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Leveling Up Esports Health: Current Status and Call to Action

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Abstract

Esports is growing at an exponential rate. While there are benefits to playing esports, little is known about the long-term health implications. This article reviews the current state of esports health-related research, focusing on physical health (i.e., physical activity, musculoskeletal injuries, eye health), sleep, nutrition, performance-enhancing drugs, and mental health (i.e., gaming disorder, emotional regulation). It identifies areas of interest with a call to action for all stakeholders within the esports ecosystem, providing a short list of recommendations to consider based on the current literature. Future research should utilize both quantitative and qualitative methods, with a particular emphasis on longitudinal and large-scale studies using validated tools to fully explore the association between esports and health.

Keywords: esports medicine, wellness, health promotion, physical health, mental health

Highlights:

- Much of the current esports health-related research focuses on players' physical activity and sedentary behavior patterns.
- Other major, but under researched, esports health concerns surround player injuries, sleep, nutrition, and performance-enhancing drug use.
- Many of the health concerns such as performance enhancing drugs require input from game publishers and tournament organizers for regulation to take place
- The health issues present in esports suggest significant value in regular health checks for competition level players.

Introduction

Esports, also known as organized competitive video gaming (Jenny et al., 2017), is a $25 USD billion-dollar, global industry growing at an exponential rate (Ahn et al., 2020). However, to date it seems that the industry's growth overshadows the health and well-being of the players. The lack of attention to health is problematic, potentially limiting its future growth or legitimacy as a global sport. For example, the International Olympic Committee (IOC) recognized the potential of virtual and simulated sports to engage younger audiences in the Olympic movement, but the IOC recognizes the challenges of incorporating elite esports and aims to continue to explore ways of supporting it (IOC, 2020). Moreover, research into formalized esports health-related academic programming worldwide reveals that no found programs (n = 115) focus on esports health or medicine, with only 1% of curriculum modules incorporating esports health/medicine content (Jenny, 2021; Jenny, Gawrysiak et al., 2021; Scott et al., 2021).

While there are benefits to playing esports, little is known about the long-term health implications. Whilst organizations such as the Esports Research Network (2021) has started to assist in this regard, the lack of research is troublesome because the nature of esports exposes players to physical and psychological risks, such as competing in competitive environments, prolonged sitting sessions, repetitive fine motor movements, and lucrative reward systems inherent in esports (Chung et al., 2020).

Methodology

This narrative review article explores the current state of esports health-related research and offers a call to action for all stakeholders within the esports ecosystem.

The literature search was conducted between December 2020 to March 2021. We utilized references relating to the physical and mental health of esports players, including: peer-review journals, conference proceedings, theses and dissertations, industry publications, Google Scholar and PubMed. Keyword search terms included: esport* OR e-sport* OR electronic sport* AND health OR exercise OR physical activity OR physical OR training OR injur* OR sleep OR nutrition OR supplement* OR hydration OR doping OR PED* OR drug* OR addicti* OR medicine OR mental OR emotional OR wellness. In addition, we reviewed the reference lists of each article for additional sources. For industry publications, we searched two leading esports websites focused on esports news and trends – Esports Observer and Esports Insider. Prior to inclusion, we read, scrutinized, and discussed the sources for their objectiveness, accuracy, and usefulness to the esports community.

Physical Activity

Much of esports health-related research focuses on physical activity. This may be due to esports being largely a sedentary activity. Likely as a result, the majority of esports players suffer from limited physical activity (Yin et al., 2020). DiFrancisco-Donoghue and colleagues (2019) found among their sample of 65 collegiate varsity esports players that less than 40% do not partake in any form of physical activity outside of gaming and 15% reported 3 or more hours of sitting without standing to take a break.

Physical inactivity is a concern because it can contribute to and/or amplify many negative health outcomes observed within the esports community. For example, esports players may be at a higher risk of developing metabolic disorders from having less lean body mass, higher body fat and lower bone mineral content compared to non-esports players (DiFrancisco-Donoghue et al., 2020; Yin et al., 2020). In addition, Andre et al. (2020) observed the heart rate change before, during and after esports competition in team members of a university team. They found that mean heart rate increased significantly during esports activity, with mean peak heart rate reaching 188 ± 33 bpm. This result is potentially problematic for esports athletes because it is likely increased heart rate while gaming is likely due to psychological stress alone and the gaming may fail to provide any of the metabolic benefits of traditional exercise (i.e., elevated energy expenditure combined with an adequate cardiovascular response). Psychological stress activates the sympathetic nervous system, but if there is no adequate physical activity to relieve the "flight or fight" symptoms, then over time, this state can lead to several stress-related illnesses like hypertension and insulin resistance (Lambert & Lambert, 2011).

While improved regular physical activity can address the negative health outcomes, they can also improve performance. De Las Heras et al (2020) found that a short bout of high-intensity cardiovascular exercise prior to playing the video game League of Legends improved performance by 17% (e.g., increased accuracy and more targets eliminated) compared to rest in a randomized counter-balanced study design (n = 20). Similarly, a pilot study found a positive correlation between physical exercise and esports performance as well as a potentially moderating effect of mental toughness on the relationship of frequency of exercise and esports performance with amateur Fortnite: Solo players (Stamatis et al., 2019). Certainly, more research is needed, but a positive relationship between exercise frequency and esports performance is not surprising as players have been reported to exhibit significantly elevated peak heart rates during competition (e.g., 188 ± 33 bpm, Andre et al., 2020; 85-137 bpm, Haupt et al., 2021) compared pre- and post-competition rates and physical conditioning may assist these players in coping with high stressful gaming situations.

In addition, Toth et al. (2020) found that regular exercise can help improve the cognitive aspects of esports performance like attention, task-switching, information processing, and memory ability. Similarly, in a randomized repeated-measures design, DiFrancisco-Donoghue et al. (2021) found that breaking up two hours of gaming with a six minute walk in the middle improves executive function in ranked male and female first-person shooter (FPS) esports players compared to six minute supine rest break and continuous game play (i.e., no break) conditions without impacting FPS gaming performance (i.e., kill/death ratio or games won/lost). Moreover, in this study, over half of the sample preferred the walk break over the other two conditions and nearly 75% of sample perceived that the six minute walk "positively helped" their gaming performance. In fact, esports players ranked in the top 10% may be more physically active than the remaining players (Trotter et al., 2020). Although the results do not indicate a direct causation, it should cause players to reflect on their physical activity habits especially because the current culture of esports does not appear to embrace physical activity. In fact, Nagorsky and Wiemeyer (2020) found that the majority of esports players across various games do not see physical fitness as beneficial to their performance. Paralleling this perception, Polman and colleagues (2018) recommend developing a fitness mindset; teaching young players how being physically fit and athletic will not only improve health, but also esports performance. Regardless of the strategy, changing the sedentary culture will take time and intention from all stakeholders (e.g., players, coaches, organizations).

Musculoskeletal Injuries

Esports players have reported playing on average up to 10 hours per day (DiFrancisco-Donoghue et al., 2019). This alone is alarming as, independent of physical activity, spending over 6 to 8 hours seated per day or watching more than 3 to 4 hours of television per day significantly increases the risk for all-cause and cardiovascular disease mortality (Patterson et al., 2018). Moreover, high-level game play requires fast, precise, repetitive fine motor movements involving primarily the shoulder, arm, hands and fingers. Elite esports players can perform in excess 500 actions per minute (APM), which include input of the mouse or keyboard during game play (Zwibel et al., 2019).

Esports players can also suffer from overuse injuries and musculoskeletal pain in the neck, back, shoulder, hand, and wrist (DiFrancisco-Donoghue et al., 2019; Hwu, 2020; Lindberg et al., 2020). As seen in Table 1, the combined reported total of neck and back pain for both DiFrancisco-Donoghue et al. (2019) and Lindberg (2020) is nearly identical: 42% versus 43%, respectively, with similar statistics of combined reported hand and wrist pain found by Hwu (2020) and DiFrancisco-Donoghue et al. (2019): 66% versus 68%, respectively. Based upon the diverse way these researchers combined various musculoskeletal injury/pain sites, it is difficult to collate and extrapolate the data further.

Table 1 - Top Reported Musculoskeletal Pain/Injury Sites for Esports Players

Study	Sample	Top Reported Pain/Injury Sites
DiFrancisco-Donoghue et al. (2019)	United States Collegiate Esports Players (n = 65)	Neck/Back (42%) Wrist (36%) Hand (32%)
Hwu (2020)	Esports Injuries Treated by 1HP in 2020 (n = 132)	Wrist/Hand (66%) Shoulder (18%) Neck (6%) Low-back (5%) Mid-back (2%)
Lindberg et al. (2020)	Danish Esports Players (n = 188)	Back (31%) Neck (11%) Shoulder (11%)

Interestingly, only 2% of these players sought medical attention for negative health outcomes (DiFrancisco-Donoghue et al., 2019). 1HP (Hwu, 2020), a collective of esports medical professionals, claimed to treat 132 esports injuries in 2020 and diagnosed zero cases of carpal tunnel syndrome (CTS). It is possible CTS is over-diagnosed in esports players by medical professionals unfamiliar with esports, as the majority of wrist/hand injuries treated by 1HP were diagnosed as extensor digitorum tendinopathy. Moreover, Hwu's (2020) low numbers of treatment for back and neck pain may be due to 1HP staff primarily being physical therapists, and esports players may have sought treatment for this type pain with chiropractors instead. Lastly, Lindberg et al. (2020) found 32% of sampled Danish esports athletes reported pain at one site, 27% at two sites, and 9% at three different sites.

There are many factors that may impact mechanism of injury for esports players, which could result from issues such as poor posture and ergonomics (Lindberg et al., 2020; Zwibel et al., 2019),

grip-style of the mouse (Ivanova, 2020), long duration of static seated positioning (Zwibel et al., 2019), repetitive upper extremity actions (DiFrancisco-Donoghue et al., 2019), and lifestyle factors (i.e., lack of physical activity, poor nutrition, etc.) that could lead to metabolic dysregulation (Zwibel et al., 2019). Moreover, Ivanova (2020) found that in a small sample of esports players, the symptom of burning in the mouse hand/wrist increased proportionally to mouse distance traveled, indicating that those using a lower mouse sensitivity may be more susceptible to wrist/hand pain. Overall, those who report more musculoskeletal pain often play less esports, most likely due to the pain negatively impacting esports participation (Ivanova, 2020; Lindberg et al., 2020).

Certainly, more research is needed surrounding esports injuries and the most effective esports injury prevention strategies. The existing empirical knowledge specific to esports medicine is nearly non-existent and certainly should be approached on a case-by-case basis specific to the individual and precise injury, but common methods to prevent esports-specific musculoskeletal injuries include gaming posture and ergonomics, gaming-specific physical warm-up and cool-down exercises, frequent and intermittent activity breaks while gaming, proper hydration and nutrition, regular general physical activity (cardiovascular, muscular strength/endurance, and flexibility), esports-specific strength and mobility training, regulated esports training schedules that monitor potential repetitive overuse symptoms, adequate sleep, and preventative massage therapy. Finally, Marsh et al. (2020) suggests tracking esports player general recovery and fatigue through monitoring heart rate variability, which is commonly utilized with traditional sports athletes.

Eye Health

Esports are highly visual activities due to the several areas of interest in these games at any given time that often occur in short periods at rapid succession. Early studies have shown that using a computer dramatically reduces the blink rate by a factor of 3 to 5 from rest (Patel, 1991; Tsubota, 1993). Whilst playing video games have been found to increase general eye movements to a target (Mack et al., 2014), playing too closely to the screen or over prolonged periods without breaks is associated with eye injury. DiFrancisco-Donoghue et al. (2019) found that the most commonly reported non-musculoskeletal medical malady of collegiate esports players was eye fatigue (56%).

Unsurprisingly, prolonged visual attention with inconsistent sleep schedules and excessive exposure to blue light from computer screens can lead to general eye strain and abnormal sleep patterns (Bonnar et al., 2019; Yin et al., 2020). Computer vision syndrome or digital eye strain is not new and has been discussed for over 30 years (Dain et al., 1988). Conventional eye issues amongst computer users can be broadly split to (a) dry eye which produces irritation, headache, and sensitivity to lights; and (b) problems with visual accommodation, such as near focal blurred vision and difficulty with refocusing.

These eye issues are common among regular computer users. It is believed to be present in as many as 50% of computer users with almost a third of office workers reporting eye discomfort and dry eye (Portello et al., 2012; Sheppard & Wolffsohn, 2018). Time spent in front of a computer screen is positively correlated with symptoms reported. A recent study by Lee et al (2019) confirmed that this phenomenon is found in college students playing video games, with visual symptoms significantly increasing after a 4-hour period of continuous video gaming.

Due to the nature of the activity, we expect these eye issues to be over-represented in esports players. Thus, there need for preventative or management measures such as eye testing, correctly prescribed glasses, avoiding dry eyes and taking regular breaks. Long term, follow-up studies are required in order to assess the evolution of eye issues in esports players, particularly in the context of continuous periods of gaming and the aforementioned interventions.

Sleep

Many esports players participate in late night gaming sessions, leading to inconsistent sleep schedules and abnormal sleep patterns (Yin et al., 2020). This is problematic because just like in traditional sports, inadequate sleep can negatively affect performance. Sleep promotes basic cognitive functions that are important in esports like cognitive and psychomotor processing speeds (Goel, 2017), attention (Chee, 2015), and working memory (Lowe et al., 2017). In addition, Bonnar et al. (2019) explained that sleep restriction impairs executive function, compromising advanced skills expected of elite players (e.g., abstract thinking, complex decision making). Since these basic and advanced cognitive skills are necessary regardless of the game played, optimal performance requires consistent and adequate sleep.

In similar primarily sedentary-based, cognitively demanding activities like esports, sleep in chess players has shown to play an important role in performance. Moen et al. (2020) found that sleep patterns of chess players with positive performance development had higher amounts of deep sleep, less rapid eye movement (REM) sleep, and lower respiration rate. Echoing the findings of other research reviewed, the Moen and colleagues (2020) concluded that the cognitive functions essential to perform at the highest levels in chess required adequate amounts of deep sleep.

Beyond performance, poor sleep negatively affects physical health and injury recovery (Alvarez & Ayas, 2007; Copenhaver & Diamond, 2017). It also increases the risk of using performance enhancing substances or over-consuming caffeine (Bonnar et al., 2019), potentially compounding the health problems associated with inadequate sleep. However, these conclusions are based on the broader sleep literature because there is limited research focused specifically on esports.

Nutrition

Improved nutrition is associated with improved cognitive function (Spencer et al, 2017). For example, participants have improved performance and reduced risk of Alzheimer's disease following consistent high-quality nutrition (Lourida et al., 2013). However, it remains unclear what improved nutrition means as it pertains to a specific cohort, performance markers, type of foods, quantity of foods, and even how the food consumed.

There is a dearth of research on esports nutrition. This is not surprising because it is difficult and expensive to collect valid and reliable nutrition data (Ioannidis, 2013). Playing video games in general, is associated with increased food intake in adolescents that is beyond the higher energy expenditure of the activity (Chaput et al., 2011). But a survey of gamers found that fruit and vegetable consumption was reasonably good across with an improving trend towards professional players (Rudolf et al, 2020).

The scant research in esports nutrition primarily focusses on the relationship between energy drink consumption and performance, with the two studies reporting conflicting results (e.g.,

Frazer, 2006; Thomas et al., 2019). Although the academic community has showed little interest in esports nutrition, corporations are seizing the opportunity to influence the growing esports fanbase to promote products like energy drinks and alcohol through sponsoring teams and individual players (Hana, 2019; Hitt, 2020). Most of these products contain higher than recommended levels of caffeine and sugar.

Supplements have a long and controversial history in sports, it was only a matter of time for it to enter the esports market. For example, Rockin' Protein Energy and Milk it! sponsor esports teams (Ashton, 2020; Murray, 2020). Like energy drinks, there is a void of research on the effectiveness or safety of these supplements. The supplement industry does publish research reports on their products (e.g., Decker, 2020), but these reports function more as promotional material given their lack of a quality methodology, objectivity, and transparency. This is important because the limited amount of impartial research studies question the effectiveness and safety of supplements. For example, Tartar et al (2019) conducted a randomized, double-blinded control study to test the effectiveness of using the supplement ASI-Nitrosigine®. This compound is a nitric oxide precursor and enhancer, leading to a variety of physiological effects, most notably, vasodilation resulting in reductions is systolic blood pressure. The study found that use of the supplement, across the 30 participants, gave highly mixed results; the placebo gave superior results to the supplement at different tasks and time points. Nitric oxide is used frequently in clinical medicine to improve coronary artery flow and reduce patient symptomology, so is certainly a potential avenue for improving cognitive and physical performance especially in the acute term due to its generally short half-life. However, research must be as transparent as possible, and it is troublesome that one of the authors was employed by the supplement company. A conflict of interest should have been declared so that the results could be interpreted with improved context. We hope more nutrition and supplement research will be conducted soon. In addition, we believe that whilst sponsorship and partnership with commercial organizations are a likelihood to make these projects feasible, the publication of such studies must be done with complete transparency. This approach will improve the value of the results for the entire industry.

Performance-Enhancing Drugs (PEDs)

As the popularity of esports has increased, so has the rise of similar traditional sport problems within esports, such as performance-enhancing drug use, match-fixing, and unregulated gambling (Holden et al., 2017). However, similar to nutrition, little empirical research exists on performance-enhancing drugs in esports. This is a problem because anecdotal evidence and individual reports indicate that esports players are using them, specifically nootropics (e.g., Adderall), drugs designed to boost cognitive function like concentration and reaction time (Holden et al., 2017). In addition, players may also be using anxiolytic medications and beta-blockers to remain calm during stressful competitions (Wattanapisit et al., 2020). Although Wattanapisit et al. (2020) emphasize that there is no empirical evidence to show that esports players use performance-enhancing drugs, the unconfirmed reports of their use (e.g., Turi, 2015), and the notion that esports organizations may be "turning a blind eye" to player drug use (Hodson, 2014), suggest that future research is necessary to maintain the integrity of the games and ensure the safety of the players. Park et al (2020) assert that banned drug lists used by the World Anti-Doping Agency (WADA) may not be appropriate within esports (which could also stunt esport growth) and that proactive drug education centering on ethical decision-making specific for esports players is needed. For example, cognitive-enhancing nootropics (e.g., Ritalin, Adderall) used for arousal, concentration, attention, and memory, are often prescribed for

individuals with attention deficit hyperactivity disorder (ADHD), but are easily obtained with a prescription, thus complicating WADA regulation (Park et al., 2020). Organizations like the Esports Integrity Commission (ESIC; 2020) are taking a lead in this area, but are not universally utilized across esports leagues and tournaments. Lastly, game publishers and tournament/league organizers are key in the fight against PEDs within esports as these entities almost exclusively create the regulations regarding PED testing. Possibly, esports player unions or collective bargaining agreements between players and organizers/publishers may assist in leveling the playing field regarding PED policies within esports.

Mental and Emotional Health

In 2013, the American Psychiatric Association (APA) included "Internet Gaming Disorder" as a condition for further study in the Diagnostic and Statistical Manual of Mental Disorders (APA, 2013). The World Health Organization (WHO) went further in 2017, including "Gaming Disorder" (GD) in the International Classification of Diseases (WHO, 2018). It is important to note that gaming behavior lies on a continuum, from normal to GD. Addictive disorders like GD affect only a small proportion of gamers, it is estimated that no more than 1% of the population suffer from it (Przybylski et al., 2017). Despite the low percentage, Chung et al (2019) stress it is still a public health concern because nearly 30% of the world population are active gamers, approximately 2.2 billion people, with an expectation of 2.73 billion by the end of 2021. That means an estimated 273 million people may suffer from GD by the end of 2021. It is important to note these figures relate to recreational video gaming and not esports, per se, but video gaming forms the foundation of esports.

These statistics are even more worrisome because problematic gaming is comorbid with several other mental health issues like anxiety disorder, substance-use behaviors, obsessive-compulsive disorder, and suicidal ideation (Chung et al., 2019). Although the esports research is this area is limited, Barrault and colleagues (2017) studied poker, a similar sedentary but cognitively demanding activity, and found that players who suffered from severe-problem gambling had significantly higher rates of depression and anxiety compared to those who did not have a severe problem.

The research examining the psychological aspects of esports primarily focuses on performance (e.g., García-Lanzo et al., 2020; Pedraza-Ramirez et al., 2020), with most ignoring players' mental and emotional health. This lack of research is concerning because esports players may be vulnerable to mental health disorders. Bányai and colleagues (2018) reported that a minority of esports players have similar behaviors as problematic gamblers like excessive gaming every single day, regular psychological distress, and a frenetic lifestyle. Recognizing the similarities, some mental health organizations are beginning to recognize that individuals can become addicted to gaming. In fact, countries where esports are most popular (e.g., South Korea, China), excessive gaming is already recognized as a mental disorder and treatment programs have been established (Chung et al., 2019).

In addition to GD, there is also problematic behavior within the esports community – e.g., harassment, bullying, discrimination (Darvin et al., 2020; Hayday et al., 2020). Anonymity with usernames and lack of in-person interactions may enable this behavior; the root cause may lie in emotional instability, aggression, addiction, or violent tendencies (Bányai et al., 2018; Yin et al., 2020).

Call to Action

As this brief review reveals, more research on the health of esports players is necessary. The field is still in its infancy, with most of the research published only within the last few years. While there are many issues, below is a short list of recommendations based on the current literature.

Esports Health Risk Factors and Determinants

There is a need to know the prevalence and determinants of physical and mental health among esports players. Koshy and Koshy (2020) recommend monitoring physiological parameters associated with both physical and mental health (e.g., heart rate variability, temperature, and physical activity) levels. This is expected to lead to greater insights into physiological stress responses which in turn can improve training and performance in general. Besides physiology, several other areas that need more attention are nutrition, performance-enhancing drugs, ergonomics, injuries, and abnormal sleep patterns. Performance enhancing drugs and nutrition in particular seem to be utilized haphazardly amongst esports teams often based on anecdotal evidence or marketing. The role of these factors is nuanced, Franke et al. (2017) found that drugs associated with improved cognitive performance such as methylphenidate, modafinil, and caffeine produced increased reflective time in chess players. However, this did not result in an improvement in performance with more losses actually found as a result of time when compared with placebo. When the losses were removed from the analysis, methylphenidate and modafinil were associated with improved performance. Sleep also must be taken with care, the majority of evidence shows that sleep deprivation is associated with reduced working memory, reaction times and reasoning (Alhola & Polo-Kantola, 2007). Conversely it would be expected that there is significant participant variation in this area with the many esports players technically sleep deprived during the competitive sessions both in build up with training and on stage. Further study is required in these areas to find determinants of health and performance.

Evaluate Current Esports Health Promotion Policies and Programs

Many esports player health-related policies, “terms of use,” or programs are created by esports entities (e.g., game developers, esports organizations, or gaming platform companies) in partnership with outside organizations (i.e., physical or mental health promotion organizations). Moreover, Miah (2020) found that most policies are simply provisions found in Codes of Conduct or User Agreements, which are likely to be born out of the company’s concerns for litigation associated with their product, rather than concern for the moral conduct or wellness of its community. In addition, the programs and partnerships are too novel to know if they are effective, and currently there is no evidence that shows efforts to intervene with risky behavior once the players/users are within the experience itself (Miah, 2020). For instance, at the scholastic and collegiate level, esports physicals could be required prior to each season, similar to other traditional sport student-athletes, but tailor them to specific risk factors associated with esports. Moreover, Marsh et al. (2020) recommends that athletic trainers be assigned to esports teams just like typical sports teams. However, for this to be successful, medical professionals must be made aware of common maladies of esports players – both physical and mental – and this must be integrated into educational training and professional development. We support the creation of an expert panel for esports professional teams. Comprised of healthcare professionals, this panel could help create policies and procedures to improve the wellbeing of players and standardize the health-focused assessments and return-to-play protocols.

The Counter-Strike Professional Players' Association (CSPPA; 2021), a self-described player-driven independent and democratic association of professional Counter-Strike: Global Offensive (CS:GO) esports players, organized a Mental Health Program that affords players access to an independent clinical psychologist where sessions remain confidential. Moreover, the Event Minimum Standards agreement between CSPPA (2020) and event organizer ESL/DreamHack accounts for other health-related player concerns such as requiring the tournament organizer to "provide at least 3 (three) meals…on each Tournament Day…[and] ensure that each such meal is healthy and…available at times fitting each Roster Member's schedule" (p. 6), offer "healthy snacks and drinks such as protein bars, smoothies, sparkling water etc." (p. 7) in tournament accommodation player lounges, and provide players access to "first aid, [and a] doctor, physiotherapist, and massage therapist" (p. 12) at the tournament venue – costs of which are all covered by the tournament organizer. While professional esports player associations or collective bargaining agreements are uncommon in esports, and research is needed on program efficacy of implementation and outcome effectiveness, this example may act as a starting point for other esports entities.

Esports Health Interventions

Although elite performance in esports demands superior cognitive skills, professional players are not retiring because of a decline in cognitive abilities. Rather, they are suffering from the many physical and mental illnesses described in this review. For example, Jian "Uzi" Zihao announced his retirement at age 23 because of being diagnosed with Type II diabetes combined with severe joint pain in his arm and hand (Rong, 2020). Similarly, Hai "Hai" Du Lam retired at the height of his career due to a wrist injury that caused severe pain, limiting his capability to compete (Irorita, 2020). Despite the high profile, medically forced retirements of these young professionals, little attention is being paid to prevention.

To address this problem, esports health intervention programs must be created based on identified risk factors and determinants. Evidenced-based esports-specific health promotion and injury prevention programs must be created that not only assist in general player health, but also esports performance. In addition, innovative ways to alter the sedentary nature of esports should be considered. This must be done in partnership with the esports industry. For example, creating immersive environments within esports games employing sensor technology can assist children and adolescents to develop fundamental movement skills (Jenny, Krause et al., 2021; Polman et al., 2018). Miah (2020) recommended an integrated, in-game tool for monitoring and caring for players. Traditional sports utilize structured quarters, halftimes, periods, and time-outs that afford athletes' rest. Esports may more purposefully structure gaming competitions in similar ways so that prolonged sitting is not encouraged. The idea that "grinding" (i.e., frequent extended gaming sessions) is the only way to improve esports performance must be thwarted.

Finally, esports teams and organizations must put a greater priority on long-term player development and holistic health through employing ancillary health-related support staff – a physical therapist, strength and conditioning coach, psychologist, nutritionist, health and wellness coach, sports medicine physician, optometrist, ergonomics specialist, etc. (DiFrancisco-Donoghue et al., 2019; Wattanapisit et al., 2020). Moving beyond this in a more proactive fashion, however, esports organizations and leagues must also consider how to best facilitate a wellness

culture that factors how practice, competition, and travel schedules may be arranged to reduce player physical and mental stress and resultant injury or burnout.

Conclusion

A greater concerted effort must be made to produce more peer-reviewed, evidence-based health-related esports research where players, practitioners, industry (including game developers), and experienced scholars partner to advance the field. However, to better establish esports legitimacy within the broader fields of sport and health science, there must be an emphasis on quality.

Conflicts of Interest and Source of Funding

No conflict of interest or financial disclosures pertaining to this manuscript exists.

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