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Research Article
Influence of Sports Participation, Knowledge, Attitude and Behavior Toward Vision Care on Vision Performance of Elementary School Students: A Comparison of Athletes and Non-athletes

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Abstract

Objective: This study examined the visual performance of elementary school students in Taiwan by investigating knowledge, attitude and behavior toward vision care of students who participate and did not participate in athletics. **Methodology:** Variance and predictive analyses of relationships between vision performance and geographic variables as well as variables of knowledge, attitude and behavior toward vision care for 350 elementary school students in Taiwan were performed. **Results:** A significantly higher percentage of athletes who played non-ball games had normal vision than non-athletes. There were no significant differences in variables for visual knowledge, attitude and behavior toward vision care between athletes and non-athletes. Furthermore, when geographic variables were processed and analyzed with hierarchical regression, four intervals could be sequentially incorporated into the model to identify indicators of student's visual performance. The results of this analysis showed that geographic and variables of knowledge, attitude and behavior toward vision care did not predict student's visual performance. **Conclusion:** Researchers recommend that school administrations promote vision care programs and outdoor activities to prevent vision loss.

Key words: Vision care, hierarchical regression, ball games, non-ball games, knowledge, attitude, behavior, student athletes

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

According to a report by the World Health Organization[1], in 2014, there were approximately 285 million visually impaired individuals, of which around 43% are ametropic, an avoidable disease. Among first grade elementary school students in Taiwan, Mainland China and Singapore, 21.5% are visually impaired and among sixth grade student the incidence increases to 65.8%[2].

Visual acuity is the clarity and/or resolving capacity of the visual system that encompasses visual focusing of the eyes, transmission of optic nerves and analysis and interpretation of vision to the brain, which together determine the clarity and sharpness of vision as well as the nerve sensitivity of the retina[3-5]. Visual impairment can be critical to a student's learning ability, psychological identification and environmental adaptation[3]. Accumulating empirical research shows that the progression of visual impairment can be delayed with increased outdoor exercise. Thus, to prevent vision loss, the Ministry of Education of Taiwan implements outdoor activities during breaks and 15 min eye exercises conducted in the classroom in the morning and afternoon[3-5].

Vision can be divided into static visual acuity (SVA) and sports vision[5], which is important for athletic success. Recent studies revealed that different exercise activities require different dynamic visual acuity. For example, playing volleyball requires dynamic visual acuity to achieve accurate spiking and blocking[6]. Quevedo *et al.*[7] further pointed out that every form of exercise has its own related visual skills.

Visual acuity is critical for fast-paced games such as table tennis, badminton, tennis and baseball in which visual information must be processed quickly to make an accurate response[8,9]. "Far and near dynamic visual acuity" (i.e., the target moves straight toward the line of sight) or "horizontal dynamic visual acuity" (i.e., the target moves horizontally across the line of sight) are both important for sports and games that require the eyes to track objects moving at high speed[10]. Evidence-based studies on baseball and pigeon shooting also revealed that horizontal dynamic visual acuity of athletes is significantly correlated with performance[11-13].

The traditional frameworks of behavioral science state that knowledge is a primary factor for predicting behavior in a health care setting. The knowledge of individuals affects their attitudes, awareness and behavioral reactions to health care. As such, suitable knowledge and positive attitudes can enhance participation in health care activities and in turn promote better health[14].

Vision care involves effective preventive behaviors that helps to maintain normal vision, including environmental precautions, healthy diet and adequate outdoor activity[15]. For students, preventative vision care involves avoiding overworking the eyes, maintaining appropriate reading distance (e.g., 35 cm) and proper posture and avoiding writing, reading, watching TV, drawing, or playing video games while lying on the stomach or back[16,17].

Numerous studies indicated that the rate of vision impairment has been increasing, in part due to insufficient implementation of vision care. Consequently, programs are needed to ensure that students have adequate knowledge of preventative strategies, attitudes and routine behaviors to preserve quality vision[18].

In this study, authors examined differences in vision knowledge, as well as attitudes and behaviors toward visual health among athletes and non-athletes in elementary school to promote engagement in exercise that could enhance vision quality.

MATERIALS AND METHODS

Participants: A total of 350 students at elementary schools in Chiayi, Taiwan were enrolled as study subjects. Among the group, 150 athletes participated in ball games, 150 athletes played non-ball games and 50 students were not engaged in athletics. Random sampling approaches were used to select study subjects for participation. Physical education teachers at the selected schools were informed of the nature of the study prior to conducting surveys and informed consent was obtained before surveys were administered. There were 195 male (55.7%) and 155 female (44.3%) athletes, of which 163 (46.6%) and 187 (53.4%) were in the 5th and 6th grades, respectively. A total of 98 (28.0%) exercised for 60 min every week, 118 (33.7%) exercised for 60-90 min and 84 (24%) for 91 min or more (Table 1).

Measures

Vision performance: Due to potential difficulties with the traditional C chart, the E chart was used to assess vision at the study schools. Students sat 6 m from the chart and those who had values of 0.8 and below for either eye were classified as having vision impairment[19]. All study participants visited the school for vision measurements using a sight list box administered by members of the school nursing staff, who uploaded the collected data to the school health care system.

Knowledge, attitude, behavior toward vision care scale: The scale for knowledge, attitude and behavior toward vision care was used as per the authorization of the Ministry of Education of Taiwan that applies "vision care issue" as a research instrument. The scale is two-fold, with geographic information collected for the research subject and questions concerning vision care, including 29 entries pertaining to "personal information", "knowledge of vision care", "attitude toward vision care" and "behavior of vision care".

The geographic information included gender, grade in elementary school, category of sport played, years playing the sport and number of hours of per practice. Surveys also included three parts with questions related to vision care: Part (1) Knowledge of vision care, including 10 yes/no questions, part (2) Attitudes toward vision care, including 9 yes/no questions and part (3) Vision care behaviors, including 10 yes/no questions. The subject answered the questions based on his/her own experience according to the description of each question. Yes/agree answers were scored with one point and zero points were scored when the answer was no/disagree.

Data analysis: The survey data were analyzed using SPSS 21.0 for Windows (IBM, NY,USA) to determine frequency distribution and percentage rate, as well as to assess differences in vision performance and knowledge, attitude and behavior toward vision care between athletes and non-athletes as tested by Pearson's chi-square analysis. Correlation analyses between groups and categories of vision performance with a contingency coefficient C were also performed.

Table 1: Demographic variables for study participants

Variables	Groups	N	%
Gender	Boys	195	55.7
	Girls	155	44.3
Grade	5th	163	46.6
	6th	187	53.4
Exercise time per week	Under 60 min	98	28.0
	61~90 min	118	33.7
	Over 91 min	84	24.0
Sports activities	Dodge ball	50	14.3
	Volley ball	50	14.3
	Table tennis	50	14.3
	Track and field	50	14.3
	Dance	50	14.3
	Taekwondo	50	14.3
	Regular students	50	14.3

RESULTS

Analysis of vision performance of athlete and non-athlete elementary school students: For measurements of visual acuity, a cutoff of £0.8 was used to define vision impairment. Among all study subjects, 131 (37.4%) students had normal vision in both eyes, 42 (12.0%) had vision impairment in either eye and 177 (50.6%) had vision impairment in both eyes (Table 2). As such, >60% of the study subjects had some degree of vision impairment. Among athletes who played ball games, 52 (34.7%) had normal vision in both eyes, 21 (14.0%) had vision impairment in both eye and 77 (51.3%) had vision impairment in both eyes (Table 2). Meanwhile, for athletes who played non-ball games, 69 (46.0%) had normal vision in both eyes, 14 (9.3%) had vision impairment in either eye and 67 (44.7%) had vision impairment in both eyes. For non-athletes, 10 (20.0%) had normal vision in both eyes, 7 (14.0%) had vision impairment in one eye and 33 (66.0%) had vision impairment in both eyes. Among elementary school students athletes had better vision performance than non athletes.

Variance analysis of vision performance and knowledge, attitude and behavior toward vision care of athletes and non-athletes at elementary schools: The study subjects were classified into 3 groups according to vision performance: (1) Normal vision in both eyes, (2) Vision impairment in one eye, and (3) Vision impairment in both eyes (Table 3).

According to the results ($\chi^2 = 12.27$, $p<0.05$, $C = 0.184$, $p<0.05$), vision performance differed significantly among

Table 2: Analysis of vision performance of the regular students and the student athletes of elementary schools

	Student athletes in ball games (N = 150)		Student athletes in ball games (N = 150)		Regular students (N = 50)		Total (N = 350)	
Vision performances	N	%	N	%	N	%	N	%
Normal vision in both eyes	52	34.7	69	46.0	10	20.0	131	37.4
Vision impairment in one eye	21	14.0	14	9.3	7	14.0	42	12.0
Vision impairment in both eyes	77	51.3	67	44.7	33	66.0	177	50.6

Table 3: Cross tabulation of vision performance of different groups

Groups	Vision performance: Normal vision in both eyes (%)	Vision impairment in one eyes (%)	Vision impairment in both eyes (%)	Total (%)
Student athletes in ball games				
Count	52.00	21.00	77.00	150.0
Within group	34.70	14.00	51.30	100.0
Within vision performance	39.70	50.00	43.50	42.9
Total	14.90	6.00	22.00	42.9
Adjusted residual	-0.92	1.00	0.25	
Student athletes in non-ball games				
Count	69.00	14.00	67.00	150.0
Within group	46.00	9.30	44.70	100.0
Within vision performance	52.70	33.30	37.90	42.9
Total	19.70	4.00	19.10	42.9
Adjusted residual	2.87	-1.33	-1.91	
Regular students				
Count	100.00	7.00	33.00	50.0
Within group	20.00	14.00	66.00	100.0
Within vision performance	7.60	16.70	18.60	14.3
Total	2.90	2.00	9.40	14.3
Adjusted residual	-2.75	0.47	2.36	
Total				
Count	131.00	42.00	177.00	350.0
Within group	37.40	12.00	50.60	100.0
Within vision performance	100.00	100.00	100.00	100.0
Total	37.40	12.00	50.60	100.0

$p<0.05$, $\chi^2 = 12.27$ df = 4 contingency coefficient C = 0.184*

Table 4: Variance analysis of knowledge, attitude and behavior of vision care of regular students, student athletes in ball games and student athletes in non-ball games of elementary schools

Independent variables	Groups	N	Mean	Standard deviation	F
Knowledge of vision care	Student athletes in ball games	150	9.48	0.80	1.26
	Student athletes in non-ball games	150	9.59	0.70	
	Student in elementary schools	50	9.64	0.60	
Attitude of vision care	Student athletes in ball games	150	8.44	0.89	2.05
	Student athletes in non-ball games	150	8.64	0.83	
	Student in elementary schools	50	8.56	0.84	
Behavior of vision care	Student athletes in ball games	150	7.43	2.21	0.18
	Student athletes in non-ball games	150	7.45	2.12	
	Student in elementary schools	50	7.64	2.23	

*$p<0.05$

different groups. The percentage of athletes playing non-ball games who had normal vision in both eyes was apparently higher than that for non-athletes.

Table 4 showed that, the perception of knowledge, attitude and behavior toward vision care among different groups was not significantly different.

Variance analysis of vision performance and knowledge, attitude and behavior toward vision care for non-athletes, athletes playing ball games and athletes playing non-ball games is shown in Table 4. An F-test revealed that athletes playing non-ball games had better vision performance in the left eye than did non-athletes ($F = 4.11$, $p<0.05$). Meanwhile, there were no significant differences in variables for knowledge, attitude and behavior toward vision care between non-athletes and athletes who played ball games ($p<0.05$).

Predictive analysis of how geographic variables and knowledge, attitude and behavior toward vision care influences vision care of elementary school students: Predictive analysis of the four intervals that were merged in the model by hierarchical regression analysis of elementary school student vision performance are shown in Table 5. For Model 1, geographic variables including student gender did not approach explanatory significance after merging into the model ($R^2 = 0.020$, $F = 2.018$, $p>0.05$). Thus, student gender, grade in school and hours of practice do not predict vision performance of elementary students.

Similarly, in models 2-4, variables associated with knowledge do not approach explanatory significance for vision performance after integration into the model (model 2: $R^2 = 0.022$, $F = 1.656$, $p>0.05$; model 3: $R^2 = 0.034$,

Table 5: Hierarchical regression analysis of geographic variables, knowledge, attitude and behavior variables of vision care on vision performance

	Model 1			Model 2			Model 3			Model 4		
Variables	Beta	t	p	Beta	t	p	Beta	t	p	Beta	t	p
Gender	-0.144*	-2.460	0.014	-0.139*	-2.365	0.019	-0.151*	-2.558	0.011	-0.150*	-2.525	0.012
Grade	0.023	0.401	0.689	0.025	0.433	0.665	0.032	0.556	0.578	0.031	0.524	0.601
Amount of exercise per week	0.008	0.130	0.897	0.010	0.176	0.861	-0.002	-0.040	0.968	-0.002	-0.028	0.977
Knowledge of vision care				-0.044	-0.761	0.447	-0.046	-0.800	0.425	-0.046	-0.785	0.433
Attitude toward vision care							0.110	1.897	0.059	0.113	1.867	0.063
Vision care behavior										-0.011	-0.178	0.859
R^2	0.020			0.022			0.034			0.034		
F	2.018			1.656			2.056			1.713		
P	0.112			0.160			0.071			0.118		
ΔR^2	0.020			0.002			0.012			0.000		
ΔF	2.018			0.580			3.600			0.032		
ΔP	0.112			0.447			0.059			0.859		

*p<0.05

$F = 2.056$, $p>0.05$; model 4: $R^2 = 0.034$, $F = 1.713$, $p>0.05$), whereas increasing explanation of variance (model 2: $\Delta R^2 = 0.002$, $\Delta F = 0.580$, $p>0.05$; model 3: $\Delta R^2 = 0.012$, $\Delta F = 3.600$, $p>0.05$; model 4: $\Delta R^2 = 0.0$, $\Delta F = 0.032$, $p>0.05$) showed that integration of the knowledge of vision care variable cannot predict vision performance.

Taken together, none of the geographic variables, or variables concerning knowledge, attitude and behavior toward vision care were predictive of elementary school student vision performance.

DISCUSSION

Vision examinations define normal vision, or visual acuity, as between 0.9~2.0, whereas values above this range indicate vision impairment. Among the 350 participants in the study, 131 (37.4%) had normal vision, 42 (12.0%) had vision impairment in one eye and 177 (50.6%) had vision impairment in both eyes. Thus, in this study over 60% of students had some degree of vision impairment, which is a higher rate than that seen for other countries and could be indicative of the need to increase awareness of visual health in Taiwan[2].

Here, the percentage of students participating in non-ball games that had normal vision in both eyes was higher than that for those who played ball games, whereas those students who were not athletes had a higher rate of vision impairment in both eyes. Participation in sports activities could increase eye movements that increase the performance of the ciliary muscle, the crystalline lens and the suspensories lentis apparatus to promote dynamic vision and improve vision impairment[20]. Results of the current study are consistent with previous studies showing that outdoor activities could reduce the rate at which vision impairment develops, suggesting that taking part in any type of outdoor activity or exercise is beneficial to vision health[20,21].

Present study analysis detected no significant differences in knowledge, attitude and behavior toward vision care between athletes and non-athletes. Furthermore, neither geographic variables nor variables for knowledge, attitude and behavior toward vision care could predict vision performance of elementary school students. Nonetheless, the scores for student knowledge, attitude and behavior toward vision care were all high, which indicated the effectiveness of programs delivered at these schools that are designed to enhance knowledge of vision care.

Factors associated with vision impairment and the high rate of vision impairment seen in this study population are complex. Some environmental factors, such as working long hours, activities conducted at close distance or with insufficient light, including using computers, smartphones, watching TV, participating in after school lessons and insufficient outdoor activity are avoidable[22,23]. Thus, students should be encouraged to maintain appropriate reading or writing distances of at least 35 cm, taking 10 min breaks for every 30 min spent watching TV or playing video games, participating in outdoor activities for at least 120 min a day and undergoing regular vision care examinations and treatments as needed[19].

Some studies suggested that the use of smartphones should be controlled by the school during school hours due to the potential for extended smartphone use at close distances to negatively impact vision. On the other hand, optimal academic performance often requires long periods of time spent studying, which could result in decreased amounts of time spent engaging in outdoor exercise[21]. Thus, schools could implement strategies to promote outdoor activities, either through independent exercise or organized sports, to decrease the likelihood of worsened vision impairment[24].

CONCLUSION AND FUTURE RECOMMENDATIONS

In this study, the rates of vision impairment between athletes and non-athletes were similar, which could be due to the prevalence of indoor ball-games in Taiwan. Therefore, authors recommend that students engage in more outdoor activity to preserve vision health.

For future research, additional variables could be considered, including time spent using electronic devices or studying, which could provide more information about the influence of sports participation on vision performance.

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