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Research Article / Araştırma Makalesi

The effects of vision training applied to kumite karate national team athletes

Kumite karate milli takım sporcularına uygulanan görme eğitiminin etkileri

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ABSTRACT

Objective: Visual perception is essential for decision-making, movement, and reaction time in karate. This study evaluates the impact of visual training on kumite athletes.

Methods: Twenty-four national athletes representing the Kocaeli Metropolitan Municipality Kağıtspor Team were randomly divided into two groups following an eye examination. The control group (n=11) continued with routine training, while the visual training group (n=12) engaged in additional visual training for four weeks (three sessions/per week). Baseline (week 0) and post-intervention (week 4) assessments included the 'Nelson Reaction Test,' 'Sit & Reach Test,' and 'Snellen Test.' Independent physiotherapists and an ophthalmologist conducted evaluations. Statistical analysis was performed using IBM SPSS V26 with parametric tests (ANOVA) at a significance level (p<0.05).

Results: Pre-test averages indicated no significant differences between groups (p>0.05). Post-test results revealed significant improvements in the visual training group for the Snellen Chart (***p=0.015***) and the Nelson Reaction Time (***p=0.009***) tests, indicating faster performance in reaction times compared to the control group. No significant differences were found for the Sit & Reach test (p>0.05).

Conclusion: Visual training improved visual acuity and reaction time but did not impact flexibility in kumite karate athletes. These results suggest that visual training programs may improve specific performance aspects, such as reaction time and visual acuity, in karate and other contact sports.

Keywords: *Karate, performance, reaction time, visual acuity, Visual Training*

ÖZ

Amaç: Görsel algı, karatede karar verme, hareket ve reaksiyon süresi için çok önemlidir. Bu çalışma görsel antrenmanın kumite sporcuları üzerindeki etkisini değerlendirmektedir.

Yöntemler: Kocaeli Büyükşehir Belediye Kağıtspor Takımı'ndan 24 milli sporcu göz muayenesinden sonra rastgele iki gruba ayrıldı. Kontrol grubu (n=11) rutin antrenmana devam ederken, görme eğitim grubu (n=12) 4 hafta boyunca (haftada 3 seans) ek olarak görsel antrenman aldı. Başlangıç (0. hafta) ve müdahale sonrası (4. hafta) değerlendirmeler 'Nelson Reaksiyon Testi', 'Otur ve Uzan Testi' ve 'Snellen Testi'ni içermiştir. Değerlendirmeler bağımsız fizyoterapistler ve oftalmolog tarafından yapılmıştır. İstatistiksel analizde IBM SPSS V26 ve anlamlılık düzeyinde (p<0.05) parametrik testler (ANOVA) kullanılmıştır.

Sonuçlar: Ön test ortalamaları anlamlı grup farklılıkları göstermedi (p>0.05). Son test sonuçları, görsel eğitim grubunda Snellen Test (***p*=0,015**) ve Nelson Reaksiyon Süresi (***p*=0,009**) testleri için anlamlı iyileşmeler olduğunu ve kontrol grubuna kıyasla daha hızlı reaksiyon süreleri olduğunu ortaya koymuştur. Otur ve Uzan testi için anlamlı bir fark bulunmamıştır (p>0.05).

Sonuç: Görsel antrenman, kumite karate sporcularında görme keskinliğini ve reaksiyon süresini geliştirmiş ancak esneklik üzerinde bir etkisi olmamıştır. Bu sonuçlar, görsel antrenman programlarının karate ve diğer temas sporlarında reaksiyon süresi ve görme keskinliği gibi performansın belirli yönlerini geliştirebileceğini göstermektedir.

Anahtar Sözcükler: *Karate, performans, reaksiyon zamanı, görme keskinliği, görsel eğitim*

INTRODUCTION

Karate is a Japanese martial art practised by over 10 million athletes and 100 million people worldwide. It consists of two main disciplines: kata and kumite. Kata involves basic techniques performed in set sequences as an imaginary defence against attacks from all directions, serving as physical and mental training. Kumite is a form of free sparring between two athletes under specific rules, where points are scored through punches to the head and body,

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blocks, and kicks (1). Kumite karate matches, in which athletes use basic techniques to engage with opponents, last three minutes and require high-intensity actions such as kicks, punches, and rapid horizontal movements. (2). It is evident that the primary areas of focus in training kumite karate athletes are cognitive skills, particularly perception and anticipation abilities. Karate competitions and training are characterized by low intensity and maximum training periods; therefore, maximum speed, timing, reaction speed and duration and explosive power are essential elements of performance in karate sports (3). Cardiorespiratory endurance, muscular strength and body composition, and cognitive-perceptual abilities, including speed, stability, strength, mobility, coordination, agility and decision-making processes are essential for each karate athlete (4). Karate is a dynamic and coordinated set of movements that require the athlete to react suddenly, attack, and have high functional activity capacity and advanced biological adaptation (5). The research results have indicated that motor and functional skills such as muscle strength, flexibility, speed, agility, balance, reaction time, and coordination should be at a high level in karate (6). Movements such as kicking, throwing, and jumping require absolute muscular strength, flexibility and reaction timing to achieve a high level of performance and meet the increasing power demand (7). In karate, which involves offence and defence against opponents, athletes need to develop pre-move visual tracking and perceptual abilities, i.e. karate-specific cognitive skills and/or non-specific basic sensory functions for the timing and speed of moves and reactions. Sports science emphasises the importance of two types of perceptual abilities for successful player performance. These are primitive, basic sensory functions, such as optometric measurements (static and dynamic visual acuity, field of vision, stereopsis, etc.), not specific to the branch/sport specialisation type, and sport-specific basic abilities (8). Vision is central to success in almost all sports, except some Paralympic disciplines. Hitting the ball in baseball, dunking in a volleyball match, and pedalling in a bicycle race rely on the sense of sight to direct precise and difficult motor actions. Such a nervous system-controlled perception-action connection is generally considered a limiting factor for excellence in a wide range of sports (9).

Just as different movement dynamics are required in all sports, different visual abilities are necessary for success. Past research has shown that Olympic athletes from different sports (10) support this idea, demonstrating that different disciplines benefit from distinct visual skills, as evidenced by athletes participating in more interoceptive sensory sports versus strategic sports (11). The basic tenet of this emerging and increasingly popular discipline of 'sports vision' is that better visual abilities underlie better athletic performance. Research has approached this question in past studies by comparing individuals at different levels of athletic achievement or by testing direct correlations between visual assessments and on-field performance and identifying cross-sectional differences. As a result, evidence in favour of both relationships has been obtained. A study on young kumite karate athletes found statistically significant relationships between lower extremity proprioceptive sensations and age, height, body fat percentage, back and leg strength, and flexibility levels. Therefore, it is recommended that these variables be considered in training planning (12).

Proprioception is a complex perception system involving the central and peripheral nervous system. One of the main components of this system is muscle spindles, which have been shown to transmit sensory signals from the muscles (13). In the literature, it is reported that proprioceptive abilities have determinant effects on sportive performance, and the development of these abilities contributes to performance improvement (14).

The stimuli received from the visual, proprioceptive, and peripheral vestibular systems are integrated into the brainstem and cerebellum, which constitute the central vestibular system (15). Based on this information, improving the visual system may positively affect proprioceptive abilities and sportive performance.

Although there is extensive literature on motor and cognitive performance variables in karate in general, studies specific to kumite athletes and the effects of visual system training on this subgroup are pretty limited. Kumite is a dynamic fighting discipline that requires fast perception, decision making and response to unpredictable stimuli. However, there is not enough experimental research in the literature to examine whether visual system training supports these skills in kumite. Therefore, this study aims to evaluate the effects of visual system training on performance variables such as visual acuity, reaction time, and flexibility in Kumite athletes and contribute to the literature by examining the effects of visual training on performance in kumite karate athletes. The hypothesis tested in this study is that vision training protocol will significantly affect visual acuity, reaction time and flexibility in kumite karate athletes. Vision training is expected to improve these variables.

MATERIAL and METHODS

Study Design

In this study, which was designed as a double-blind, randomised controlled study, all participants in the Kumite

Karate team were screened with a questionnaire form questioning their physical characteristics and general health status, and each athlete was numbered by giving codes to the questionnaire. An ophthalmologist examined all the athletes and evaluated them for eligibility for the study. In the ophthalmologist control, the athletes were evaluated for eye diseases (myopia, hyperopia, astigmatism, etc.) that would prevent them from being included in the study. Athletes who agreed to participate in the research and met the inclusion criteria were assigned to two groups: control (n = 12) and vision training (experimental) (n = 12) by simple randomisation using 'www.randomizer.org' (16). Participants in the control group continued their regular training planned by their karate coaches. This training included kicking, punching, striking and blocking movements in fixed and variable positions and match-specific training six days a week. Athletes in the vision training group were included in a 'vision training' program and their regular sport-specific training. The vision training program was conducted three times a week for four weeks according to the training content provided by 'Z Health Education'(17). There are exercise protocols and applications in the literature that include different but similar eye exercises such as 'Chinese eye exercises', 'yoga and eye exercises', and 'oculomotor exercises'. The 'vision training program' that has been created by using these several different protocols (18)and based on the content of the Z Health Education training is as follows:

Isometric Eye Exercises: The eyes are fixed at a certain point, and the muscles are kept under tension, increasing the endurance and focus stability in the extraocular muscles.

Eye Circles (Bidirectional): The eyes are moved in a circular motion, clockwise and counter-clockwise, improving the coordination and flexibility of the extraocular muscles.

Eye Spirals (Medial-Lateral, Up-Down): Spiral-shaped movements are made with the eyes from inside to outside and up and down, increasing visual tracking and focusing ability.

Pencil Push-up: The participant focuses on a pencil and brings it closer to the tip of the nose; it develops convergence and focusing reflexes.

Convergence Studies (With Different Charts): Studies done with different convergence charts have shown that both eyes can focus more effectively together.

Divergence Studies (With Different Stereograms): Different stereograms exercise the ability of the eyes to focus outward, strengthening three-dimensional visual perception.

Peripheral Gait: The participant looks at a central point while walking and tries to pay attention to environmental (peripheral) stimuli; peripheral vision awareness is increased.

Table 1. Design of the Training Program

Group	Control Group (CG)	Vision Training Group (VTG)
Training Content	Continued Sports Specific Training (SST)	Continued sports specific training + Vision training (VT)
Training Duration	Four Weeks	Four Weeks
Training Frequency	Six sessions per week (SST)	Six sessions per week (SST) Three sessions per week (VT)
Vision Training Content	-	Isometric Eye Exercises Eye Circles - Bidirectional Eye Spirals (Medial-Lateral, Up-Down) Pencil Push-up Conversion Studies (With Different Charts) Divergence Studies (With Different Stereograms) Peripheral Gait (Total 10 minutes)

CG: Control Group, VTG: Vision Training Group, SST: Sports Specific Training, VT: Vision Training

All participants took the first measurement (Measurement 1) at the beginning of the study (week 0) and the second measurement (Measurement 2) after the vision training protocol (week 4). Visual acuity, reaction time and lower extremity flexibility were assessed. In the study, a physiotherapist researcher gave 'vision training'. An ophthalmologist performed visual acuity measurements, and a second physiotherapist researcher who had not implemented the vision training program performed reaction time and lower extremity flexibility measurements.

The ophthalmologist and physiotherapist researchers did not know which group the athletes were in. Each test was performed three times, and mean values were recorded. A five-minute break was given between each test. The measurement days coincided with rest days; all participants were asked not to perform moderate to vigorous physical activity. The same researchers carried out the measurement trials at the same time of the day. The targeted gains at the end of the visual training program are increased visual acuity, shortened reaction time, and increased flexibility.

Settings

The study was conducted with the athletes of the Kocaeli Metropolitan Municipality Kağıtspor kumite karate team affiliated with the Turkish Karate Federation (TKF) between July and October 2024. No athlete participated in national or international competitions during the four-week vision training period. The vision training program was implemented for four weeks, three days a week on, Tuesdays, Thursdays and Saturdays.

Participants

The inclusion criteria required participants to be between 15 and 35 years of age and to regularly engage in sports activities. All licensed kumite athletes aged 18-35 included in this study have been actively training and competing for more than 2 years. Athletes with any systemic disease, balance problem, communication problem, suspicion of pregnancy and a history of trauma or surgery in the last six months were excluded from the study. All athletes were fully informed about the study procedures and possible problems that may arise due to this study with the official permission and knowledge of their clubs. The dominant hand and foot of the athletes were determined using the Edinburgh Handedness Inventory (19) and the Waterloo Footedness Questionnaire (20). The study was approved by the Marmara University Clinical Research Ethics Committee and conducted according to the Declaration of Helsinki (21). All participants were provided with information about the study, and written informed consent was obtained prior to participation.

Procedure

Context of Data Collection

Each pre-study (Measurement 1) and post-study (Measurement 2) measurements were performed on rest days, one day after the last training session. The 'Snellen Chart Test' for visual acuity assessment by an ophthalmologist, 'Nelson Reaction Test' for reaction time, and 'Sit & Reach Test' for lower extremity flexibility by a physiotherapist were performed, respectively. The evaluations were carried out in the gyms where the athletes trained.

Visual Acuity (Snellen Chart Test) Assessment

The Snellen Test (**Figure 1**), which is often preferred for the assessment of visual acuity, is used in the evaluation of visual acuity of children over seven years of age and adults. In this test, which consists of a series of black letters on a white background, after the three capital letters at the beginning of the table, there are letters of different sizes in each line, gradually getting smaller in the following lines (22). In a suitable environment, the distance should be six metres. It should be applied in an illuminated environment, on a plain flat wall, so that when the person sits on the chair, the eye distance and the table are in the same line (23). The results were coded according to logMAR (Logarithm of Minimum Angle of Resolution) analysis and added to the statistical data set. According to the ratings representing visual acuity in the Snellen Chart Test, the corresponding values in the LogMAR threshold were calculated according to the values shown in **Table 2**below (24). As LogMAR scores decrease in the negative direction, visual acuity improves, and visual acuity decreases as they increase in the positive direction. For example, a LogMAR score of 0.0 corresponds to a Snellen equivalent of 1.0 (20/20). In contrast, a LogMAR score of -0.1 corresponds to better vision (approximately 20/16) and a LogMAR score of 0.3 corresponds to lower visual acuity (approximately 20/40).

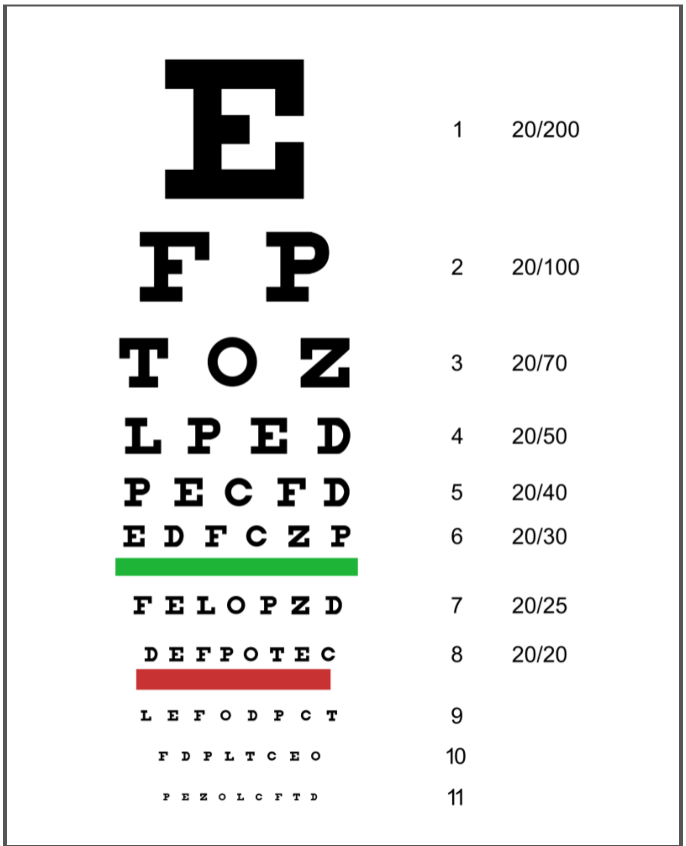

Figure 1. Snellen Chart Test - Green colour: visual acuity score considered normal - Red colour: visual acuity score better than normal visual acuity

Table 2. Snellen Chart & LogMAR Scoring

Snellen Chart Number	Snellen Chart Value	LogMAR Value
1	20/200	1,0
2	20/100	0,8
3	20/70	0,6
4	20/50	0,4
5	20/40	0,3
6	20/30	0,2
7	20/25	0,1
8	20/20	0
9	20/15	-0,1
10	20/12,5	-0,2
11	20/10	-0,3

Nelson Reaction Test

It is a test that measures reaction time to visual stimuli. In the hand reaction test, the ruler is placed between the fingers of the hand. The practitioner holds the ruler by the tip and above. He/she releases the ruler sometime after giving the ready signal. The subject tries to catch the ruler as soon as possible. The reaction time is calculated using the following formula: the distance at the point he/she catches and recorded in sec(25). This formula was used to calculate the reaction time (t): t=√2d/g (d: Distance the ruler falls (calculated from the ruler in cm) / g: Acceleration of gravity (980 cm/s^2), / t: Reaction time (seconds).

Lower Extremity Flexibility (Sit & Reach Test) Assessment

In kumite karate, kicks are performed with rapid knee extension-flexion activation, as they require a target-awareness strike-pull. Poor joint proprioception is a risk factor for athletes. Lower extremity flexibility is important in kumite karate athletes, like many other performance parameters (26). Therefore, the sit-and-reach test was preferred to measure the flexibility of the hamstring muscles practically. Flexibility in this region is important for movement control during kicking and injury prevention. Visual training is expected to positively affect the test result by ensuring the correct application of flexibility exercises. Flexibility measurements were performed using the Baseline Sit and Reach Trunk Flexibility Box (Baseline Evaluation Instruments, New York, NY, USA). Participants were asked to place their feet on the box in a long sitting position and flex their trunk 90 degrees. They put both hands on the device with a trunk flexion movement to move on the device and slowly flexed forwards (25).

Statistical Procedures

Data were analysed using the IBM SPSS Statistics Standard Concurrent User V 26 (IBM Corp., Armonk, New York, USA) statistical package program. Descriptive statistics were given as number of units (n), percentage (%), mean (X), standard deviation (SD), median (M), minimum (min) and maximum (max) values.

Parametric tests were used since numerical descriptive properties and variables were normally distributed. Compliance with normal distribution was analysed by Independent Sample t Test (t) and Chi-Square Test (x2). A mixed-order analysis of variance (ANOVA) was used to compare the groups variables according to follow-up times. Bonferroni correction was applied to compare the main effects in the studies. $p<0.05$ was considered statistically significant. The magnitude of differences was tested using Cohen's standardised effect size. The sample size was calculated post hoc, and the power of the study was calculated using G*Power software (latest ver. 3.1.9.7; Heinrich-Heine Universität Düsseldorf, Düsseldorf, Germany)." "The effect size for the group time change in the sit-lie test, t-ruler reaction and Snellen Chart Test values was calculated as (n2=0.428 (f=0.865); n2=0.004 (f=0.063); n2=0.249 (f=0.576), respectively) for 24 participants at 5% significance level. The power of the study for this effect size was found to be 99.9%, 9.1%, 99.6%, respectively."

RESULTS

A total of 24 professional karate players, 12 women and 12 men from the same club, participated in the study, and some descriptive characteristics of the participants are given in **Table 3**. However, after the questionnaire scans and determination of the groups, one participant in the control group was excluded from the study due to personal reasons, and the study was started and continued with 23 participants. The demographic and clinical evaluations of the participants were similar before the study (**Table 3**).

After the study, 'The Snellen Chart Test' results changed statistically significantly in the visual training group. According to the measurement differences obtained between the two evaluations, the change obtained in the visual training group was statistically superior to the control group ***(p=0.015)*** (**Table 4**).

The reaction time evaluations after the study showed a statistically significant decrease in the visual training group. When the differences between the two assessments were compared, there was a statistically significant superiority in the visual training group compared to the control group ***(p=0.09)*** (**Table 4**).

DISCUSSION

This study, found that the visual training protocol applied to professional kumite karate players had significant effects on visual acuity and reaction time but not on lower extremity flexibility. This result suggests that the effect of visual stimuli on motor responses can be improved by regular visual training.

Many studies have shown that professional athletes develop visual-perceptual and visual-cognitive abilities (27, 28), superior visual acuity (29), increased contrast sensitivity, and much better visual tracking capabilities (30). Evidence has been presented in the literature that.

Table 3. Comparison of the Descriptive Characteristics of the Participants According to Groups (*n*=24).

	Vision Training Group *n*=12	Control Group *n*=12	Test (*p*)
Age, (*year*)			
X ± SS	19,42 ± 4,89	19,58 ± 4,68	*t*=-0,085 *p*=0,933
M (min-max)	17,5 (15-33)	17,5 (16-31)	
Gender, *n (%)*			
Male	5 (%41,7)	7 (%58,3)	x^2=0,667 *p*=0,414
Female	7 (%58,3)	5 (%41,7)	
Body mass index, (*kg/m²*)			
X ± SS	20,29 ± 2,47	20,56 ± 2,72	*t*=-0,250 *p*=0,805
M (min-max)	20,1 (17-25,1)	20,1 (17-27)	
Dominant foot, *n (%)*			
Right	12 (%100)	11 (%91,7)	x^2=1,043 *p*=0,307
Left	0 (%0)	1 (%8,3)	
Dominant hand, *n (%)*			
Right	11 (%91,7)	12 (%100)	x^2=1,043 *p*=0,307
Left	1 (%8,3)	0 (%0)	

Independent Sample t Test (t); Chi-Square Test (χ2); Descriptive statistics are given as mean (X), standard deviation (SD), median (M), minimum (min), maximum (max), number (n), percentage (%)

Table 4. Comparison of Measurements According to Groups at Follow-up Times (*n*=23).

	Group		
	Vision Training *n*=12	Control *n*=11	Test Statistics †
Sit & Reach Test			
Pre-test	18,67 ± 1,57	18,64 ± 2,00	*F*=0,001 *p*=0,977 η^2=0,001
Post-test	18,35 ± 1,52	18,16 ± 1,88	*F*=0,069 *p*=0,796 η^2=0,003
Test Statistics ϕ	*F*=0,528 *p*=0,475 η^2=0,025	*F*=1,332 *p*=0,261 η^2=0,060	
Difference & (Post-Pre)	-0,32 ± 0,89	-0,48 ± 1,81	*F*=0,075 *p*=0,787 η^2=0,004 Power (1-*β*) = 0,091
Snellen Chart Test			
Pre-test	0,22 ± 0,04	0,22 ± 0,07	*F*=0,004 *p*=0,952 η^2=0,001
Post-test	0,13 ± 0,11	0,21 ± 0,08	***F*=4,147 *p*=0,015 η^2=0,165**
Test Statistics ϕ	***F*=16,143 *p*=0,001 η^2=0,435**	*F*=0,148 *p*=0,704 η^2=0,007	
Difference & (Post-Pre)	-0,09 ± 0,10	-0,01 ± 0,03	***F*=6,949 *p*=0,015 η^2=0,249 Power (1-*β*) = 0,996**
Reaction Time (Nelson Test)			
Pre-test	0,21 ± 0,13	0,15 ± 0,02	*F*=1,992 *p*=0,173 η^2=0,087
Post-test	0,11 ± 0,02	0,16 ± 0,03	***F*=28,480 *p*<0,001 η^2=0,576**
Test Statistics ϕ	***F*=13,540 *p*=0,001 η^2=0,392**	*F*=0,027 *p*=0,872 η^2=0,001	
Difference & (Post-Pre)	-0,10 ± 0,12	0,01 ± 0,03	***F*=7,677 *p*=0,011 η^2=0,268 Power (1-*β*) = 0,999**

Mixed Pattern ANOVA (*F*), Effect Size (η^2), ϕ In-group comparison, † Inter-group comparison, & Comparison of pre and post score differences between groups, Descriptive statistics are given as mean (X) and standard deviation (SD) values. Bolded sections are statistically significant (*p*<0,05).

Findings such as that high-achieving and high-performing athletes are better at detecting perceptual cues, make more efficient eye movements and have better attentional processing than less successful athletes or individuals who are not professional athletes have been synthesised in two meta-analyses of the sports specialism literature (31, 32)

Vision in sport, a new speciality that has attracted the interest of athletes in the last 20 years (33), especially those looking for new ways to improve their visual skills to achieve better performance on the field, aims to strengthen and maintain visual function to enhance sports performance (34). Nowadays, sports vision training is used to improve athletes' level of play and to performance competition. Only sound, visual processing and high reaction speed are the elements that distinguish an excellent performance, and these can be developed through sports vision training in any athlete, regardless of the level of play. The athlete with a more developed visual reaction speed will be able to see the game almost in 'slow motion' and will, therefore, be able to react and make decisions ahead of time within fractions of seconds on behalf of his move, which will positively affect his performance (33). Improving visual performance has been associated with a higher speed in the decoding and transforming of visual signals at the cortical level into motor actions by athletes (35). In contact and attack sports such as karate, training the visual system is essential for the successful performance and development of cognitive and mixed tasks such as decision-making for a move, following the opponent, and observing the referee and the scoreboard. Some evidence in the literature suggests that the visual system, like other systems in the body, can be improved through specific visual training (36). Eye movement training has been reported to positively change performance in elite athletes (37). Studies examining the effects of visual training on performance in contact sports such as karate are very few in the literature. One of the rare studies showing that visual acuity is improved by visual training, as in our study, Morimoto et al. reported that dynamic visual acuity and stability limit of healthy individuals improved significantly after three weeks of ocular-motor exercises (38). In the study investigating the role of vision in postural stability, Meshkati et al. compared two groups of 25 men, professional karate athletes and non-athletes. Postural and visual stability depends on afferent audio-visual and deep sensations, and this afferent is under the influence of multiple receptors in brain regions to provide practical outputs to maintain posture and control ocular movement. Incorrect information due to of a defect in sensory receptors leads to an imbalance in vision and posture and a mismatch of receptors (39). Incomplete or inaccurate visual information may cause deficiencies in skills such as anticipating, countering and responding to the opponent and the opponent's moves, such as karate, and may adversely affect performance. Improving visual acuity and postural control can also improve performance. Balance starts from the vestibular nerve and travels to the cerebellum and vestibular nuclei in the brain, to the reticular nuclei in the brain stem and the brain via the vestibulospinal and reticulospinal pathways. This control is significant when performing sports skills and physical activity (40).

Due to the fast movements in karate, visual skills are very important, and one needs a proper dynamic vision to focus on the visual field. Therefore, knowledge of dynamic vision is important for processing speed and easy perception of movement. When justifying the results obtained from the effect of performing exercises involving eye movements on the improvement of dynamic visual acuity and stability limit in the intervention group, one can mention fixation as one of the components of ocular-motor skills. It is very important to focus on the ball or opponent to make an attack (41).

Studies conducted in different sports branches have shown the positive effects of visual system training on cognitive-motor skills. Nascimento et al. (42) attributed this development to the support of visual system development test-based exercises in environmental awareness and rapid decision-making processes. Another study on futsal athletes indicated that this type of training stimulated mechanisms related to visual attention, timing and memory (33). Maman et al. (43) explained the development in table tennis athletes because visual stimuli trigger fast motor responses specific to the sport. The visual acuity and reaction time developments obtained in our current study similarly reveal the role of the visual system in cognitive and motor processes; they show that the gains obtained in different branches can be similarly observed in karate athletes.

Previous studies support the positive effects of vision training on athletes' motor skills and reaction time. Altuncu et al. investigated the effects of gaze-stabilised oculomotor exercises applied for six weeks on hand-eye coordination, reaction time, visual perception and dynamic visual acuity in table tennis players aged 15-25. They obtained positive improvements in hand-eye coordination and visual perception parameters (44). Mallahi et al. investigated the effect of an eight-week sports skills training program combined with visual skills on table tennis and basketball players. They found that the table tennis group performed better (45).

It has been reported that visual acuity training improves offensive and defensive reflexes in martial arts athletes. These findings support that visual training can provide an important advantage in sports such as karate that requires rapid decision-making. In high-intensity sports such as karate, visual acuity and fast reactions are critical for successful performance. The indirect effects of vision training on reaction time and flexibility may be related to the improving neuromuscular coordination and proprioceptive perception.

This study's limitations include the sample size and the lack of investigation of the long-term effects of the vision training protocol. Furthermore, the generalisability of the results may be limited by the fact that it was restricted to kumite karate athletes only. Long-term studies with larger groups of participants are needed to understand the long-term effects of vision training protocols. After a certain period of time after vision training, measurements can be made again to investigate the effects after the cessation of training.

Investigating the effects of vision training in different contact, individual, or team sports may help us to better understand these training programmes' effects on sporting performance. Designing studies to improve performance and sport-specific skills may lead to gains in terms of improving athletes' performance. In addition, neuroimaging techniques may be useful to examine the effects of such training programmes on the brain in more detail.

CONCLUSION

The results of this study showed that a four-week vision training program can improve the visual acuity and reaction times of professional kumite karate athletes, which are important in sports players.

Ethics Committee Approval / Etik Komite Onayı

The approval for this study was obtained from Marmara University Clinical Research Ethics Committee, İstanbul, Türkiye (Decision no: 09.2024.611, Date: 09/07/2024.

Conflict of Interest / Çıkar Çatışması

The authors declared no conflicts of interest with respect to authorship and/or publication of the article.

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Author Contributions / Yazar Katkıları

Concept Design: MSE, TKC; Supervision/ Consultancy: TKC; Materials: MSE; Data Collection and Processing: MSE, BC, KC; Analysis and Interpretation: MSE, TKC; Literature Review: MSE, TKC; Writing: MSE, TKC; Critical Review: MSE, TKC. All authors contributed to the final version of the manuscript and discussed the results and contributed to the final manuscript.

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