imagine how difficult it is for athletes with myopia, astigmatism, and farsightedness to function with these conditions since vision is essential during the game or training. The process of assessing the refractive errors of athletes has to be completed according to standards.

In another study were assessed soccer and cricket players and 70% had never had complete ocular examination, 8% were found with refractive error, 60% with stereo acuity equal or less than 40 seconds of arc and 65% with ocular complaints [21]. Stereo acuity, reported in minutes or seconds of arc, describes the smallest horizontal disparity in binocular images that leads to depth perception in the observed stimulus. In observers with equal normal visual acuity and developing normal vision, stereo acuity thresholds are typically 20 to 40 seconds of arc [22]. The low vision includes different degrees of sight loss, from blind spots, poor night vision, and problems with the glare to an almost complete loss of sight. The American Optometric Association [8] defines low vision as two categories: (i) partially sighted: the person has VA between 20/70 feet (i.e. 6/21 meters) and 20/200 feet (i.e.6/60 meters) with conventional prescription lenses. Legally blind: the person has VA no better than 20/200 feet (i.e.6/60 meters) feet with conventional correction and/or a restricted field of vision less than degrees wide. The ratio measurement of vision describes VA, or the sharpness of vision, at 20 feet from an object. For example, having 20/70 feet (i.e. 6/21 meters) vision means that you must be at 20 feet to see what a person with normal vision can see at 70 feet [8].

Previous studies have shown that athletes show an average VA higher than the average population of non-athletes [23, 24]. Although in our study no players had shown significant changes in VA, it is an important outcome of screening because visual impairment is associated with reduced postural balance when compared with individuals with high VA [25]. However, many studies [41, 42, 43, 44] have focused on reporting eye injuries related to various types of sports, recreational activities, equipment, prevention and epidemiology, but few describe VA and IOP in non-contact sport [26]. The sport does not give the importance that the ophthalmology deserves. Data from the 1992 Olympics games revealed some interesting statistics: Only half of the athletes had ever had their eyes examined. Yet, one in four athletes admitted to visual difficulties. Data from the Olympic Games of 1994 revealed that: 58% of competitors rating vision important but had never had an eye examination; 19.6% wore spectacles but only 3.2% used them for sport, compared with 94.3% of contact lens wearers; 12.5% had substandard acuity in one eye and 4.6%, had substandard acuity in both eyes [27]. The present screening on soccer players is relevant because we found that 86% of visual impairment that was superior to the study of Griffiths [5] that showed 40% of vision problems in elite athletes.

Studies have investigated the speed of recognition ability discovered that athletes can answer the information more quickly than non-athletes can [28]. Certainly, the athlete with visual deficiencies decreases technical efficiency needed for optimal performance [24]. Some studies have reported a correlation between sports and visual functions of the athletes. Ueno et al. [29] reported that junior soccer players possess superior visual functions in such areas as naked-eye vision, reflection, stereoscopic acuity, motion visual acuity, and contrast sensitivity. The same authors before also state by referring to university students that those majoring in sports have better visual acuity and stereoscopic acuity than non-sports majoring students [30]. This study indicates that among students attending sport-specializing universities, ball game athletes possess particularly great vision functions in all the tested areas of visual acuity, stereoscopic vision, and reflection, compared to athletes of non-ball individualistic sports such as gymnastics, kendo martial art, archery, and sumo wrestling [30]. Some examples of sports that require high levels of static VA include pistol and rifle shooting, and archery. Sports teams as soccer and basketball have a medium demand for high static acuity, and while soccer strikers have a relatively low demand for good static acuity because opposing players are relatively large and slow moving [18].

In the current study, refractive errors with varying degrees were seen in both eyes, and small errors could be ignored. However, important alterations were detected for myopia and astigmatism and mandatory corrective lenses were required. It is a known truth that high-level athletes as professional soccer players often have high visual demand and the literature has indicated that optimal vision correction can enhance sporting performance even with corrections as small as -0.25D [31]. Hypermetropy over +1.00D should be corrected as this may relieve fatigue, especially for near and intermediate targets. Correcting small amounts of astigmatism (starting from 0.50D) and anisometropia (0.50D and more) may also be beneficial. In everyday life, correcting very low levels of refractive error or changing a correction by just 0.25D may not always be worthwhile but, in elite athletes, as in soccer, optimum foot-eye coordination and peripheral vision can provide an extra edge in competition [20]. Several authors advocate the benefits of correcting small refractive errors, so it is still an open question [32]. In the experience of Mann et al. [33], low levels of blur in cricket players were not enough to affect the players' coupled anticipation. On the contrary, according to the experience of Hatch et al. [34], those activities that require higher and higher intensity require a very fast decision-making level and an ominous dynamic vision. When the myopic defocus value exceeds 1.00D, the performance will decline. The results of Laby et al. [35], seems to be the same as that of Hatch [34]. Because when their colleagues evaluated baseball players, they concluded that ambiguities greater than 1.00D were unacceptable. Any advantage, though seemingly small, can make a great difference to performance at this level [31]. Further investigations beyond the scope of this preliminary study indicate that more routine and consensus efforts are needed to prevent and improve athlete's visual abilities.

The present study confirmed the important role of ophthalmology for soccer as a preventive measure in the possible identification of ocular deficiencies that may compromise the technical performance and above all, to preserve the integrity of the ocular athlete's health. If coaches suspect that a soccer player has a vision problem, they should consult sports vision professional associations for referrals. Visual studies in the future should include comparisons between different classes of athletes, visual acuity in different planes of motion, and a larger sample size. The literature does not provide eye screening in all sports which makes comparisons difficult [45].

Perspectives

Our study showed that ophthalmologic inspection of athletes is a necessity that should be conducted within the routines of evaluations in soccer teams. We did a literature search, but we observed that there are few studies that present data from athletes with different ophthalmological dysfunctions [18]. The current study, although with limitations, showed that simple and very low-cost methodologies may provide a posteriori in the diagnostic evaluation and monitoring of these athletes and should be a routine practice performed by the medical department of soccer teams. Sport vision is still a surprisingly new specialty. Since the first report by Walker [36] about the eye in sport, sports ophthalmology has been advancing. Although the importance of ophthalmology is consolidated, the vast majority of players are not submitted to this tool. When comparing this area of support for the athlete between Latin America, the United States, and Europe, the discrepancy of the results found is clear. There is great inequality in the level and distribution of ophthalmologists between and within Latin American countries, with a disproportionate number concentrated in more developed and socially favored areas [39, 40].

Study limitation

First, our sample size was too small, and this is particularly dangerous. Second, we could not compare our findings to others, because there is little or no standard measurement of sports vision in our country. Third, the VA was only performed in the horizontal plane and there was no comparison with a group of non-athletes. Due to the nature of the investigation, there was also no adjustment for multiple comparisons. These factors must be taken into account to generalize and validate these results. The present study draws attention to the most individual values.

Conclusion

The research is a warning sign to soccer team mangers and their coaches. In the current study, in fact, there are significant refractive errors of varying degrees in all positions. In soccer, the perfect ability to observe and create appropriate movements depends on vision. Therefore, in sports, vision is a key variable for athlete's technical performance. Screening has shown that the program can identify soccer players whose refractive errors are large enough to impair their performance. Although there is no difference between the visual acuity and intraocular pressure of the athletes assessed, the proportion of myopic astigmatism exceeding 40% is high. This study emphasizes the importance of visual function tests included in health diagnosis to detect and therefore correct visual defects at an early stage. All athletes ought to be aware of the significance of the visible gadget and the impact that it may have on sports overall performance. In conclusion, identifying an athlete's visual needs and correcting the deficiencies increases his likelihood of success, whether he is an amateur or a professional.

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Table1. Differences in the prevalence of refractive errors between right and left eyes among positions in male soccer players.

Athletes Nº	Pitch Position	Right eye	Left eye
1	Goalkeeper	Hyperopic astigmatism	Hyperopic astigmatism
2	Midfielder	Hyperopic astigmatism	Emetrope
3	Midfielder	Hyperopic astigmatism	Myopic astigmatism
4	Fullbacker	Hyperopic astigmatism	Myopic astigmatism
5	Midfielder	Hyperopic astigmatism	Hyperopic astigmatism
6	Midfielder	Hyperopic astigmatism	Hyperopic astigmatism
7	Fullbacker	Myopic astigmatism	Myopic astigmatism
8	Striker	Hyperopic astigmatism	Hyperopic astigmatism
9	Midfielder	Hyperopic astigmatism	Hyperopic astigmatism
10	Midfielder	Myopic astigmatism	Myopic astigmatism
11	Midfielder	Myopic astigmatism	Hyperopic astigmatism
12	Striker	Hyperopic astigmatism	Hyperopic astigmatism
13	Fullbacker	Myopic astigmatism	Myopic astigmatism
14	Striker	Emetrope	Hyperopic astigmatism
15	Midfielder	Emetrope	Hyperopic astigmatism
16	Midfielder	Hyperopic astigmatism	Hyperopic astigmatism
17	Central Defender	Hyperopic astigmatism	Hyperopic astigmatism
18	Midfielder	Hyperopic astigmatism	Emetrope
19	Midfielder	Myopic astigmatism	Myopic astigmatism
20	Midfielder	Hyperopic astigmatism	Hyperopic astigmatism
21	Midfielder	Emetrope	Hyperopic astigmatism
22	Midfielder	Myopia	Myopic astigmatism
23	Striker	Hypermetropy	Hypermetropy
24	Central Defender	Hyperopic astigmatism	Hyperopic astigmatism
25	Central Defender	Emetrope	Hyperopic astigmatism
26	Midfielder	Hypermetropy	Myopia
27	Striker	Emetrope	Hypermetropy
28	Striker	Hyperopic astigmatism	Hyperopic astigmatism
29	Goalkeeper	Hypermetropy	Emetrope
30	Central Defender	Myopic astigmatism	Hyperopic astigmatism
31	Goalkeeper	Hyperopic astigmatism	Emetrope
32	Striker	Emetrope	Myopia
33	Striker	Myopic astigmatism	Myopic astigmatism
34	Midfielder	Hyperopic astigmatism	Hyperopic astigmatism
35	Midfielder	Hyperopic astigmatism	Myopia
36	Fullbacker	Myopia	Hyperopic astigmatism
37	Goalkeeper	Myopia	Myopia
38	Midfielder	Emetrope	Hyperopic astigmatism
39	Fullbacker	Myopic astigmatism	Myopic astigmatism
40	Fullbacker	Hyperopic astigmatism	Emetrope
41	Goalkeeper	Hyperopic astigmatism	Hyperopic astigmatism
42	Striker	Emetrope	Hypermetropy
43	Striker	Hyperopic astigmatism	Hyperopic astigmatism
44	Goalkeeper	Myopic astigmatism	Myopic astigmatism
45	Striker	Myopia	Emetrope
46	Striker	Hyperopic astigmatism	Hyperopic astigmatism
47	Central Defender	Hyperopic astigmatism	Myopia
48	Midfielder	Myopia	Myopic astigmatism
49	Central Defender	Emetrope	Hyperopic astigmatism
50	Central Defender	Myopia	Myopic astigmatism
51	Midfielder	Myopia	Myopia
52	Central Defender	Myopia	Hyperopic astigmatism
53	Midfielder	Hyperopic astigmatism	Hyperopic astigmatism
54	Midfielder	Myopic astigmatism	Myopia

Table 2. Values of individual measures of self-refraction distribution computed right (RE) and left (LE) eyes among positions in male soccer players.

N°	Age (Y)	Pitch position	RE SFERICAL	RE CYLINDRICAL	LE SFERICAL	LE CYLINDRICAL
1	19	Goalkeeper	+ 0.75º D	- 2.50 º D	+ 0.50 º D	- 1.75 º D
2	19	Midfielder	+ 1.00º D	- 5.50 º D	0.00 º D	0.00 º D
3	19	Midfielder	0.00 º D	- 1.25 º D	- 0.50 º D	- 0.75 º D
4	22	Fullbacker	0.00 º D	- 2.50 º D	- 0.25 º D	- 1.75 º D
5	19	Midfielder	+ 0.50ºD	- 0.50 º D	0.00 º D	- 0.75 º D
6	19	Midfielder	0.00 º D	- 0.50 º D	0.00 º D	- 0.75 º D
7	19	Fullbacker	- 0.25º D	- 0.75 º D	- 0.25 º D	- 0.75 º D
8	21	Striker	+ 0.25 º D	- 1.50 º D	+ 0.50 º D	- 1.25 º D
9	20	Midfielder	+ 0.50 º D	- 1.00 º D	+ 0.50 º D	- 1.00 º D
10	22	Midfielder	- 0.50 º D	- 0.50 º D	- 0.50 º D	- 0.50 º D
11	19	Midfielder	- 0.50 º D	- 1.00 º D	- 0.25 º D	- 1.00 º D
12	19	Striker	+ 0.25 º D	- 0.50 º D	0.00 º D	- 0.50 º D
13	19	Fullbacker	- 0.25 º D	- 0.25 º D	- 0.50 º D	- 0.50 º D
14	19	Striker	0.00 º D	0.00 º D	0.00 º D	- 0.25 º D
15	19	Midfielder	0.00 º D	0.00 º D	0.00 º D	- 0.25 º D
16	19	Midfielder	0.00 º D	- 0.25 º D	0.00 º D	- 0.25 º D
17	19	Central Defender	+ 0.25 º D	+ 0.25 º D	0.00 º D	- 0.25 º D
18	20	Midfielder	+ 0.25 º D	- 0.50 º D	0.00 º D	0.00 º D
19	20	Midfielder	- 2.25 º D	- 0.50 º D	- 1.50 º D	- 1.50 º D
20	19	Midfielder	+ 0.75 º D	- 0.25 º D	+ 0.75 º D	0.00 º D
21	20	Midfielder	0.00 º D	0.00 º D	0.00 º D	- 1.25 º D
22	23	Midfielder	- 0.50 º D	0.00 º D	- 0.25 º D	- 0.50 º D
23	20	Striker	+ 0.75 º D	0.00 º D	+ 0.75 º D	0.00 º D
24	21	Central Defender	0.00 º D	- 0.75 º D	0.00 º D	- 0.50 º D
25	19	Central Defender	0.00 º D	0.00 º D	+ 0.25 º D	- 0.25 º D
26	19	Midfielder	+ 0.25 º D	0.00 º D	- 0.25 º D	0.00 º D
27	19	Striker	0.00 º D	0.00 º D	+ 0.25 º D	0.00 º D
28	19	Striker	0.00 º D	- 0.50 º D	0.00 º D	- 0.50 º D
29	19	Goalkeeper	+ 0.50 º D	0.00 º D	0.00 º D	0.00 º D
30	19	Central Defender	- 0.50 º D	- 0.50 º D	0.00 º D	- 0.75 º D
31	19	Goalkeeper	0.00 º D	- 0.50 º D	0.00 º D	0.00 º D
32	19	Striker	0.00 º D	0.00 º D	- 1.00 º D	0.00 º D
33	19	Striker	- 0.25 º D	- 0.50 º D	- 0.50 º D	- 1.00 º D
34	29	Midfielder	+ 0.25 º D	- 0.50 º D	0.00 º D	- 0.50 º D
35	27	Midfielder	- 0.25 º D	0.00 º D	0.00 º D	- 0.25 º D
36	24	Fullbacker	- 0.25 º D	0.00 º D	- 0.50 º D	0.00 º D
37	23	Goalkeeper	- 0.50 º D	- 0.25 º D	- 0.25 º D	- 0.25 º D
38	29	Midfielder	0.00 º D	- 0.50 º D	0.00 º D	0.00 º D
39	28	Fullbacker	0.00 º D	- 0.50 º D	0.00 º D	- 0.50 º D
40	25	Fullbacker	0.00 º D	0.00 º D	+ 0.25 º D	0.00 º D
41	24	Goalkeeper	0.00 º D	- 0.50 º D	0.00 º D	- 0.25 º D
42	22	Striker	- 0.50 º D	- 0.50 º D	- 0.50 º D	- 0.25 º D
43	21	Striker	- 0.25 º D	0.00 º D	0.00 º D	0.00 º D
44	21	Goalkeeper	0.00 º D	- 0.50 º D	0.00 º D	- 0.50 º D
45	22	Striker	0.00 º D	- 0.25 º D	- 0.25 º D	0.00 º D
46	21	Striker	- 0.75 º D	0.00 º D	- 0.50 º D	- 0.25 º D
47	23	Central Defender	0.00 º D	0.00 º D	0.00 º D	- 0.25 º D
48	33	Midfielder	- 1.25 º D	0.00 º D	- 1.50 º D	- 0.25 º D
49	23	Central Defender	- 0.25 º D	0.00 º D	- 0.50 º D	0.00 º D
50	22	Central Defender	- 0.25 º D	0.00 º D	+ 1.00 º D	- 0.50 º D
51	27	Midfielder	0.00 º D	- 0.50 º D	0.00 º D	- 0.50 º D
52	23	Central Defender	- 0.25 º D	- 0.50 º D	- 0.25 º D	0.00 º D
53	24	Midfielder	- 1.00 º D	- 0.50 º D	- 0.75 º D	- 0.50 º D
54	28	Midfielder	0.00ºD	-0.25º D	0.00º D	-0.25 º D

Table 3. Comparison of the results of intraocular pressure (IOP) and visual acuity (VA) by Snellen chart between men soccer players

Group of soccer athletes	**RE (meter) 54 eyes**	**LE (meter) 54 eyes**	**t test p value**
IOP (mmHg) (n, 54=108 eyes)	12.7±3.4	12.6±3.2	0.782 95% CI: -0.496 to 0.655
VA (meter) (n, 54=108 eyes)	6/6.1 ± 0.6	6/8.5 ± 10.9	0.109 95% CI: -5.35 to 0.55

Values are shown as the mean ± SD. RE, right eye; LE, left eye

Table 4. Visual Acuity Conversion Chart (feet, meter and refractive error)

Visual acuity (feet)	Visual acuity (meter)	Refractive error
20/10	6/3	0
20/15	6/4.5	0
20/20	6/6	0 to -0.125
20/25	6/7.5	-0.375
20/30	6/9	-0.625
20/40	6/12	-1
20/50	6/15	-1.125
20/60	6/18	-1.25
20/70	6/21	-1.375
20/90	6/24	-1.5
20/100	6/30	-1.75
20/120	6/36	-2
20/160	6/45	-2.25
20/200	6/60	-2.5
20/250	6/75	-3
20/350	6/90	-3.5
20/400	6/120	-4

Note: Normal vision" is 20/20 feet's. The vision of a legally blind person is at least 10 times worse than that of someone with normal vision. A person is considered blind if their best-eye corrected vision is 20/200 feet´s or less, that is, if he can see at 20 feet's (6 meters) what a normally sighted person can see at 200 feet´s (60 meters). Their visual field is 20 degrees or less in the better-seeing eye.

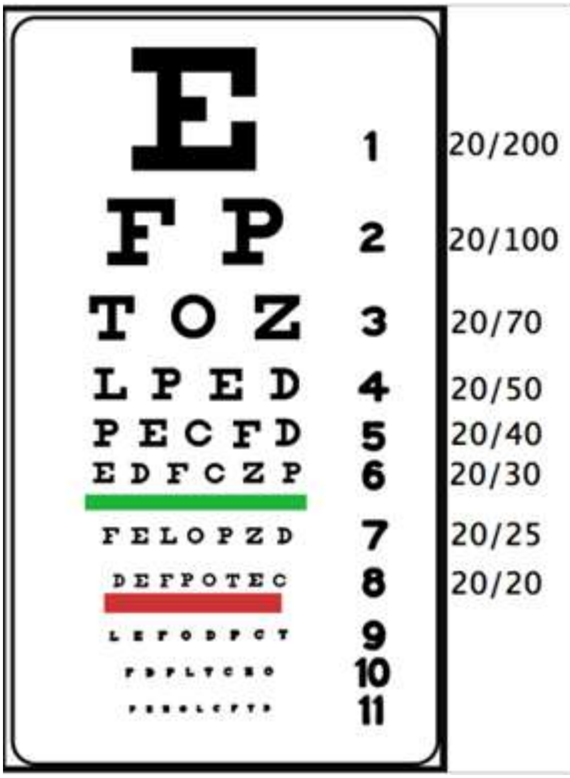

Figure 1. A standard Snellen vision-testing chart.

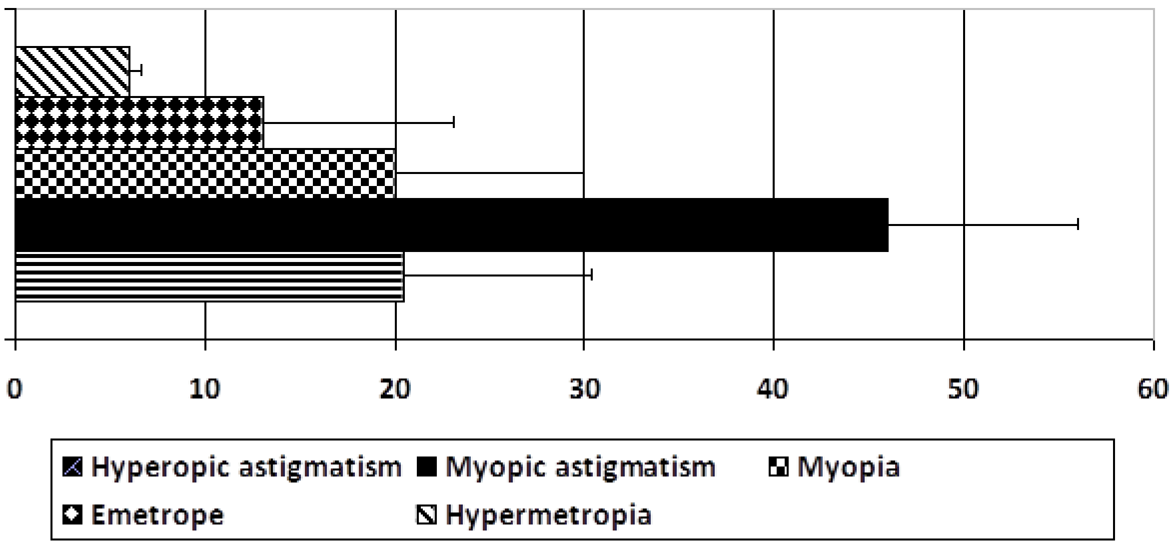

Figure 2. Prevalence of uncorrected refractive errors in percentage in male soccer players