Article ▸ # Sports Vision Screening of Amateur Athletic Union Junior Olympic Athletes: A Ten-Year Follow-Up

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ABSTRACT

Background: There are epidemiological studies which suggest that the athletic population is underserved by the eye care professions. The purpose of this investigation was to compare the epidemiological and visual examination findings from a cohort of amateur athletes to a similar cohort of amateur athletes that had been tested 10 years previously.

Methods: Data collected from the 2009 Amateur Athletic Union Junior Olympic Games (AAUJOG) was analyzed and compared to data gathered from the 1997 and 1998 AAUJOG. A total of 12 sports were represented by 116 athletes, ranging in age from 6 to 18 years. Protocols were similar between the two screening events and included a history and appropriate vision examinations. Performance-based testing was calculated and compared to previous research by age group and sporting activity.

Results: Among the 2009 athletes, more than 29% of participants had not received eye care for >3 years, with more than 20% indicating that they had never been examined by an eye care professional. This was slightly better than the 1997/8 rates. None of the 2009 athletes used the appropriate protective eyewear to prevent ocular injuries as compared to 1% in 1997/8. The most common visual symptoms were headaches, difficulty seeing, and light sensitivity. Comparing performance between the two screening events, no significant differences were identified. Increased performance with increased age for most tests was documented.

Conclusions: The results of this study indicate a continued need for optometric services within the athletic population to ensure that the visual system is not limiting athletic performance and that eye protection is used to prevent injury.

Keywords: eye care, eye protection, optometry, sports vision

Introduction

The American Optometric Association Sports Vision Section's (AOASVS) mission is dedicated to advancing the quality and delivery of optometric sports vision care through education, injury prevention, and enhancement of the visual performance of athletes.[1] The AOASVS recently celebrated its 30th anniversary, and both practitioners and researchers have shown a significantly increased interest in vision and its relationship to the athletic population.[2] Unfortunately, sports vision evaluations continue to demonstrate a need for more optometric services within this population.

Athletic success and dependence on enhanced visual skills has been debated for many years, and to date, a direct relationship between these has not been demonstrated. Some research indicates that successful athletes have enhanced visual skills that the general population lacks, while other studies dispute any differences between the visual attributes of athletes and nonathletes.[3-12]

The Amateur Athletic Union Junior Olympic Games (AAUJOG) is a national multi-sport event that is the largest annual youth competition in the United States.[13] Since 1997, the AOASVS has conducted free vision screening evaluations for athletes competing at these events. These sports vision screenings have played an essential part in developing an epidemiologic profile of the visual attributes of this young athletic population. Additionally, the AAUJOG evaluations have aided in the establishment of standardized testing protocols, have assessed new sports vision equipment, and have identified vision problems in these athletes. By screening athletes of different ages, competition levels, and specific sporting activities, normative data for this athletic population has been generated that can be compared to data in the general population.

The purpose of this study was to collect data from the 2009 AAUJOG sports vision screening and to compare these results to data generated from the same events held in 1997 and 1998. This study investigated epidemiologic changes and identified differences in eye care education, vision-related problems, and normative data for sports vision performance within this young athletic population.

Methods

In July 2009, the AOASVS of the Illinois College of Optometry and the Indiana University School of Optometry provided a sports vision screening for the AAUJOG held in Jacksonville, IL. All of the estimated 10,000 athletes were

Table 1. Distribution of Athletes by Sport (N = 109)

Sport	Frequency	%
Taekwondo	31	28
Jump Rope	24	22
Karate	18	17
Bowling	10	9
Gymnastics	7	6
Baseball	6	5
Power Lifting	4	4
Skipping	3	3
Table Tennis	2	2
Volleyball	1	1
Softball	1	1
Baton	1	1
Soccer	1	1

Table 2. Symptoms Experienced by Athletes (N = 116)

Symptom	No.	%
Difficulty seeing	21	18.1
Headaches	21	18.1
Sensitivity to lights	17	14.7
Blurred vision after close work	5	4.3
Reduced performance as stress builds	4	3.4
Difficulty following moving objects	3	2.6
Reduced peripheral vision	2	1.7
Poor depth perception	2	1.7
Lack of consistency of play	1	0.9

Table 3. Last Eye Examination (N = 113)

Last eye examination	No.	%
Never	24	21
< 1 year	38	34
1 to < 2 years	21	19
2 to < 3 years	20	17
> 3 years	10	9

Table 4. Refractive Correction Worn by Athlete (N = 114)

Correction	No.	%
None	108	93.1
Prescription sports protective eyewear	0	0
Non-prescription sports protective eyeware	0	0
Standard spectacles	6	5.2
Contact lenses	11	9.5

Table 5. Type of Contact Lens Correction Used (N = 11)

Contact lens type	No.	%
Soft Sphere Daily	4	36
Soft Sphere Extended Wear	0	0
Soft Toric	1	9
Rigid Gas-Permeable	1	9
Unreported	5	46

given the opportunity to take part in the screening. For those who volunteered for the vision screening, a standardized history form and testing procedures as outlined the AOASVS protocols were used.[1] Included in the history was a series of questions addressing both sports vision performance and near binocular vision. These nearpoint-related binocular vision questions were added in order to help identify the presence of binocular vision dysfunction in this school-aged population. Most of these screening protocols were identical to those used at the same events in 1997 and 1998. This included visual acuity, dominant eye/hand–Wisconsin sports vision program dominance wand (WSVP), internal health of the eye, external health of the eye, color vision, Randot stereopsis, cover test, tachistoscope, eye movements (Ober II Visagraph), eye-hand coordination, foot speed, hand speed, contrast sensitivity, and speed of stereopsis.[14] In addition, a protocol measuring distance stereopsis was performed in 2009, although it was not performed in the 1997 and 1998 screenings. Distance stereopsis was measured with the Howard Dolman Stereoacuity Test under normal room illumination at 6 meters (20 feet).[15] The athlete was seated with habitual sports vision correction. Five trials for stereopsis were performed at stereopsis levels corresponding to 30.94, 20.63, 13.75, 6.88, and 3.44 seconds of arc. Stereoacuity was recorded at the level at which 3 or 4 correct responses were given. The athlete was asked to respond quickly without moving their body or head. The Indiana University School of Optometry and the Illinois College of Optometry Institutional Review Boards approved the screening and protocols.

Descriptive statistics, including means, frequency counts, and percentages, were calculated for each of the variables. Where appropriate, paired sample t-tests, Kruskal-Wallis 1-Way ANOVA, and multiple comparisons were calculated using SPSS software (IBM, Armonk, NY).

Results

One hundred and sixteen athletes were examined during the 2009 Games, as compared to 449 in the 1997-98 Games. At both screenings, 52% of the athletes were male, and 48% were female. In 1997-98, the athletes' ages ranged from 5 to 19 years (mean 12.9), while in 2009, the athletes' ages ranged from 6 to 16 years (mean 12.4). Table 1 shows a comparison of the sports in which the athletes participated.

Of the athletes with a complaint, in 2009, difficulty seeing and headaches tied as the most commonly reported symptoms, while in 1997-98, headache was the most frequent complaint

(Table 2). The time at which the athletes reported having their last eye exam in a doctor's office is shown in Table 3. Table 4 shows the participants' use of eyewear, both protective and prescription correction, for sporting activities, with a breakdown of the type of contact lenses used by the athletes shown in Table 5.

Visual examination findings are shown in Tables 6-15. In 2009, only right or left eye dominance was determined, while in 1997-98, central dominance and non-dominance were also considered. Also, only in 2009 were the hand dominance and eye-hand dominance patterns determined. Analysis of the Howard Dolman distance stereopsis testing in 2009 by ANOVA revealed no statistical differences across age brackets. Analysis of tachistoscope testing by ANOVA and multiple comparisons revealed a significant difference ($p<0.01$) between the age groups of the athletic population. Similar to our previous evaluation, older participants were able to get a higher score, or more numbers correct, than younger age subjects. Analysis of ocular motor movement testing using an Ober II Visagraph by ANOVA and multiple comparisons showed no statistical difference between age groups for fixation losses/10 seconds or for saccades/15 seconds. Results of the Wayne Saccadic Fixator analysis by ANOVA and paired sample t-tests showed statistically improved performance with increasing age groups on all proaction and reaction testing.

Gross evaluation of the anterior segment and undilated direct ophthalmoscopy of the posterior segment were performed on the screened participants. In 2009, all participants were found to have healthy anterior and posterior segments, and no athletes manifested ocular pathology. In 1997-98, 2.4% had an eyelid pathology, and 1% each had a conjunctival or a corneal abnormality. Strabismus was observed in only one subject during the vision screening evaluations. This athlete presented with esotropia at both distance and near. Color vision deficiency was suspected in 2 participants. Further evaluation would be necessary to determine a specific color vision deficient diagnosis.

Discussion

This study collected data from the 2009 AAUJOG sports vision screening and compared these results to data generated from the same events held in 1997 and 1998. The results of this study demonstrate important epidemiologic features of the young athletic population. More than 20% of the athletes had never received a comprehensive eye examination, and another 8% of the athletes reported no eye care in more than 3 years. In 1997 and 1998, 25% of the young athletic population reported no eye care service prior to the screening evaluation, and 14% had no eye care in more than 3 years.[14] While the percentages in 2009 are better than those from a decade before, they are still disturbingly high.

Similar to results obtained during the 1997 and 1998 vision screening, in the 2009 screening, the lack of use of protective eyewear in this young population is alarming. No

Table 6. Habitual Visual Acuity: Right Eye (N = 116)

Visual acuity	Frequency	%
< 20/20	34	29
20/20	47	41
20/25 to 20/40	29	25
20/50 to 20/100	4	3
> 20/100	2	2

Table 7. Uncorrected Refractive Error

Right eye (N = 85)

Refractive error	Frequency	%
-10.00 to -2.00	3	4
-1.99 to -0.75	2	2
+0.75 to -0.75	49	58
+0.76 to +1.99	25	29
+2.00 to +10.00	6	7

Left eye (N = 83)

Refractive error	Frequency	%
-10.00 to -2.00	1	1
-1.99 to -0.75	4	5
+0.75 to -0.75	49	59
+0.76 to +1.99	24	29
+2.00 to +10.00	5	6

Table 8. Uncorrected Cylinder Power

Right eye (N = 41)

Refractive cylinder	Frequency	%
< -0.75	29	71
-0.75 to -2.25	11	27
> -2.25	1	2

Left eye (N = 35)

Refractive cylinder	Frequency	%
< -0.75	27	77
-0.75 to -2.25	8	23
> -2.25	0	0

Table 9. Uncorrected Cylinder Axis

Right eye (N = 42)

Axis	Frequency	%
31 - 60	0	0
61 - 120	8	19
121 - 150	1	2
151 - 30	33	79

Left eye (N = 34)

Axis	Frequency	%
31 - 60	0	0
61 - 120	3	9
121 - 150	1	3
151 - 30	30	88

Table 10. Eye and Hand Dominance

Dominant eye (N = 116)

Eye	Frequency	%
Right	62	53
Left	54	47

Dominant hand (N = 114)

Eye	Frequency	%
Right	102	89
Left	12	11

Eye-hand dominance (N = 114)

Pattern	Frequency	%
Same Side	61	54
Crossed	53	46

Table 11. Howard Dolman Static Distance Stereopsis

Age	Mean sec arc	SD	N
5 to 9 years	9.15	7.43	24
10 to 14 years	9.38	8.02	59
15 to 19 years	9.46	8.95	32

Table 12. Tachistoscope (number correct out of 18)

Age	Mean sec arc	SD	N
5 to 9 years	8.29	2.85	25
10 to 14 years	11.08	2.73	59
15 to 19 years	13.25	2.59	32

Table 13. Ober II Visagraph

	Age	Means	SD	N
Fixation losses/10 sec.	5 to 9 years	8.12	5.4	25
	10 to 14 years	9.36	5.82	56
	15 to 19 years	8.26	7.29	31
Saccades/15 sec.	5 to 9 years	22.58	6.38	25
	10 to 14 years	24.48	9.33	56
	15 to 19 years	27.32	9.6	31

Table 14. Wayne Saccadic Fixator: Proaction

	Age	Means	SD	N
1st proaction (no. in 30 sec)	5 to 9 years	20	3.86	14
	10 to 14 years	27.88	4.5	48
	15 to 19 years	33.41	7.1	22
Saccades/15 sec.	5 to 9 years	22.14	4.02	14
	10 to 14 years	31.04	4.44	48
	15 to 19 years	36.77	4.58	22

Table 15. Wayne Saccadic Fixator: Reaction

	Age	Means	SD	N
Number of buttons pressed	5 to 9 years	14.67	4.98	12
	10 to 14 years	20.68	3.11	25
	15 to 19 years	22.45	4.62	20
Reaction speed (seconds)	5 to 9 years	63	12.14	12
	10 to 14 years	75.24	19.97	25
	15 to 19 years	85.65	12.21	20

participants in our screening reported the use of protective sports eyewear, plano-shield or prescription, compared to the 1% of athletes evaluated 10 years prior who reported wear of American Society for Testing and Materials-approved (ASTM) protective eyewear.[16] Reports of standard spectacle wear were 5.2% in this athletic population, and 9.5% of the athletes wore contact lenses.

Children and adolescents share the highest incidence of sports-related ocular injuries. Highest-risk sporting activities for ocular injuries are those sports that use a rapidly moving object or involve aggressive body contact,[17] and according to Nelson et al., baseball (31%), basketball (15%), tennis (14%), and hockey (13%) have the highest risk of eye injury.[18] Sports with the fewest reports of ocular trauma include swimming, track and field, and gymnastics.

Protective eyewear is available for most sporting activities and is recommended by the Committee on Sports Medicine and Fitness for all youths involved in organized sports.[5] Even though eyewear protection has substantially reduced the incidence and severity of eye injuries, there appears to be a lack of awareness among athletes about the importance of vision care and vision correction for sporting events.[19] In addition, the young athletic population seems to be undereducated in areas of sports vision correction and standard protective eyewear for contact sports where there is an increased risk for eye injuries. It cannot be ruled out that some athletes prefer not to use protective eyewear because of a perceived notion that it may cloud their vision if the lenses get dirty, sweaty, foggy, etc.

Because compliance with protective eyewear continues to appear problematic with young athletes, it is necessary to increase optometric services and ocular safety education to this population. Vision care for athletes must include not only routine vision care, but also education on eye protection, ophthalmic products, and current recommendations for specific sports. Despite the apparent unawareness of optometric services, many practitioners continue to report concerns over prevention of eye injuries and to describe efforts to promote the use of sports correction and protective eyewear in their practices.[19] Many optometrists feel that there is a large potential for growth in the sports vision services.[20]

The incidence of visual symptoms and refractive error found at the Junior Olympic Games are similar to the general population.[14] This suggests that Junior Olympic athletes do not have superior visual acuity or greater refractive independence than non-athletes. In fact, results from the present study show that 5.1% of athletes screened presented with a monocular visual acuity of less than 20/40, a slightly higher percentage than was found in similar screenings 10 years earlier.[14] Contact lenses were worn by 9.5% of participants, and 5.2% reported use of spectacle lenses. Although just over 90% of the athletes in our study did not use vision correction, most athletes can benefit from a sport-specific refractive prescription, tinted spectacle or contact lenses, and protective eyewear.[21]

Contact lens wear is popular among athletes. In our study, we found that a much smaller percentage of athletes were using contact lenses compared to similar age groups in the general population. It has been suggested that contact lens wear can improve athletic competence and self-esteem in areas such as perceived physical appearance and social acceptance over spectacle wear for refractive correction.[22,23] In a survey conducted by Zieman et al., 84-94% of optometrists preferred contact over spectacle lens wear for athletes, and 85% preferred fitting soft contacts over a gas permeable material.[19] Although it appears that optometrists promote the use of contact lenses for sporting activities, it would seem that this perception is skewed towards older age groups based on our study results. This persists despite the evidence demonstrating that children as young as 8 years old are capable of wearing and handling contact lenses.[24] There is a continued need for promoting and educating young athletes on the option of contact lens wear.

Refractive error greater than ±0.75 D was found in approximately 30% of participants. Several studies have reported the prevalence of myopia, hyperopia, and astigmatism in school-aged children. Many refractive error studies in children report similar percentages of refractive error; summarizing many studies, there is a range of prevalence of hyperopia from 4.6% to 23%, myopia from 2% to 55%, and astigmatic prevalence is around 16%.[25-29] Our findings of the incidence of hyperopia (4.3%), myopia (25%), and astigmatism (10.4%) appear similar to those of the general population.

With regard to sports vision performance, several performance norms were gathered during the screening of the athletic population during our study. With the help of sports vision screening instruments, we were able to gather data for various athletic age groups concerning eye movements, depth perception, speed of recognition, eye-hand coordination, and visual reaction time, which are aspects of the visual system that are commonly used during various sporting activities.

It has been shown that 20% to 40% of the population is cross-dominant; i.e., favoring one hand, eye, ear, or foot for some tasks and the other one for other tasks, similar to our study results.[30] Although many studies have attempted to establish dominance patterns that benefit the success of athletes, the advantages and disadvantages of dominance patterns are inconclusive.[31-34] Even so, this testing procedure is nevertheless a common screening assessment in sports vision evaluations.

All functions of oculomotor control can be crucial in providing accurate and precise visual information during sports tasks. The three oculomotor functions that provide information are pursuit and saccadic eye movements and steadiness of fixation. Research shows that these three aspects of oculomotor control are of a better quality in athletes compared to non-athletes.[5] Looking mainly at saccadic eye movements and fixation steadiness, most studies have found that successful athletes have steady fixation[35] and quick saccadic abilities described by a short initiation latency time.[36,37] In the previous 1997 and 1998 study, analysis of the Ober II Visagraph showed statistical differences between age groups for fixation losses/10 seconds but no difference between groups for saccades/15 seconds.[14] In 2009, no significant difference in either test protocol was demonstrated, suggesting that overall performance is not associated with age and growth.

Athletes are required to make precise judgments of depth and spatial localization in many sporting activities. Studies looking at superior depth perception in athletes verses non-athletes have given mixed results.[38,39] Our results indicate a lack of statistical difference between different age groups of athletes. Further analysis comparing norms between the general population and athletes is needed to determine whether superior stereopsis skills are more prevalent in youth athletes.

Eye-hand coordination and visual reaction time have been found to be superior in the athletic population.[7] Our research aimed to develop norms for the widened design, dual Wayne Saccadic Fixator instrument for a more peripheral screening test. Similar to normative data collected from the single-use Wayne Saccadic Fixator, we found a significant increase in speed and accuracy with increasing age. In comparison, between the first proaction and second proaction series, statistical analysis revealed increased performance for each age group, indicating that a significant learning curve is gained after a one-time test screening. Additional research is needed in order to develop a threshold of increased performance based on attempted trial periods for more accurate testing and recording methods for athletes.

Lastly, results generated 10 years prior found that the number of correct responses on the tachistoscope correlated directly with athletes' age.[14] The same result was found in our study. Tachistoscope testing evaluates the athlete's ability to analyze visual information rapidly. A review of the literature indicates that experienced athletes have superior ability in this aspect of vision and can evaluate information more quickly than non-athletes in sporting situations encountered in cricket, volleyball, tennis, and "fast ball" sports.[5]

Conclusion

The sports vision evaluation and performance testing shows a continued need for optometric services and education for young athletes. Performance testing shows improved visual skills with increasing age and indicates that sport evaluations and testing norms should be separated based on age. It is unknown at this time whether different sporting activities influence normative data for athletes. Further study is warranted for specific sports. Additionally, future studies are needed in order to establish a relationship between visual skills and performance in young athletes.

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Beatty RM, Bakkum WB, Hitzman SA, Beckerman SA. Sports vision screening of Amateur Athletic Union Junior Olympic athletes: A ten-year follow-up. Optom Vis Perf 2016;4(3):97-102.

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