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AOASM Position Statement on Esports, Active Video Gaming, and the Role of the Sports Medicine Physician

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Abstract: Electronic sports, or esports, has a global audience of over 300 million fans and is increasing in popularity, resulting in projected revenue of over \$1 billion by the end of this past year. The global pandemic of 2020 had little to no effect on these increasing numbers because athletes have been able to continue to engage in sports because of its electronic nature and fans have been able to follow them virtually. Esports has been recognized as an organized sport by the International Olympic Committee, the US National Collegiate Athletic Association, and several secondary school athletic associations within the United States. In addition, professional teams have been established in several major cities within the United States, Canada, Europe, and Australia. With the growth of esports, the necessity of incorporating esports medicine into the practice of sports medicine physicians has become paramount. Esports can be played on a monitor or screen and played using physical activity in what has become known as active video gaming. Within both of these platforms, there have emerged certain conditions unique to esports. There are also certain conditions seen in other sports applicable to esports athletes. This document will review the evaluation of the esports athlete, introduce conditions unique to these athletes and review common conditions seen in esports, discuss diagnostics used in the evaluation of esports athletes, introduce treatment options for conditions unique to esports and review those for commonly seen injuries in esports, discuss prevention of injuries in esports, and introduce a framework for the future development of esports medicine that can be introduced into the daily practice of the sports medicine physician.

Key Words: esports, active video gaming, upper crossed syndrome, digital eye strain, computer vision syndrome, internet gaming disorder

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INTRODUCTION

2020 will forever be known as the year of the pandemic. At one point, this public health emergency halted most sports in the United States, but one group of athletes had no changes in their activities. These athletes were the electronic sports or esports athletes. Esports athletes are athletes who compete using a video screen or computer monitor. With the shutdown of all major sports leagues and lack of broadcast sports for several months, the number of athletes participating in esports and expected revenue have increased exponentially.

Esports is believed to have a global audience of over 300 million fans and increasing. In 2018, esports was believed to have generated \$905 million in revenue with projections

crossing the \$1 billion mark by the end of 2020, with over half of that generated by China and North America.¹ When Robert Morris University established an esports team in 2014, it became the first US college to do so and was followed by more than 80 additional universities with several offering scholarships.² The International Olympic Committee accepted esports as a sport in 2017.³

Professionally, the most popular game as far as audiences are concerned is Dota 2, followed by League of Legends and Counter Strike: Global Offensive.¹ Games may be viewed in person, such as in an arena as large as Madison Square Garden in New York City, on the YouTube gaming channel, or on Twitch, a dedicated web-gaming channel. In 2018, the National Basketball Association, in association with Take-Two Interactive, launched its own league representing several NBA teams called the NBA 2K League. The NBA 2K League is now one of the most popular esports leagues whose games have been broadcast on ESPN2.⁴

There is a growing prevalence and interest in active video gaming (AVG) as an avenue for recreation, health promotion, and rehabilitation. Video games that require physical activity beyond that of conventional hand-controlled games are referred to as active video games. The term “active video game” or “exergame” has been used to describe games in which body movement is necessary or encouraged to control the game. Typically, active games use a motion-sensing or motion-encouraging controller rather than a traditional hand-held gamepad controller. These controllers may take the form

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of mats, boards, motion-sensing cameras, or hand-held motion-sensing devices. There are four main game types: shooter (played with traditional controllers), band simulation (guitar or drum controller), dance simulation (dance mat controller), and fitness (balance board controller).

Active video gaming offers the potential to overcome many of the current barriers to physical activity in children; however, AVG play should be approached with caution. Low to moderate intensity may be achieved, thus improving the health and well-being of sedentary individuals who typically play passive video games. Arguments against AVGs cite lack of vigorous physical activity. In addition, other potential negative effects include threats to child safety, inappropriate content, exposure to violence, bullying, internet “addiction,” displacement of moderate/vigorous physical activity, exposure to junk food advertising, sleep displacement, vision problems, and musculoskeletal overuse and injury.⁵⁻⁹

The potential benefits of AVG include opportunities for group participation and competition regardless of location. Individuals or groups play remotely (ie, online) or in a local setting. Active video gaming may offer physical activity to those individuals with physical and cognitive disabilities who may not otherwise play traditional sports. Active video gaming offers modes of nonstructured opportunities for physical activity which is in agreement with recommendations put forth by the American Academy of Pediatrics.¹⁰ Active video gaming programs can be structured or nonstructured forms of physical activity with individual or recreational programs and organized competitive leagues. Other potentially positive effects of AVG include enhanced cognitive development and school achievement, reduced barriers to social interaction, enhanced fine motor skills and visual processing, and effective rehabilitation.

Esports medicine is the subsection of sports medicine which concentrates on prevention, diagnosis, and treatment of esports-related injuries. These injuries may be acute or chronic. Furthermore, esports medicine is providing for the development of long-term health, safety, and well-being of all athletes who participate in esports, whether amateur or professional, adult, or pediatric. Esports medicine is also supplying the bulk of medical research into this new and innovative sport.

A recent study by DiFrancisco-Donoghue et al¹¹ surveyed 65 National Collegiate Athletic Association esports players between the ages of 18 and 22 years, looking at lifestyle and sports medicine health necessities. They found that the average length of practice was between 5.5 and 10 hours daily, with less than 40% getting any aerobic activity, and approximately 15% reported being sedentary for 3 hours or more per day without standing.¹¹ A typical child aged 8 to 10 years spends an average of 65 minutes per day in video game play.¹² Among US high school students, 4 of 10 report participating in active gaming.¹³ At present, organized esports is becoming a competitor to replace recreational sports participation among the youth.

Esports athletes in the study by DiFrancisco-Donoghue et al had several complaints when asked about injuries from their sport. Eye fatigue was the most common complaint (56%), followed by neck and back pain (42%), wrist pain (36%), and hand pain (32%).¹¹ In a study by De Las Heras et al,¹⁴ the authors showed that one single session of cardiovascular exercise through high-intensity interval training performed

before a customized League of Legends task improved target elimination, accuracy, and athlete affect.

Esports requires a multidisciplinary team to address the ophthalmologic, musculoskeletal, metabolic, and mental health conditions associated with esports.³ Eye fixation on video monitors or computer screens for extended periods of time can cause visual disturbances and/or headache. As for ergonomics, several hours in a sedentary position while performing rapid, repetitive, manual dexterous movements often leads to acute or chronic cervical and/or lumbar pain. Upper extremity pain, including shoulder, elbow, or wrist, is often caused by the same things. Sedentary activity found in esports players combined with a lack of aerobic activity as well as diet choices and supplement use may lead to deleterious cardiovascular events including deep venous thrombosis. Esports players may also suffer from changes in circadian rhythm because of the emission of blue light from video screens or computer monitors causing altered sleep patterns, insomnia resulting in fatigue, mood disorders, substance abuse, and weight gain.³ Finally, mental health issues are common in esports with over 5 million people diagnosed with Internet Gaming Disorder³ and other considerations including anxiety and depression.

EVALUATION OF ESPORTS ATHLETES

Evaluation of esports athletes not only concentrates on overuse injuries most commonly in the musculoskeletal and ophthalmologic systems but also considers psychological conditions such as mental fatigue, burnout, and anxiety.¹⁵ It is important when evaluating these athletes to focus on the acute issues and assess for the global health of the athlete. Currently, there is no consensus on a standardized initial assessment of the esports athlete; however, an evaluation should encompass the history and physical examination presented in Table 1.

COMMON CONDITIONS

Injuries

Because AVGs differ from traditional video games and traditional sports, AVG play is not limited by physical strength, endurance, and training. Specific characteristics of AVG play may lead the participant to increased risk of acute and overuse injuries such as upper extremity overuse syndrome, delayed onset muscle soreness, and acute muscular strains. Active video gaming activities often mimic those of traditional sports. As such, many injuries incurred are similar to those experienced by the nongaming athlete.

Activity intensity varies greatly among participants of various levels of fitness, interest, and age. Physical function and level of exertion vary greatly according to game type. Those games involving lower extremity activity offer more energy expenditure. Hand-held devices may increase injury risk for upper extremity, whereas use of dance mats and balance boards may lead to lower extremity injuries. The repetitive nature of esports mechanics and volume of continual motion predisposes the athlete to experience muscle soreness, muscle fatigue, and overuse injuries such as impingement, tendonitis, and apophysitis. The clinician must understand the nature of the game played, technique required to

TABLE 1. History and Physical Examination of Esports Athletes

<p>History</p>	<p>History to include medical, surgical, obstetrical/gynecological (for females), and psychiatric history. Personal/social history to include occupation/schooling and performance in those activities, home situation and significant others, sources of stress, leisure activities, sleep hygiene (use a validated sleep questionnaire such as the Pittsburgh Sleep Quality Index),¹⁶ exercise, and diet/nutrition habits. Screen for addictive behaviors with substances such as tobacco, alcohol, and illicit drugs by using a screening tool such as ASSIST.¹⁸ Esports athletes should also be screened for depression, anxiety, and gaming addiction. Family history, immunizations and screening tests, and complete review of systems.</p>
<p>Physical examination</p>	<p>Vision evaluation Assess the visual acuity and screen the visual fields. Evaluate position and alignment of the eyes and assess extraocular movements. Inspect the eyelids, sclera, and conjunctiva of each eye, cornea, iris, and lens. Compare the pupils and test their reactions to light. Assess the visual acuity using visual charts and phoropter. Perform the Vestibular Ocular Motor Screen. Assess near point of convergence to assess convergence amplitude. Assess near point of accommodation to assess accommodation amplitude. Perform fusional vergence by having the athlete read a line of print through a prism with increasing magnitude until the patient can no longer maintain a single image.¹⁷ Test smooth pursuit by having the patient follow an object moved across their full range of horizontal and vertical eye movements. Test saccades by holding 2 widely spaced targets in front of the patient (such as the examiner's thumb on one hand and index finger on the other) and asking the patient to look back and forth between the targets in the horizontal and vertical plane.¹⁹</p> <p>Musculoskeletal evaluation Use the Inspection, Palpation, Active Range of Motion, Strength, and Special Tests mnemonic to perform components of the examination.</p> <p>Ergonomic assessment Monitor placement, chair type and placement, desktop placement, keyboard/mouse/controller placement, and assessment of lighting.²⁰ Proper ergonomics evaluation and game station fitting can benefit esports athletes by reducing injury risks, improve quality of performance, and reducing stress injuries.²¹ There are a number of ergonomics assessment tools available in the public domain that have been developed by organizations such as the National Institute of Occupational Safety and Health²¹: WISHA Caution Zone Checklist and WISHA Hazard Zone Checklist; Lifting and Lowering Tasks: The NIOSH Lifting Equation; Entire Body Posture: Rapid Entire Body Assessment; Upper-Body Posture: Rapid Upper-Limb Assessment; and Hand-Arm Vibration Calculator.</p>

compete, and frequency and intensity of play to appreciate risks incurred by the esports athlete.

Postural and Kinetic Chain

Hours of video game use in the setting of awkward posture and intense concentration may result in sustained musculoskeletal disorders involving the posterior kinetic chain. Gamers who play at stations that are not ergonomically fit to their body size may experience acute or chronic neck, shoulder, and/or back pain. The initial complaint of diffuse pain during waking hours may progress through the posterior muscles of the neck, shoulders, and trunk. Pain or tightness may be reported with seated activities, such as use of screen devices during school, gaming, or social media. Diffuse posterior muscular pain with other daily activities can develop. Musculoskeletal examination often reveals slumped posture with anterior positioned shoulders because of weakened posterior scapular musculature, tight anterior pectoral muscles, and poor scapular control. Mild strength deficits may be present. Scapular winging may be prevalent on examination and pronounced with shoulder

abduction when performing simple maneuvers such as wall push-ups. Impingement signs may be positive as well.²²

Emerging data show that, within 30 minutes of competition, a decline in the vertical and upright seated position occurs.²³ A common deviation of this position includes forward head posture. For every one-inch migration of the head forward, an additional 10 pounds of torque force is required of the cervical extensor muscles.²³ This situation lends itself to the player developing what is known as upper crossed syndrome. Athletes exhibit weakness of the deep flexors of the neck including the lower trapezius and serratus anterior muscles while there is increased tension in the antagonist muscles of the pectorals, upper trapezius, levator scapulae, and sternocleidomastoid.²⁴ This affects the position of the scapula and glenoid fossa and can predispose the athlete to decreased glenohumeral joint stability.²⁵ The athlete frequently displays shoulders which are elevated and protracted while the scapulae appear rotated and abducted or winged. To counteract this, the levator scapulae and upper trapezius are more activated to maintain the central location of the humeral head in the glenoid fossa.²⁵ With this syndrome and posturing, the athlete can also exhibit an increased cervical lordosis and increased thoracic

kyphosis. Muscular imbalance develops leading to abnormal movement patterns and subsequent postural pain syndromes.²⁶

Overuse Injuries

Injuries incurred during esports are similar to the overuse injuries seen in any form of physical activity. Several case reports have described injury presentations associated with the use of various gaming consoles, volume of repetitive motion, and length of time playing a specific game. Injuries occurred with video games are similar to the injuries associated with the sport or activity encouraged by the particular AVG.

Tendonitis

Tendonitis is due to repetitive motion often associated with sudden increases in volume often with limited rest. Pain onset is typically insidious, worsens with continued gaming, and eventually remains after training. The tendon is tender to palpation, and muscle activation reproduces pain. Sites of lower extremity tendonitis are the Achilles or patellar tendon for dancing or running simulated activities. Upper extremity tendonitis may present at the supraspinatus tendon because of intense, repetitive shoulder activation required for baseball, boxing, tennis, or bowling games. Volar and extensor tendonitis of the elbow and wrist is also common with the use of hand-held devices. Extensor pollicis longus tendonitis may occur with increased thumb-activated game controller use.

Apophysitis

Active video gaming may cause apophysitis in youth athletes. Repetitive muscle activation produces tendon traction at the cartilaginous attachment site of the skeletally immature athlete. Esports athletes may be at increased risk of developing apophysitis because of the frequency, duration, and repetitive movement patterns produced during play. Participants of AVGs involving dance and running motions may experience lower extremity apophysitis such as Sinding–Larsen–Johansson Syndrome or Osgood–Schlatter or Sever Disease. Less commonly, upper extremity apophysitis may develop at the medial epicondyle of the elbow for athletes performing repeated bowling, tennis, and throwing motions.

Apophysitis is a clinical diagnosis with reported pain at the apophysis that increases with physical activity that may remain with cessation of sports and with activities of daily living. Common signs may include swelling and/or tenderness of the apophysis, pain at the apophysis with activation of the attached muscles, and decreased flexibility of the involved muscles. Range of motion is typically normal, but stretching the attached muscle may increase pain.

Anxiety/Mood/Sleep Issues

Mood and psychological well-being should be investigated. Exercise is associated with improving psychological mood states; however, there are few studies on the psychological benefits of AVG use. Individuals who participate in intense gaming may be at increased risk for mental health disorders because of the number of hours gaming without equal attention to emotional, social, and psychological development, especially during the critical period of adolescence.

Special attention should be given to adolescent gamers who forego participation in academic, social, and free-play activities as physical and psychological health may suffer.

The effect of video games on children's mental health should consider time spent playing video games, the effects of violent games, and their association with risk of suicidality, depression, addictive behavior, and inattention. Emerging evidence suggests that video games may exacerbate attention problems and produce harmful effects on cognitive control.²⁷ Some studies demonstrate that volume of time playing video games is associated with greater attention problems in childhood as displayed by weakening children's abilities to maintain focus on less entertaining tasks (ie, schoolwork).²⁸ Excessive computer game playing has been associated with addictive use across all age groups. Children with ADHD are especially vulnerable to addictive use of computer games. Moreover, excessive violent computer game playing may increase aggressive behavior in some youth populations.

Unique to the demands of esports, these athletes are subject to a condition called Internet Gaming Disorder. Criteria for diagnosis include five or more of the following in a 12-month period: preoccupation with internet games, withdrawal symptoms when internet gaming is taken away, tolerance, unsuccessful attempts to control participation in internet gaming, loss of interest in previous hobbies because of internet gaming (and not including internet gaming itself), continued use of internet gaming despite the knowledge of psychosocial problems, deception of others regarding the amount of time spent gaming, use of internet gaming to escape or relieve a negative mood, and jeopardized or loss of something of meaning (ie, job, relationship, educational, or career opportunity) because of internet gaming.²⁸

Bullying

Online gaming offers social interaction for many youth gamers; however, bullying and cyberbullying also exist. Cyberbullying delivers intentional harm directly to the victim through impersonation, threatening posts or threads, revealing explicit information, or by hacking into personal data. Indirect cyberbullying may involve group dislikes of posts or shares, creating a canceling culture, or through ignoring or excluding behaviors. Online gaming, mobile apps, and the internet create a medium of presumed anonymity whereby the victim may reveal personal information that then allows identification, victimization, and the delivery of aggressive behavior by the perpetrator. Individuals who participate massively multiplayer online role-playing games operate in larger social circles of increased exposure and vulnerability. Adolescent gamers who display symptoms of depression, suicidality, inattention, aggression, and/or sleep disturbance may be suffering from cyberbullying. Attention should be directed to the promotion of safe gaming environments to prevent bullying.²⁹

Aggression

Many children use games for emotional regulation, and a growing body of research is linking violent video game play to aggressive thoughts, feelings, and behaviors.²⁹ During cognitive, emotional, social, and neurological development, adolescents remain vulnerable to the influence of violent content. Most young adolescent boys and many girls routinely play M-rated games, and increased playing hours have been correlated with greater use of M-rated games.³⁰ The content and goals of

TABLE 2. Future Expansions of Esports Medicine

The esports medicine team	Outline the roles and responsibilities of the athletes, coaches, certified athletic trainers, physical and occupational therapists, nutritionists, strength and conditioning specialists, ophthalmologists, neuro/optometrists, sports psychologists/psychiatrists, and team physician, both primary care and orthopedic.
Preparticipation evaluation (PPE)	There are specific ergonomic, physical, and vision-based evaluations that could be assessed during a PPE for predisposing injury patterns before esports competition. Active video games (AVGs) should be placed in the PPE table “Classification of Sports by Physical Intensity.” We would recommend the following considerations: Potential classification of seated esports as an AI sport (<40% maximal O ₂ and <20% maximal voluntary contraction {MVC}) alongside billiards and riflery. Potential classification of AVG esports as an All sport (<40% maximal O ₂ and 20%-50% MVC) alongside archery, auto racing, and motorcycling.
Education	Athlete, parent, coach, and healthcare provider education regarding overtraining and concerns related to musculoskeletal health, ergonomics, nutrition, cardiovascular activity, vision, sleep health, psychological well-being, practice and competition duration, and team dynamics.
Mental health	An esports athlete’s career can involve pressure from competition and fan expectations, frequent international travel, and in some cases, living away from home for prolonged periods of time.
Mass participation event coverage	Esports tournaments are held in sold-out arenas and stadiums. This is considered a “mass participation event,” presenting unique challenges for medical professionals. In the era of COVID-19, mass touch points and potential aerosolized transmission of virus will necessitate the team physician develop safety protocols including masking, social distancing, and enhanced and frequent cleaning of touch-point surfaces and decisions about those allowed in the arena of play.
Performance enhancing substances	A future opportunity exists to decrease the use of addictive and potentially illegal substances, solidify the role of esports medicine involvement in esports, and promote the same expectations of athletic competition integrity as traditional sports.
Esports medicine research	Potential areas of esports research could include: (1) musculoskeletal injury awareness, diagnosis, treatment, and prevention; (2) ergonomic optimization; (3) esports vision screening and therapy; (4) esports health and wellness through nutrition strength and conditioning; (5) esports athlete longevity; and (6) esports performance assessment and enhancement.

M-rated games can vary considerably, with some rewarding for avoiding bloodshed while others require violent acts for advancement. Parents need to identify game content and environments that may promote aggressive behavior, increase fear, or desensitize children to violence and should note content shared between siblings because often older siblings introduce M-rated games to younger ones.³¹

Sleep Deficits

Adolescents routinely do not obtain the 8 to 9 hours of sleep as recommended by the National Sleep Foundation, and esports may disrupt appropriate sleeping behavior. Participation in private areas, such as bedrooms, is less supervised by parents and may lead to excessive play, play that disrupts sleep and/or academic work, and unsupervised choice of game selection.²⁹ Many children have electronic game devices and other media in their bedrooms with one study noting significant access to computers (31%) and video game consoles (46.2%).³⁰ In this study, children who had a computer, game console, and television in their bedroom were more than twice as likely to play 15 + hours per week and to play M-rated games.³⁰

Visual Issues

Prolonged use of screen time can lead to increased visual symptoms and the emerging phenomenon of “Digital Eye

Strain” (DES),¹⁹ also referred to as computer vision syndrome.^{32,33} This condition is a combination of eye and vision symptoms ranging from asthenopia, extraocular, ocular, and visual changes all resulting from prolonged screen use.

DIAGNOSTICS

Imaging modalities can help identify structural abnormalities that can be a source of pain or limitation in athletes. In addition, there are several indices and scales available to assist clinicians in identifying underlying or concomitant psychological conditions that affect the health and performance of athletes.

Plain radiographs using standardized views for specific regions are the recommended initial modality for musculoskeletal imaging.³⁴ Radiographs in skeletally immature patients can show an open apophysis at the location of pain. Bone scan aids in the diagnosis of stress injury because of its ability to detect metabolic changes in the bone before radiographic changes develop.³⁵ In addition, it can help differentiate between soft tissue and osseous pathology. However, despite its high sensitivity and negative predictive value, it cannot distinguish between stress reactions versus stress fractures.³⁵ Magnetic resonance imaging is more sensitive, with the ability to provide prognostic and diagnostic information.³⁵ Magnetic resonance imaging is also useful for the detection of cartilage and other soft tissue pathology, such

as tendon, ligament, and articular cartilage pathology.³⁴ Musculoskeletal ultrasound has become more available and accessible, especially regarding evaluating superficial tendons and ligaments.³⁴ In addition, it can be used in real time for dynamic assessments and to guide procedures such as injections.³⁴ Disadvantages include operator dependence and disproportionate access to musculoskeletal-trained radiologists to perform diagnostic evaluations.

A modality used to assess for the presence of functional pathology is electromyography (EMG), an electrodiagnostic study used to evaluate sources of pain, paresthesias, and weakness. It can be useful in assessing whether symptoms are due to myopathic or neurogenic causes.³⁶ In addition, the test can localize a lesion to a focal nerve, such as a peripheral entrapment, plexopathy, or radiculopathy.³⁷ Electromyography can also help determine chronicity of an injury.³⁸ Given the repetitive nature of movements performed in esports competition, EMG is a helpful modality in the detection and localization of nerve-related pathology.

In comparison to EMG, nerve conduction studies (NCSs) are used to assess for disorders of the peripheral nervous system, involving nerve roots, peripheral nerves, muscles, and the neuromuscular junction.³⁷ Nerve conduction studies are helpful with localization of an injury but do not yield much information about chronicity.³⁸ The main disadvantage of NCS is operator dependence, in both test execution and interpretation.³⁷ When used in conjunction with EMG, these electrodiagnostic studies can help distinguish between a neurogenic versus myopathic etiology.

Assessing for visual and oculomotor dysfunction in esports can be useful for identifying and treating underlying pathology. As such, the evaluation of DES can include the Vestibular Ocular Motor Screen. These assessments can be performed as part of the physical examination but are usually performed by an optometrist or by a neuro-optometrist, who has more expertise with oculomotor dysfunction, although their availability may be geographically limited. Visual movement disorders can have detrimental effects on an esports athlete's ability to process visual information quickly and accurately.

Esports athletes may be subject to psychological pathology that can affect performance. The Patient Health Questionnaire (PHQ)-2, followed by the PHQ-9 can screen for Major Depressive Disorder (MDD). The combination of the two tools versus the PHQ-9 alone had a similar sensitivity and higher specificity for detecting MDD.³⁹ The PHQ-9 can be used to subsequently monitor a patient's response to treatment.⁴⁰ Generalized Anxiety Disorder (GAD) can be screened using the GAD-2 and GAD-7 questionnaires, with the GAD-7 demonstrating a higher sensitivity and specificity for the detection of GAD with cut-off scores between 7 and 10 and the GAD-2 demonstrating a higher specificity and sensitivity with cut-off scores at 3.⁴¹ Internet Gaming Disorder can be screened using the Internet Gaming Disorder Scale 9-Short Form which can be used to make the diagnosis with good validity and reliability.⁴²

TREATMENT

Combined physical–cognitive training may be a beneficial therapeutic approach to the esports athlete.⁴³ Exertion levels can vary between game types and players depending on demographics, gaming intensity, and skill level.⁴⁴ Participants in competition have been shown to exhibit elevated heart rates

of 160 to 180 beats per minute.⁴³ Cardiovascular fitness training can improve the heart rate variability and respiratory rate. It can also enhance the cardiovascular endurance needed to achieve performance goals.

Ergonomics after extended use of computer or gaming systems can affect the respiratory system resulting in decreased amplitude of the diaphragm and decreased activation of the transverse abdominis.²⁶ Core and postural muscle strengthening can help mitigate these effects. Maintaining physiological spinal curvature while seated improves mobility of the chest and tidal volumes and decreases the frequency of postural pain syndromes.²⁶

Strength training is integral to building endurance and assist stability of the core and trunk musculature including various kinetic chains involved in the sport. Upper crossed syndrome can be treated by strengthening the weak musculature which includes the rhomboids, lower trapezius, and cervical flexors while relaxing the tight musculature by stretching or targeting myofascial release of the upper trapezius or pectorals. Specific strengthening exercises targeting scapular stabilization to promote normal humeroscapular motion can help treat this complication of upper crossed syndrome.

A study of professional and high-level esports athletes found that participants consider physical exercise to be helpful by promoting better health and a more active lifestyle.⁴⁵ This increases concentration, mood, and energy levels and helps focus during training and competition.⁴⁵ Combined physical and cognitive training triggers different metabolic brain pathways which can facilitate neuroplastic and plastic processes which enhance cognitive reserve.⁴³ This cognitive training through multisensory stimulation of the audiovisual or proprioception level can help with executive function for inhibition and flexibility.⁴³ The cognitive workload during esports demands various cognitive domains including attention, perception, information processing, and visual spatial skills.⁴³ A foundation of mental and psychological skills such as emotional regulation and attention control helps to achieve optimal performance.⁴³ The incorporation of calming and relaxation techniques such as yoga or breathing exercises can assist with anxiety, stress, and other psychophysiological, psychosomatic, and mental issues.⁴³ Regular breathing exercises increase parasympathetic tone, decrease sympathetic activity, and improve cardiovascular and respiratory function which decrease stress, thereby improving physical and mental health.⁴⁶ Developing mental strength can also counteract the effects of depression and burnout.⁴³ Addressing cognitive and behavioral performance can help with performance goals and social well-being.

Oculomotor system training optimizes performance as well. The increased saccadic movements, convergence, and accommodation as well as decreased blink rate associated with monitor viewing frequently fatigues the oculomotor system.³ Placing the center of the monitor 5 to 6 inches below the straight vision line at a distance of 20 to 28 inches away and limiting the amount of glare on the screen can help optimize performance.³ Retraining of the oculomotor system with vestibular rehabilitation exercises, proprioception training, and visual-spatial skills also aids the esports athlete. Incorporating eye exercises and regular breathing exercises (pranayama) have been shown to improve visual reaction time.⁴⁶ Such visual exercises include near and far focusing, shifting gaze, palming, and splashing.⁴⁶ Addressing refractive errors, astigmatism, and any accommodation or convergence disorders will also influence the oculomotor system.³

Sleep is an important factor that affects performance, physical health, emotional well-being, and recovery. Blue light emitted from screens can affect the sleep hygiene of athletes, so consider limiting exposure to these lights 30 minutes before bed and suggesting lenses that block blue light from the screen to help prevent eye strain.⁶⁰ Removal of electronic devices from the bedroom and use of dark mode can also improve sleep hygiene.

Physical and occupational therapy can prevent and treat injury.¹¹ The repetitive movements of the thumb and fingers involved with sustained gripping can lead to tendinosis or myofascial pain syndromes affecting the upper extremity and apophysitis in younger athletes. First-line treatments with injuries attributed to overuse include rest, icing, compression, elevation, consideration of nonsteroidal anti-inflammatory drugs or acetaminophen, and taping or bracing. One study looked at a 4-phase treatment model using a sequenced protocol over a 2- to 4-week period.⁴⁷ In Phase 1, therapists used soft tissue mobilization techniques. Phase 2 incorporated active and passive stretching of the upper extremity, hydrotherapy, ergonomic modification, and EMG biofeedback.⁴⁷ Phases 3 and 4 went on to focus on strengthening of the upper extremity, postural awareness, and retraining activities of daily living and a home program.⁴⁷ Postural considerations not only involve the core, back, and neck musculature but also should consider the impact of the lower extremity. For example, tight hamstrings can increase pelvic tilt, flattening the lumbar spine.⁴⁸

Osteopathic medicine integrates physical, mental, and social health to improve performance. As previously discussed, individualized exercise programs targeting cardiovascular and muscular training and attention to the ergonomics affecting posture are mainstays of a treatment approach to prevent chronic physical and psychological conditions. Using osteopathic manipulative medicine as a part of the treatment plan can help prevent and treat muscular imbalances, tissue texture changes seen with muscle tension, or address altered or restricted motion. Treatments can incorporate techniques targeting any pelvic tilt which affects the biomechanics of the lumbar spine which in turn can affect the thoracic and cervical spine. Upper and/or lower extremity somatic dysfunctions can also be targeted by osteopathic techniques targeting the upper and/or lower extremity kinetic chains.

PREVENTION

Eye Fatigue Prevention

Several interventions can minimize symptoms associated with computer vision syndrome. The esports athlete should be provided with a gaming station which has the center of the monitor 5 to 6 inches below the straight vision line at a distance of 20 to 28 inches away.^{3,49} The lights in the room should be modified to limit glare.³ Athletes should receive a periodic vision test and should be counseled and educated about the correction of eventual vision refractive errors, accommodation/convergence disorders, and astigmatism.⁵⁰ Esports athletes may also be instructed on exercises that reduce eye fatigue while they are gaming. These exercises include near-far focusing, palming, and the “20-20-20 rule” that instructs athletes to look 20 feet away for 20 seconds every 20 minutes.^{3,49,50}

Neck and Back Pain Prevention

Approximately 35% of collegiate esports athletes report neck or back pain while gaming.¹¹ Mechanical reasons are predominant in gamers and result from prolonged obligated posture while gaming. As with other reasons for back pain, a routine of strengthening and stretching exercise, assisted by a physical therapist or alone, is hugely beneficial.⁵¹⁻⁵³ Core-focused exercise, including back extension, rhomboids, balance training, and active and passive stretching, is a simple example.

Upper Extremity Dysfunction Prevention

To help prevent upper extremity injuries and decrease strain and stress when playing, correct posture and biomechanics should be emphasized. Splints and orthotics can be of use for forearm tendinopathy. More invasive treatment (ie, injection and surgery) is typically not needed as rest, and decreased gaming is suggested.

Sleep Hygiene

Sleep deprivation secondary to blue light from screen exposure is a consequence of the newer forms of monitor light emitting large amounts of blue light (440-500 nm), which leads to photochemical damage.⁵⁴ Research has also confirmed that screens of digital devices may interfere with children's sleep because of blue light emission,⁵⁵ which suppresses melatonin production,⁵⁶ negatively affecting circadian rhythms and cognitive performance.⁵⁷ This leads to a vicious circle of poor sleep hygiene because of excessive use of screen-enabled devices that are augmented by the circadian rhythm disruption.⁵⁸ Many athletes engage in play during night time because night playing can offer longer uninterrupted duration of play and is conducive to game genres which need dedicated time to organize multiple players.⁵⁹ This can severely affect the quality and quantity of sleep and should be monitored. As discussed, the use of blue light blocking glasses and a sleep hygiene plan can improve sleep duration and quality while reducing subjective alertness.⁶⁰

Guidelines

No widely accepted guidelines for esports training in athletes are published. It is advised that a child not train more hours per week than the child's age in years. Limiting the hours of participation or training in esports should be monitored with consideration given to age of the participant. The clinician should also discuss time spent away from esports participation to identify other interests. As with other athletics, periodization can be implemented between major competitions to help establish good habits in not just physical health but sleep and mental and emotional health as well. Periods of rest, other activities, and focusing on individual physical components of gaming can be beneficial for preventing many of the issues presented.

THE FUTURE OF ESPORTS MEDICINE

Sports medicine physicians will be crucial in integrating esports into a traditional sports medicine practice. Several

developments will be necessary to make this a reality. These developments are presented in Table 2.

Future research in esports will be critical. Minimal research has evaluated the use of electronic gaming devices or described the prevalence of injuries among AVG participants. Because AVG training and competition is increasing in young athletes, research should evaluate the injury rate and body mechanics during play, especially about adolescent development, to promote the guidelines specific to the esports athlete.

The future of esports and esports medicine will evolve but that future needs to be outlined, developed, and managed. Sports medicine physicians need to coordinate to build this future together for the legitimization and specialized care needed for esports athletes just like any other traditional sports athlete.

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