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A SYSTEMATIC REVIEW REGARDING THE IMPORTANCE OF PHYSICAL TRAINING IN E-SPORTS

Review Article

Beyza Akyüz  <https://orcid.org/0000-0001-9740-2177>
Faculty of Sports Sciences, Fenerbahçe University, İstanbul, Turkey
beyza.akyuz@fbu.edu.tr

Biodata:

Beyza Akyüz graduated from Middle East Technical University, Department of Physical Education and Sports Teaching. She is currently working as faculty member at Fenerbahçe University, Department of Coaching Education. Field of study is movement and training and exercise physiology.

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THE IMPORTANCE OF PHYSICAL TRAINING IN E-SPORTS

Beyza Akyüz

beyza.akyuz@fbu.edu.tr

Abstract

In this study, it is aimed to reveal the importance of physical training in e-sports. Today, with the development of technology, people have become sedentary and even carried the sports in their lives to the virtual world. E-sports is a good example of this subject. It is necessary to find an answer to the question of how this situation can be made healthier, taking into account the harm that may occur in terms of health, although it is a sport performed in the virtual environment and on the computer. At this point, the subject that should be emphasized is movement education and physical education. Physical and mental training is crucial important for e-sports players to continue their careers without losing their health. In this case, besides the technical training of the athletes, it is necessary to give importance to their mental and physical training and to add educational programs on awareness of health and performance. Articles about the requirements of e-sports, physiological and mental reflections of e-sports, negative and positive effects of e-sports on players' health, physical training, movement education and e-sports have been researched and compiled, and the importance of physical training in terms of e-sports has revealed. E-sports is a virtual competition between people and electronic games. In recent years, as the rapid development of technology and the place of digitalization in human life have increased, electronic games have taken their place in the world of sports and the number of both players and spectators has grown exponentially. This situation has created anxiety in terms of the health of the society, which is becoming more and more inactive with each passing day. In this case, the focus is to answer the question of how it can be made healthier for both the e-sports player and the society. At this point, we meet the concepts of movement training and physical training emerge. The inclusion of physical training in e-sports training and its regular implementation has critical importance.

Keywords: Physical training, E-sports, movement education, physical training in e-sports

1. Introduction

In recent years, with the rapid increase in digitalization in human life there has been a sharp transition to the online world. Especially during the coronavirus pandemic, countless people have been socially restricted, looking for new activities to spend their free time, socializing with friends, education and work, have started to take place online (Verdoodt et al.; 2021). Not only daily routines, but also sports have moved to the virtual environment. E-sports can be defined as competitive video games and it is accepted as sporting activity in 2017 by International Olympic Committee. Over 250 million viewers attracted by e-sports competition globally. (Zwibel, et. al., 2019). Compared to other sports branches, the fact that it is not compelling in terms of financial resources in terms of facility and equipment needs provides an increase in e-sports participants in terms of spectators or players every year. According to OECD reports in 2015, 34% of adolescences plays video games (OECD, 2017; Gordon, 2021) The growing popularity of e-sports or other video games has raised public health concerns about game consumption (Gibbs et al., 2018).

1.1. What are the requirements for esports and competitive video games?

When considering the requirements of e-sports it seems that it exceptionally demands fine motor skills, anticipation and eye-hand coordination (Kim et. al;2022, Verdoodth et. al;2018, Gibbs;2018). Anticipating a stimulus from opponent and react to it quickly and accurately is critically important for an e-sports player. Players should follow the visual informations from monitor and auditory information from headphones carefully and give response as soon as possible. Controlling the keyboard and mouse essential for successful performance so we can say that advanced perceptual motor skills are the key to success in e-sports (Pluss et al., 2020, McDermot et al., 2014).

1.2. Risks and opportunities of e-sports and competitive video gaming

There have been many studies in the literature investigating the effects of e-sports on human health. So there are two sides of the medal. Research findings indicate that some improvements have been observed in the cognitive strategies, fine motor skills, decision making, reaction time and anticipation time of e-sports players'. In addition, due to developing the spatial orientation abilities of players, they can rotate objects spatially in their minds. It has been observed that professional players have an earlier anticipating time and a wider visual perception range compared to novice players (Kim et al. (2022)).

On the other hands, e-sports have excessive gaming consumption, increased screen time and shortened physical activity time, manipulative effects of commercial content embedded in to gaming content are also serious problems especially for children' physical and mental (Verdoodt and Lievens, 2016; Donoghue and Balentine, 2022; Gümüşdağ, 2021). Due to inactivity of e-spors many e-spor players suffer from poor posture; thoracic kyphosis, pelvic tilt and musculoskeletal injuries in neck, back, wrist and upper extremity. Additionally, blue lights increase alertness and warn of sleep disturbance caused metabolic disturbance and mental health. In this case, the circadian rhythm of the players is interrupted (Zwibel, et. al., 2019; Legates et.al, 2015).

1.3. Life style perspectives and habits of e-spors players

Physical activity, proper nutrition, enough and good quality sleep, avoiding blue light emitting devices are necessary for both healthy life and optimal e-sport performance. On the contrary, daily routines and habits of e-sports players are somewhat far from this. Baumann et. al (2022) interviewed with 20 e-spor players about their life style perspectives and habits such as, sleeping, nutrition and energy drinks. According to survey results, players reported that the key point of their performance were their energy level and focus. However, many of them also reported sub-optimal lifestyle habits, skipping breakfast, lack of sleep, using blue light emitting devices before bedtime, and consuming energy drinks and 150 mg of caffeine per serving. These are factors that affect focus and the body's energy level. Because of the sedentary nature of e-sports, players spend long hours in front of the computer and remain inactive during training and competition time. Players do not take a standing break before 2 hours and focus on the screen for a long time. Therefore, they have vision syndrome. which is characterized by blurry vision, low back pain, and headache (DiFrancisco-Donoghue et al,

2019). In order to deal with this situation, it can be some arrangement about playing area. For example monitor should be 5 to 6 inches below the straight vision line and the distance should be 20 to 28 inches away. blink rate should decreased, glare should be limited in the room. On the other hand, pixel generated and low contrast caused strain on eye so it should rearranged (Akinbinu & Mashalla, 2014). Indeed, players can apply 20-20-20 rule” It means, that look 20 feet away for 20 seconds every 20 minutes (Akinbinu & Mashalla, 2014; Gosewade, 2013; Gosewade, 2016). DiFrancisco and Balentine (2018) studied on forty e-sports team players and study results showed that when the average players logs 3-4 h.d-1 of practice, advanced players spend time more than 10h.d-1 to prepare for competition. Because of intensive using of mouse or sitting many hours in front of computer some special orthopedic injuries such as carpal tunnel syndrome low back pain or spine problems are occurred in early ages.

E-sports players must anticipate faster than his/her opponents, attack or defend faster, and should have shorter reaction times. Reaction time is defined as the time between the onset of the stimulus and the response time of the organism to the stimulus and is an indicator of the central nervous system's ability to perceive the stimulus and synchronize the movement through the peripheral nervous system (Garg et. al, 2013; Kosinski, 2013). Donoghue (2019) stated in his study that inexperienced e-sports players perform 50 action movements per minute, while more experienced players perform 10 actions per second or 500-600 actions per minute. Therefore, having short reaction time increases the number of moves per minute, helping him/her to gain the advantage of being able to move faster against his opponent. E-sports players can compete either individually or as a team. As depending on the nature, games have different needs. For example, games like Counter Strike or League of Legends require both fine motor skills and advanced tactical understanding. In this case, the e-Sports player needs the cognitive performance to be able to read the game and attack by quickly deciding on the most appropriate tactical maneuver, as well as the motor skills to move quickly on the keyboard.

Being inactive and sitting at the same position for many hours causes health problems. 45% of players suffer from eye fatigue, 34% of players complained of neck and back pain. 27% of players complained from wrist and hand injury. In the 30 minutes of game forward displacement of the head is seen. In that position, cervicothoracic junction and paraspinal muscles stay under stress. (Gugliotti, 2028, Groszek, 2011). It also cause decrease in shoulder external rotator strength (Pheasant, 2018). Using keyboard at least 30-60 minutes can lead ulnar deviation and carpal tunnel syndrome (Toosi at.al., 2015). Because of the sedentary nature of e-sports, players come face to face more crucial problems such as deep vein thrombosis related with central vascular health. While gaming, sitting for a long time can damage spine and promote flattened lumbar lordosis, herniation and posterior pelvic tilt. In that case core training is very useful for strengthening abdominal and paraspinal muscles which is the piece of core muscle group. In addition to core training, stretching, strength training and osteopathic manipulative medicine should perform for postural control, improve range of motion and avoiding pain (Szczygiel et al., 2017; Zwibel, 2019). Mobilization training also help improve physical function. Moreover, digital playing can cause not only

musculoskeletal illness, dryness, pain and redness in eye but also mental problems such as aggression, anxiety, depression and sleep disorder in children Mustafaoğlu et al, 2018). Long hours of practice or competition times, keep players stressed. When considering the entire e-sports league, the negative effects of stress on players are also reflected in their health and performance. During periods when e-sports players cannot control their anxiety, it is seen that their social communication with each other is negatively affected by the team spirit and accordingly their performance decreases. If the reaction to the stress during the competition is understood, the situation can be adapted, the level of cognitive health can be improved, and thus performance can be increased (Table 1).

Table 1. E-sports Players Health Concerns, Cause and Interventions

Health Concern	Cause	Intervention
Visual syndrome	Reduced blink rate	Organization of gaming station
	Image pixelation	Limitation of glare
Neck and back dysfunction	Forward head displacement	Stretching
	Stress of Intervertebral disk and Cervicothoracic junction	Strength training
	Lattened lumbar lordosis	Osteopathic manipulative medicine Lumbar mobilization
Upper extremity dysfunction	flexor tendons of wrist hypertrophy	Fascial distortion of shoulder
		Carpal tunnel myofascial
Metabolic dysregulation	Duration of gaming	
	Exercise deficiency	10000 steps/day and 150 min moderate intensity exercise/week
	Energy drinks	
Circadian rhythm	Blue light	Blue light blocking lens
	Gameplay timing	Shygiene counselingleep
Mental health	Anxiety	Anxiety outcome Scale
	Depression	Patient health questionnaire

Zwibel, DiFrancisco-Donoghue, DeFeo, & Yao, (2019)

1.4. The importance physical training in e-sports

The positive effects of exercise on the health of individuals have been proven by years of scientific studies, and a consensus has been reached that exercise is the cheapest and most effective way to protect and improve health. The first study in this area was carried out by Moris et al in 1953, and it was determined that the risk of coronary heart disease and mortality in those who work at a desk in an inactive manner is higher than the individuals with an active and physically active working life. In addition, it has been found in many studies that exercise has an effect on increasing red blood cells and improving the immune system, as well as increasing the number of hematopoietic (blood-forming) stem cells in the bone marrow and muscle-related stem cells in skeletal muscles (Pedersen ve ark; 1999; Wei, 2015). E-sports players spend long hours inactively in front of the screen, experience sleep disorders, and are exposed to intense stress. All these are factors that threaten health and lower immunity. In this case, it is critical for e-sports players to train physically and organize their training programs within this framework for the protection of health and the continuity of performance.

The World Health Organization (WHO), American Heart Association (AHA) and American College of Cardiology (ACC) recommend sedentary individuals to do moderate-intensity exercise for a total of 150 minutes, 30 minutes a day, 5 days a week, to maintain health. The activity duration and intensity recommended for individuals between the ages of 5-17 have been included in the literature as 60 minutes of moderate or vigorous exercise per day (WHO, 2019; Wei, 2015). Since e-sports players are not physically active, they can actually be considered sedentary in terms of activity level. Therefore, they should exercise at least at the level prescribed by the WHO, AHA and ACC. It has been observed that aerobic type of training causes an increase in gray and white matter in the brain, and positively affects the cognitive performance and decision-making mechanisms of individuals (Colcombe, 2006; Hogan, 2013; Chang,2012)

In addition to the physiological effects of exercise on human health, there are contributions to mental health. Studies have shown that exercise increases the level of serotonin, which is an important neurotransmitter and is responsible for carrying electrical signals between nerve cells, by showing the effect of some antidepressant drugs. In a study conducted with firefighters from a stressful profession, it was observed that lower heart rate and blood pressure, and lower anxiety and negative mood reactions developed after a 16-week exercise program (Otto, 2011). In addition to the physiological and psychological positive effects of exercise in reducing stress, anxiety and depression, which have been proven by scientific studies, if the effective role of exercise in providing social integration is considered, the physical training that will be applied regularly to e-sports player who try to provide optimal performance under such pressure and stress will result in positive results. will bring.

Serotonin also controls the circadian rhythm and has positive effects on happiness, vitality, learning and memory. In case of deficiency, it causes mental disorders such as

depression and irritability (Donoghue, 2019). The increase in the amount of serotonin also provides positive mood, digestion and sleep patterns of people (Otto & Smits, 2011). This is one of the factors that play an important role in increasing the physical and mental health and sportive performance of esports players who are exposed to high levels of anxiety and stress due to being inactive for a long time and irregular sleep periods. In addition, in a study conducted on children, it was proven that moderate-intensity aerobic exercises increase children's cognitive and self-control abilities, while they focus more on learning (Pan, 2018).

Kari (2016) examined the participation levels of the players in the exercise program in his study on 115 elite e-sports players, and found that 81% of the e-sports players had an exercise program and that the majority of the players created their own programs and did not receive professional help in planning the training program. In another study, e-athletes were asked whether they did physical exercise and 24% of the athletes stated that they did not do any exercise, and 30% stated that they tried to exercise for 30-60 minutes several times a week (Donoghue and Balentine, 2018).

In addition, Donoghue (2018) in his research on 65 e-sports players stated that e-sports players spend an average of 1.08 hours a day for physical activity, while 40% of the athletes do not participate in any physical activity. As can be understood from the findings of the studies, some of these athletes do not exercise at all, while those who state that they exercise do not receive any professional support during the creation and implementation of their training programs and manage this process with their own efforts. In the same study, when it was questioned whether the exercise program of the players had an effect on their e-Sports performance, 16.5% of the e-Athletes were definitely positively affected, 39.1% were positively affected, 18.3% were physical activity had no effect on their performance, and finally 4.4%. It was reported that ten of them had statements that they were negatively affected. Regular physical training should be provided and the training program should be followed. If the content and volume and intensity of the training is left to the athlete's own initiative, the athlete may not be able to stick to the program in terms of regular practice. In addition, the content of the training may be insufficient for the target to be achieved. In this situation, with the professional support to be received, the physical and mental evaluation of the athlete can be made, the appropriate training program can be planned, implemented and followed.

In the study conducted to examine the heart rates and cortisol hormone levels of esports players during the competition, it was determined that the heart rates of the players were 160-180 beats per minute, while the cortisol levels were high. According to this result, it has been determined that e-sports players also show physiological changes similar to other traditional sports as a result of stress and anxiety experienced during the competition (Schultz, 2016). Koshy et. al investigated the physiological parameters of e-sports players such as, heart rate, respiratory rate and they reported that the both parameters higher in the winning team. Therefore, it is necessary to improve the cardiovascular endurance of e-sports players with the training to be applied. Although it is not a type of sport in which the whole body is active during training and

competition, physical training should be regularly included in the training program of e-sports players in order to protect health and provide healthy responses to physiological changes. Beyond the developing motor skills or cognitive strategies for performance that's exactly why they should get them to physical exercise training in daily routine.

1.5. What kind of training program should be implemented?

In addition to the technical training of e-sports players on the computer, getting professional support from an expert coach will provide great benefits to e-sports players in terms of both protecting health and improving physical and mental performance. Players needs some special training such as, core training, cardiovascular training, strength training, mobility training and stretching.

The core region is the center of the body and provides transferring force to the extremities. The core muscle group consist of the abdominal muscles, the erector spinae, lumbar multifidus, and quadratus lumborum, the diaphragm, the pelvic floor and the iliac psoas. Strengthenig core muscle groups hold the body upright and not only reduces the possibility of spinal cord injuries but also provide postural stability (Akuthota & Nadler, 2004; Oliva-Lozano & Muyor, 2020). On the other hand, stretching and strengthening for the elbow, forearm, wrist, and hand to maintain appropriate alignment while not sacrificing speed of action. Hand-eye coordination, strong wrist and fingers in order to be able to control different keys on the keyboard as fast as possible with both hands in order to attack or defend against the opponent at the same time. In addition, range of motion exercises reduce the risk of ulnar and carpal tunnel syndromes.

When inactivity, sleep disturbance and malnutrition come together, they prevent the organism from continuing its existence in a healthy way and create a threat for immune system and life. Cardiorespiratory fitness is a strong predictor for morbidity and mortality. Because of the nature of e-sports players have three of all factors and some serious illness like heart attack, diabetus mellitus or hypertension compose to big risk because of this kind of life conditions (Emara et. Al, 2020). So, application of cardiorespiratory trainings are crucial in this respect. At least 3-4 day a week and 20-40 minute cardiovascular exercise (at moderate intensity) should be done by players. In addition, before starting the game, 5 minutes of stretching for warm-up purposes, 5 to 10 minutes breaks every hour and 20 minutes breaks every 3 hours are recommended in order to relieve the stress of the players, increase blood circulation and provide full body mobility.

2. Discussion and Conclusions

As a result, e-sports players who are criticized for the time spent with virtual environment and lack of physical activity, in order to protect their health from diseases caused by inactivity, to enable them to be fitter and more energetic, to perform optimally in

front of the screen for hours, in a very short time. Improving mental health is critical for the success of the esports player, in order to improve cognitive performance and facilitate coping with stress in order to develop motor skills in order to implement the necessary moves and tactical maneuvers, and to be able to easily solve the game and make quick decisions.

In order to meet all these needs, the esports player needs to include physical training programs in their daily routines as well as their technical training for the game. It is extremely important to get professional help in the planning, implementation and evaluation of physical trainings, both to ensure that the esports player continues the program, and to perform an efficient training by establishing the correct training planning and the appropriate duration, frequency and intensity relationship.

In the light of all these, physical training will play an important role in ensuring that the players aim to improve their cognitive abilities along with their technical skills, have advantages such as easier and faster analysis of the game, quick decision-making, and thus reach optimal performance.

3. Recommendations

The necessity of physical training in order to protect the health of the players and increase their performance in e-sports, which is rapidly gaining popularity in the digital world, was emphasized in this study. Although there are many studies addressing different aspects of e-sports, studies on the content of physical training are insufficient. In order to protect the physical and mental health of e-sports players and to increase their performance, there is a need for more detailed studies that will focus on the necessary physical training.

Table 2. Healthy Application Recommendations for E-sports

Parameters	Recommendations
Musculoskeletal	Stretching whole body during gaming time Flexion, ekstansion, rotation of cervical, toracic and spine Strengthening cervical and core muscles Maintain appropriate postüre Sitting at the right angle in terms of eye, spine, elbow and wrist
Vision	Following the rule of 20-20-20 Limitation of continous gaming sesions Avoiding blue light for a long time Organizing glare, contrast and pixel generation
Auditory	Avoiding exposure to sound above 100 decibels for more than 15 minutes

	Maintaining volume within 60-80 decibell
	Audiology evaluation in terms of tinnitus or hearing difficulties
Psychomotor	Reaction time, psychomotor speed, anticipation time evaluation and training
Cardiorespiratory fitness	Doing cardiorespiratuary fitness training
	20 to 40 minute moderate itensity level of exercise, 3-4 day/week Resistance training at least 2 day/week
	Whole body strengthenig exercise
	Core exercise
Nutrition	2500 calories for men and 2000 calories for women
	Avoiding dehydration
	Avoiding more sugar and caffein
Cognitive and psychological	Engaging healthy social interaction Regular exercise for endorphine secretion Taking time to socialize

Emaara, 2020

Table 2 illustrates recommendations for the parameters, such as Musculoskeletal, Vision, Auditory, Psychomotor, Cardiorespiratory fitness, Nutrition and Cognitive and psychological.

References

- Akinbinu TR, Mashalla YJ. Impact of computer technology on health: computer vision syndrome (CVS). *Med Practice Rev.* 2014;5(3):20-30. doi:10.5897/MPR2013.0121
- Akuthota, V.; Nadler, S.F. Core strengthening. *Arch. Phys. Med. Rehabil.* 2004, 85, S86–S92
- Baumann, A., Mentzoni, R. A., Erevik, E., & Pallesen, S. (2022). A qualitative study on Norwegian esports students' sleep, nutritional and physical activity habits and the link to health and performance. *International Journal of Esports*, 2(2).
- Burgess, H. J., & Fogg, L. F. (2008). Individual differences in the amount and timing of salivary melatonin secretion. *PloS one*, 3(8), e3055. DOI 10.1371/journal.pone/0003055
- Chang, Y. K., Labban, J. D., Gapin, J. I., & Etnier, J. L. (2012). The effects of acute exercise on cognitive performance: a meta-analysis. *Brain research*, 1453, 87-101. DOI 10.1016/j.brainres.2012.02.068
- Colcombe, S. J., Erickson, K. I., Scalf, P. E., Kim, J. S., Prakash, R., McAuley, E., & Kramer, A. F. (2006). Aerobic exercise training increases brain volume in aging humans. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, 61(11), 1166-1170. DOI 10.1093/gerona/61.11.1166.
- DiFrancisco-Donoghue, J., & Balentine, J. R. (2018). Collegiate eSport: where do we fit in?. *Current sports medicine reports*, 17(4), 117-118.
- DiFrancisco-Donoghue, J., Balentine, J., Schmidt, G., & Zwibel, H. (2019). Managing the health of the eSport athlete: an integrated health management model. *BMJ open sport & exercise medicine*, 5(1), 1-6. DOI 10.1136/bmjsem-2018-000467
- De Lisio, M., Parise, G. (2012). Characterization of the effects of exercise training on hematopoietic stem cell quantity and function. *Journal of Applied Physiology*, 113(10), 1576-1584. DOI 10.1152/jappphysiol.00717.2012
- Donoghue, J. (2020). An observation of common physiological parameters during esports activity. *International Journal of Esports*, 1(1).
- Emara, A. K., Ng, M. K., Cruickshank, J. A., Kampert, M. W., Piuze, N. S., Schaffer, J. L., & King, D. (2020). Gamer's health guide: optimizing performance, recognizing hazards, and promoting wellness in esports. *Current Sports Medicine Reports*, 19(12), 537-545.
- Garg, M., Lata, H., Walia, L., & Goyal, O. (2013). Effect of aerobic exercise on auditory and visual reaction times: a prospective study. *Indian J Physiol Pharmacol*, 57(2), 138-145.

Gibbs, M., Carter, M., Cumming, D., Fordyce, R. and Witkowski, E., (2018).“ Esports Spectatorship in Australia”, Networked Society Institute research Paper, Melbourne: University of Melbourne, australia-nsi_gibbs_carter_cumming_fordyce_witkowski_2018.pdf.

Gordon, F. (2021). Research Report-Online Harms Experienced by Children and Young People: ‘Acceptable Use’ and Regulation. London: Catch22, 2021, 1-113.

Gosewade NB, Shende VS, Kashalikar SJ. (2013). Effect of various eye exercise techniques along with pranayama on visual reaction time: a case control study. J Clin Diagn Res.;7(9):1870-1873.

doi:10.7860/JCDR/2013/6324.3338

Gosewade N, Drugkar A, Shende V. Effect of pranayama and eye exercises on visual acuity of medical students: a case control study. Int J Contemp Med Res. 2016;3(4):1133-1136.

Groszek M, Babula G, Nagraba Ł, Stolarczyk A, Mitek T. Risks connected with a wrong sitting position. Arthroscopy Joint Surg. 2011;7(3-4):50-61.

Gugliotti M. Contribution of aberrant postures to neck pain and headaches in esport athletes. Res Inves Sports Med. 2018;3(1):1-2. doi:10.31031/RISM.2018.03.000554

Gümüşdağ, H., Aydoğan, M., & Salehian, M. (2021). E-Spor and Health. *Pakistan Journal of Medical & Health Sciences*, 15(4).

Hogan, C. L., Mata, J., & Carstensen, L. L. (2013). Exercise holds immediate benefits for affect and cognition in younger and older adults. *Psychology and aging*, 28(2), 587.

Kari, T., Karhulahti, V. M. (2016). Do E-Athletes Move?: A Study on Training and Physical Exercise in Elite E-Sports. *International Journal of Gaming and Computer-Mediated Simulations (IJGCMS)*, 8(4), 53-66. DOI 10.4018/IJGCMS.2016100104

Kim, H., Kim, S., & Wu, J. (2022). Perceptual-Motor Abilities of Professional Esports Gamers and Amateurs. *Journal of Electronic Gaming and Esports*, 1(aop), 1-6.

Koshy, A., Cironis, L., McVey, M., Sousa, A., Ahmad, S. L., Hassan, T., & DiFrancisco-Donoghue, J. (2020). An observation of common physiological parameters during esports activity. *International Journal of Esports*, 1(1)

Kosinski, Robert J. A Literature Review on Reaction Time. Clemson University, Sept. 2013. Web. 7 Feb. 2014.

McDermott, A.F., Bavelier, D., & Green, C.S. (2014). Memory abilities in action video game players. *Computers in Human Behavior*, 34, 69–78.

LeGates TA, Fernandez DC, Hattar S. Light as a central modulator of circadian rhythms, sleep and affect. *Nat Rev Neurosci*. 2014;15 (7):443-454. doi:10.1038/nrn3743

- Morris, J. N., Heady, J. A., Raffle, P. A. B., Roberts, C. G., & Parks, J. W. (1953). Coronary heart-disease and physical activity of work. *The Lancet*, 262(6796), 1111-1120. DOI 10.1016/S0140-6736(53)91495-0
- Murphy S. Video games, competition and exercise: A new opportunity for sport psychologists? *The Sport Psychologist* 2009;23(4):487-503.
- Mustafaoğlu R, Yasacı Z.(2018). Dijital oyun oynamanın çocukların ruhsal ve fiziksel sağlığı üzerine olumsuz etkileri. *Bağımlılık Dergisi* ; 19(3):51-58.
- OECD, *PISA 2015 Results (Volume III): Students' Well-Being* (Paris: oecd Publishing, 2017).
- Oliva-Lozano, J. M., & Muyor, J. M. (2020). Core muscle activity during physical fitness exercises: A systematic review. *International journal of environmental research and public health*, 17(12), 4306.
- Otto, M., Smits, J., & Smits, J. A. (2011). *Exercise for mood and anxiety: Proven strategies for overcoming depression and enhancing well-being*. OUP USA.
- Pan, T. (2018). Study on the influence of exercise on children's cognitive learning ability. *Educational Sciences: Theory and Practice*, 18(5), 1940-1947. DOI 10.12738/estp.2018.5.093.
- Pedersen, B. K., Bruunsgaard, H., Jensen, M., Toft, A. D., Hansen, H., & Ostrowski, K. (1999). Exercise and the immune system-influence of nutrition and ageing. *Journal of science and medicine in sport*, 2(3), 234-252. DOI 10.1016/S1440-2440(99)80176-5.
- Pheasant S, Haydt R, Gottstein T, et al. Shoulder external rotator strength in response to various sitting postures: a controlled study. *Int J Sports Phys Ther*. 2018;13(1):50-57. doi:10.26603/ijsp20180050
- Pluss, M.A., Novak, A.R., Bennett, K.J.M., Panchuk, D., Coutts, A.J., & Fransen, J. (2020). Perceptual-motor abilities underlying expertise in esports. *Journal of Expertise*, 3(2), 133–143.
- Schütz, M. (2016). Science shows that eSports professionals are real athletes. *Deutsche Welle*.
- Shinkle, J.; Nesser, T.W.; Demchak, T.J.; McMannus, D.M. Effect of core strength on the measure of power in the extremities. *J. Strength Cond. Res*. 2012, 26, 373–380.
- Szczygieł E, Zielonka K, Mętel S, Golec J. Musculo-skeletal and pulmonary effects of sitting position—a systematic review. *Ann Agric Environ Med*. 2017;24(1):8-12. doi:10.5604/1231966.1227647
- Toosi KK, Hogaboom NS, Oyster ML, et al. Computer keyboarding biomechanics and acute changes in median nerve indicative of carpal tunnel syndrome. *Clin Biomech*. 2015;30(6):546-550. doi:10.1016/j.

clinbiomech.2015.04.008

Verdoodt, V., Clifford, D. and Lievens, E., “Toying with children’s emotions, the new game in town?”, *Computer Law and Security Review*, 2016, 599–614.

Verdoodt, V., Fordyce, R., Archbold, L., Gordon, F., & Clifford, D. (2021). Esports and the Platforming of Child’s Play During covid-19. *The International Journal of Children's Rights*, 29(2), 496-520.

Wei, X., Liu, X., & Rosenzweig, A. (2015). What do we know about the cardiac benefits of exercise?. *Trends in cardiovascular medicine*, 25(6), 529-536. DOI 10.1016/j.tcm.2014.12.014

Zwibel, H., DiFrancisco-Donoghue, J., DeFeo, A., & Yao, S. (2019). An osteopathic physician's approach to the Esports athlete. *Journal of Osteopathic Medicine*, 119(11), 756-762.