THE EMERGENCE OF ESPORTS NUTRITION: A REVIEW

Fernando J. Ribeiro,[1, 2, A, B, D] Victor M. Viana,[1, 3, 4, D] Nuno P. Borges,[1, 4, D]
Vitor H. Teixeira[1, 5, A, D]

[1] Faculty of Nutrition and Food Science of the University of Porto (FCNAUP), Porto, Portugal
[2] Faculty of Sciences of the University of Porto (FCUP), Porto, Portugal
[3] Centro Hospitalar Universitário S. João, Porto, Portugal
[4] CINTESIS, Porto, Portugal
[5] Research Centre in Physical Activity, Health and Leisure (CIAFEL), Porto, Portugal

[A] Study Design; [B] Data Collection; [D] Manuscript Preparation

Address for correspondence:
Fernando J. Ribeiro
Rua da Certaínha, n.º 143, 4630-247 Marco de Canaveses, Portugal
E-mail: fernandoribeiro1393@gmail.com

Abstract Peak cognitive performance is of paramount importance for the sports and competitive activities that depend on a high level of cognitive performance, such as eSports. The popularity of eSports has increased rapidly in recent years and will probably continue to rise in the forthcoming years. Above all, eSports practitioners require higher levels of cognitive abilities and motor skills for optimal performance and may benefit from adequate body composition and proper nutrition, as happens with more traditional athletes. However, there is a noticeable shortage of scientific knowledge in this area, including in nutritional-related aspects. Therefore, the objective of this non-systematic review is to summarize the nutritional strategies that may enhance health, cognitive performance, decrease reaction time and minimize fatigue. This information may be relevant for eSports competitors and set a base for further investigations, which could ultimately lead to the establishment of nutritional recommendations specific for this competitive population.

Key words eSports, nutrition, eSports nutrition, video games, cognitive performance

Introduction

Traditionally, sports nutrition has focused on promoting an optimum level of physical fitness particularly for athletes of more physically intense sports, such as the marathon, football, weightlifting, etc. (Kerksick et al., 2018). However, sport is not limited to these modalities. There are other sports and competitive activities that depend mainly on another type of skills, like a high level of cognitive capacity, high-speed response, accuracy and resistance to mental fatigue, such as billiards, darts, motorsports, drone racing, chess, and eSports (Campbell, Toth, Moran, Kowal, Exton, 2018).

eSports involve video game competitions with other players. Some examples of eSports games include League of Legends, Dota 2, Starcraft II, Counter-Strike: Global Offensive, and the FIFA series (Hamari, Sjöblom, 2017).

While it is debatable if eSports are considered a true sport or not, its popularity has been growing tremendously, and it is estimated that by the end of the year 2018, it may have reached a total of 380 million fans and $906 million in incomes (Hallmann, Giel, 2018).

The practice of eSports may provide benefits in various cognitive domains, including refined attention, memory, plasticity, spatial reasoning and problem-solving, among others (Taylor, Elam, 2018). It may also motivate students to reduce school absenteeism and improve their grades, and, as it is practiced in teams, it could also improve soft skills that are desired by universities and employers, such as teamwork, communication skills and problem-solving in high-pressure contexts (Rothwell, Shaffer, 2019).

The average age of eSports professional players maybe around 21–25 years (ESPN, 2017, acessed: 22.01.2020) and their careers are usually very brief, lasting until their mid-twenties, an age from which their speed of responsive action starts decreasing and younger competitors may be in advantage (Hallmann, Giel, 2018). The scientific literature mentions various cognitive domains that seem to be of the utmost importance in the competitive practice of video games, namely: fine cognitive motor skills, including aiming and manual dexterity (Reeves, Brown, Laurier, 2009), cognitive motor speed, including reaction time, speed of action and actions per-minute (Huang, Yan, Cheung, Nagappan, Zimmermann, 2017; Reeves et al., 2009), fluid intelligence, memory (Kokkinakis, Cowling, Drachen, Wade, 2017), visuospatial attention (Han, Lyoo, Renshaw, 2012), concentration (Cottrell, McMillen, Harris, 2019), resistance to mental fatigue (Thomas, Rothschild, Earnest, Blaisdell, 2019), multitasking, management and organization (Huang et al., 2017).

Nonetheless, it seems that most competitors do not recognize the cognitive and physiological demands of competitive eSports, and fail to adhere to healthy dietary patterns, not preparing themselves for competition in a professional manner (Schütz, 2016). As in most sports, and as the level of demand rises, a progressive increase in demand for strategies to improve performance is expected, and there are already companies dedicated to providing personalized programs, including nutritional plans (Himmelstein, Liu, Shapiro, 2017). However, there is a noticeable shortage of scientific knowledge in this area, including in the field of nutritional science.

The objective of this review is to summarize how nutritional status and dietary strategies can influence health, cognitive performance, decrease reaction time and minimize fatigue. While the information here summarized may be relevant for eSports competitors, it may have a higher favorable influence for typical adolescents and young adults, as high-level eSports players may already be operating close to the limit of human cognitive ability, leaving little room for performance improvement (Bernard, Louise, Louise, 2018).

Methods

This article is a non-systematic review and the information here resumed was collected through research on Google Scholar, PubMed, and Web of Science. The searches included the following keywords: “esports”, “cognition”, “nutrition”, “diet”, “breakfast”, “lunch”, “snack”, “evening meal”, “protein”. “carbohydrates”, “glucose”, “fat”, “saturated fats”, “polyunsaturated fats”, “vitamins”, “minerals”, “hydration”, “alcohol”, “coffee”, “caffeine”, “BMI”, “overweight”, “obesity”, and “weight loss”. The information considered relevant was included in this review. In addition, published books on nutrition and cognition were also consulted for retrieval of additional information and references.

Diet-related aspects influence on cognition

Diet quality

Diet quality may impact cognitive capacities, including learning and memory of the immature and adult brain (Reichelt, Westbrook, Morris, 2017). Poor eating habits are associated with decreased performance in various cognitive domains (Wright, Gerassimakis, Bygrave, Waldstein, 2017), which may be partially explained by ethanol neurotoxicity (Brust, 2010), increased brain inflammation promoted by high fat (Pistell et al., 2010) and high sugar diets (Yeomans, 2017). The western pattern diet, which is typically high in refined sugars and cereals, sodium, saturated fats and alcohol (Statovci, Aguilera, MacSharry, Melgar, 2017), may predispose to obesity, is linked to an overall decrease in cognitive function, and may have a negative influence in the hippocampus, which is implicated in memorization and learning (Morris, Beilharz, Maniam, Reichelt, Westbrook, 2015).

On the other hand, a healthier diet correlates with optimum mental performance (Kim, Kang, 2017). The Mediterranean diet, which is composed mainly by significant amounts of whole grains, legumes, vegetables, fruit and a modest amount of fish, dairy and olive oil, may decrease the risk of cognitive impairments (Radd-Vagenas Duffy, Naismith, Brew, Flood, Fiatarone Singh, 2018).

Meal patterns

Meal timing, size, and composition also have the potential to affect cognitive performance (Dye, Lluch, Blundell, 2000; Leigh Gibson, Green, 2002; Prasad, Lieberman, Kanarek, 2005).

Moreover, the ingestion of a meal with a nutritional composition different to the one that is usually eaten seems to worsen the mood and energy ratings (Cunliffe, Obeid, Powell-Tuck, 1997).

The frequent omission of meals, especially breakfast, in young adults, is correlated with inferior diet quality, reduced intake of micronutrients, greater BMI and risk of abdominal adiposity, increased insulin resistance (Pendergast, Livingstone, Worsley, McNaughton, 2016), poorer sleep (Tanaka et al., 2002), fatigue, decreased attention, and inferior academic performance (Ackuaku-Dogbe, Abaidoo, 2014).

Breakfast intake enhances cognitive aspects linked to attention, executive function, memory (Adolphus, Lawton, Champ, Dye, 2016), test scores (Rampersaud, Pereira, Girard, Adams, Metzl, 2005), and improves the capacity to cope with cognitive workload (Sihvola et al., 2013).

There is some evidence that lunch is a major contributor for the post-prandial dip in performance, and leads to a decline in some aspects of cognitive performance, including in discrimination efficiency, sustained attention (Smith,Miles, 1986), and increased response time (Lloyd, Green, Rogers, 1994). These detrimental effects may be modulated by personality type (Craig, Baer, Diekmann, 1981) and meal size, with biggest decrements being observed after the ingestion of a big (922–1,380 Kcal) versus a light lunch (260–305 Kcal) (Craig, Richardson, 1989; Reyner, Wells, Mortlock, Horne, 2012). The ingestion of a lunch containing high amounts of fat or carbohydrates decreases alertness and cognitive efficiency (Lloyd et al., 1994).

In a study involving university students as volunteers, those who had an evening meal felt more energetic, more attentive, more competent and achieved a better performance in a logical reasoning test than those who didn't (Smith, Maben, Brockman, 1994). On the other hand, the ingestion of a big supper (30% of daily total energy intake) at late night increased sleepiness (Gupta et al., 2019), decreased driving performance and vigilant attention

(Gupta et al., 2019; Gupta et al., 2017), while the ingestion of a light meal (10% of 24 h energy intake) led to improved performance in those parameters (Gupta et al., 2019).

Hydration

It is estimated that 54.5% of the USA children and adolescents (Kenney, Long, Cradock, Gortmaker, 2015) and 15,8% of the adults (20–29 years) are dehydrated and 40% have borderline blood plasma hypertonicity (295 to 300 mmol/L) (Stookey, 2005).

Water accounts for 75% of brain mass (Zhang, Du, Zhang, Ma, 2019) and hydration status may be one of the main variables that affect the performance of eSports practitioners since there is reasonably consistent evidence that a dehydration level greater than 2% of body mass decreases cognitive performance (Adan, 2012; Riebl, Davy, 2013) decreases alertness, mood and increases fatigue (Benton, Young, 2015). Seemingly, a greater level of dehydration correlates with greater decreases in cognitive performance and mood (Pross et al., 2013), while water consumption can improve these parameters (Masento, Golightly, Field, Butler, van Reekum, 2014).

Moreover, some studies suggest that a dehydration level of 1–2% is enough to diminish cognitive performance (Riebl, Davy, 2013), and a more recent study found that a dehydration level of only 0.22% had a negative influence on memory and attention (Benton, Jenkins, Watkins, Young, 2016).

Indeed, the mere sensation of thirst may negatively affect memory and attention (Benton et al., 2016; Benton, Young, 2015) possibly by diverting some attention from cognitive performance (Benton, Young, 2015), and it was observed that the consumption of water favors mental performance in thirsty young adults, although it impaired it in those who were not thirsty (Rogers, Kainth, Smit, 2001).

Even if a moderate level of dehydration doesn't decrease cognitive test performance in adolescents and healthy adults, it may require more brainwork to reach a similar cognitive output as in a hydrated condition (Barulli, Stern, 2013; Kempton et al., 2011; Stern, 2017), and these individuals also exhibit lower mental clarity, well-being and greater fatigue (Kempton et al., 2011).

The daily amount of water necessary to maintain euhydration varies between individuals and must be adjusted to environmental conditions. The European Food Safety Agency (EFSA) has set an adequate total water intake value of 2,5L/day for males and 2,0L/day for females (EFSA, 2017).

Nutrients

Glucose. Notwithstanding constituting just ~2% of an adult individual's body mass, the energy expenditure of the brain represents ~20% of the body total expenditure (Herculano-Houzel, 2011). Because its energy reserves are limited, brain depends on continued delivery of glucose, its main fuel substrate (Murray, Rosenbloom, 2018) except during long periods of fasting, in which it oxidizes ketone bodies (Morris, 2005). In fasting and resting conditions, approximately 60% of blood glucose is metabolized by the brain (Wasserman, 2009), totalizing around 130 g about glucose/day (Lupton, Brooks, Butte, Caballero, Flatt, Fried, 2005).

In cognitively demanding scenarios, brain glucose consumption can increase by up to 12% (Madsen et al., 1995), and blood glucose levels may drop by as much as 10% (Fairclough, Houston, 2004; Gailliot et al., 2007; Scholey, Harper, Kennedy, 2001; Scholey, Laing, Kennedy, 2006). It has been shown that playing Tetris consumes a significant quantity of glucose (Haier, Siegel, Tang, Abel, Buchsbaum, 1992) and decreases blood glucose levels (Lange, Seer, Rapior, Rose, Eggert, 2014). In this context, the consumption of glucose may increase the availability of this nutrient and support the brain areas involved in the heightened workload and ultimately increase cognitive performance (Smith, Riby, Eekelen, Foster, 2011).

The potential mechanisms behind glucose cognitive enhancement effects through a) increased acetylcholine production, whose synthesis depends upon glucose (Messier, 2004); b) raised insulin levels, which may promote hippocampus glucose utilization (Craft, Murphy, Wemstrom, 1994); c) rewarding pathways upon activation of glucose-sensitive receptors present in the mouth (Hagger, Chatzisarantis, 2013); d) interplay with dopamine, serotonin, and opiates (Riby, 2004).

The positive effects of glucose administration on cognitive performance have been supported by the results of a meta-analysis (Riby, 2004), with larger effects on episodic memory, and possible benefits on sustained attention and vigilance (Bernard et al., 2018). The cognitive enhancements may be visible up to 20 min after its ingestion (Jones, Sunram-Lea, Wesnes, 2012) and glucose blood levels may start to decline after around 30 min, dropping to basal levels in approximately 2 hours (Benton, Parker, Donohoe, 1996). The nootropics effects of glucose seem more noticeable on prolonged and cognitively demanding tasks and in fasting conditions (Riby, 2004). This may explain why most interventions were performed at breakfast time (Hoyland, Lawton, Dye, 2008). These nootropic effects may be short-lived, as impairments in working memory have been detected 60 min after the administration of 25 g of glucose, possible due to a subsequent decrease in plasma glucose levels, secondary to increased insulin levels (Jones et al., 2012).

It may not be necessary to ingest carbohydrates through a pure glucose solution to potentiate cognition. The ingestion of a dietary source of carbohydrates (breakfast cereals) at early morning also improves spatial memory (Smith, Clark, Gallagher, 1999). Moreover, the regular ingestion of sugary drinks, including energy drinks and sports drinks, should be discouraged due to its association with increased inflammation, weight gain and oral health problems (Aeberli et al., 2011; Malik, Pan, Willett, Hu, 2013; Hardy, Bell, Bauman, Mihrshahi, 2018).

It should be noted that practicing eSports for many hours a day and during various months may lower or block the cognitive benefits associated with glucose intake. Playing Tetris daily for 4–8 weeks result in a decrease in cerebral glucose expenditure, despite a concomitant >7-fold increase in performance (Haier et al., 1992).

Lipids. Lipids account for 50–60% of adult brain's dry weight (Sastry, 1985) and it was found that alterations in the lipid constituents of neurons membrane may affect neurotransmission by modulating the activity of ion channels, receptors, enzymes and ion channels wrapped or involved with the membrane phospholipids (Prasad et al., 2005). In humans, high-fat diets have been documented to modify the brain metabolism of glucose, causing the electroconvulsive threshold to rise (Appleton, DeVivo, 1974), and the consumption of fatty foods has been robustly correlated with an increase in reaction time (Phillimore, 1988).

The type of fat may also influence cognition. The ingestion of higher amounts of unsaturated fatty acids has been correlated with optimized cognitive health in comparison with saturated fatty acids (Cao et al., 2019), while the ingestion of trans fatty acids is strongly linked with the worsening of word recall ability (Golomb, Bui, 2015). Trans fatty acids, which are produced in industrial installations (Stender, Astrup, Dyerberg, 2008), are associated to increased oxidative stress (Tomey et al., 2007), negative repercussions on blood lipids, metabolic processes, decreased glucose tolerance, general body inflammation, disrupted endothelial function, visceral adiposity, increased BMI, worsening of cardiac and general health (Mozaffarian, Aro, Willett, 2009), which may impair cognition (Atzmon et al., 2002; Eggermont et al., 2012; Geroldi et al., 2005; Isaac et al., 2011; Messerotti, Benvenuti, Zanatta, Valfre, Polesel, Palomba, 2012; van Exel et al., 2003).

Additionally, dietary trans fats decrease the availability of the long chain omega-3 fatty acids EPA and DHA, which are anti-inflammatory (Kaur, Chugh, Gupta, 2014), important to brain health and have been associated with a more favorable cognitive function (Lim, Gammack, Van Niekerk, Dangour, 2006; Robinson, Ijioma, Harris, 2010).

According to EFSA, for adults, the ingestion of total fat should represent 20–35% of total energy intake, the adequate intake of EPA + DHA is 250 mg/day, and the intake of saturated fat and trans fats should be as low as possible (EFSA, 2017).

Unlike glucose, the effects of acute consumption of pure fat and protein on cognition have been scarcely studied, with contradictory results. These inconsistencies may have been due to different methodologies applied in these studies. Additional investigations must be conducted before any conclusions can be drawn (Bachlechner et al., 2017; Jones et al., 2012).

Protein. The ingestion of adequate amounts of protein is also necessary for optimum brain development and functioning. With a protein content of approximately 10% (Banay-Schwartz, Kenessey, DeGuzman, Lajtha, Palkovits, 1992), the brain has a daily turnover rate of 3–4%, superior to that of skeletal muscle mass (1–2%) (Smeets et al., 2018). The central nervous systems also uses amino acids as neurotransmitters or as substrates for the synthesis of neurotransmitters and neuromodulators (Chertoff, 2015). The production of the neurotransmitters serotonin and catecholamines requires tryptophan and tyrosine as substrates, respectively, and its synthesis rate is influenced by the blood availability of these amino acids and, consequently, by the ingestion of protein (Fernstrom, Fernstrom, 2007).

It has been observed that the ingestion of a larger proportion of carbohydrates relative to protein raises tryptophan levels by elevating insulin levels, which promotes the uptake of the large neutral amino acids (LNAA) valine, leucine, and isoleucine by muscle tissues, thus dropping their blood levels, while tryptophan levels remain relatively unaltered. As tryptophan competes with these branched chain amino acids for the same transporter through the blood-brain barrier (BBB), the rate of transport of tryptophan through the BBB increases, as well as the brain availability of this amino acid, thus increasing serotonin production, a neurotransmitter that exerts sedating effects and consequently slows motor performance (Lieberman, 1999; van de Rest, van der Zwaluw, de Groot, 2013).

In general, dietary protein sources contains higher proportions of tyrosine in comparison with tryptophan. Being a LNAA, tyrosine competes for transport through the BBB with tryptophan and other LNAAs. As the proportion of protein to carbohydrates of a given meal increases, greater decreases in tryptophan levels are observed and, consequently, the brain synthesis of serotonin also decreases (Lieberman, 1999; van de Rest et al., 2013).

Acute high-stress conditions may decrease brain tyrosine levels due to heightened catecholamines synthesis triggered by an increased fire rate of central catecholaminergic neurons. In these cases, the ingestion of a protein-rich food increases blood tyrosine levels, favors its transport through the BBB, and boosts brain catecholamines synthesis, which may increase alertness and enhance cognition (Lieberman, 1999; van de Rest et al., 2013). Arguably, the lifestyle of eSports professional players may be considered stressful, especially in periods congested with important competitions (Pereira, Brito, Figueiredo, Verhagen, 2019).

In 2010 Jakobsen et al. applied a high protein diet (3.0 g kg/body weight) to a group of healthy young male college students (19–31 years), for 3 weeks, while another group followed a usual protein diet (1.5 g kg). These authors observed a significantly reduction in the reaction time in the high protein group, in comparison with the usual protein diet group, and attributed these effects mainly to increased levels of tyrosine, but also to raised phenylalanine and BCAA concentration in the high protein group (Jakobsen, Kondrup, Zellner, Tetens, Roth, 2011). However, there is clearly a need for further investigations on this topic. Moreover, the amount ingested by the high protein diet largely surpassed the population reference intake value of 0.83 g/kg proposed by EFSA (EFSA, 2017).

Micronutrients. The brain energy metabolism is also dependent on an adequate supply of vitamins and minerals (Kennedy et al., 2016). Low brain magnesium levels appear to decrease serotonin levels and promote depressive states (Eby, Eby, 2010), which may decrease performance in cognitive tasks, possibly due to a reduced capacity to allocate cognitive resources to challenging tasks (Jones, Siegle, Muelly, Haggerty, Ghinassi, 2010). Due to its key role in myoglobin, cytochromes, and many other cellular proteins and enzymes (DeLoughery, 2017), iron deficiency has been strongly associated with fatigue (Brunner, Wuillemin, 2010) and decreased mental performance in children (Lozoff, Beard, Connor, Barbara, Georgieff, Schallert, 2006) and young adults (Scott,Murray-Kolb, 2016). Iodine is necessary for the endogenous production of two hormones in the thyroid (triiodothyronine and thyroxine), which influence human development and growth, including the central nervous system (Zimmermann, 2009). Iodine deficiency may cause a number of negative health consequences, including impaired cognition capacity (Zimmermann, 2009). Zinc plays a key role in controlling the expression of genes and in normal synaptic signaling processes (Trumbo, Yates, Schlicker, Poos, 2001). Vitamin D deficiency might have negatives effects on the brain because it also has vitamin D receptors (Garcion, Wion-Barbot, Montero-Menei, Berger, Wion, 2002) and some studies suggest that hypovitaminosis D is associated with a lower cognition performance in adults (Goodwill, Szoeke, 2017).

Caffeine. Caffeine is considered the main constituent of coffee that provides cognitive facilitation effects (Haskell-Ramsay, Jackson, Forster, Dodd, Bowerbank, Kennedy, 2018). A dosage of 100 ml of coffee, extracted by the drip method, contains 60–100 mg of caffeine, an amount found sufficient to improve reaction time, alertness, vigilance, and attention (□0,5 to 4 mg/kg) (McLellan, Caldwell, Lieberman, 2016). This value is below the EFSA established safe upper limit for acute caffeine ingestion (3 mg/kg) (EFSA Panel on Dietetic Products & Allergies, 2015). Nonetheless, coffee contains other components, such as chlorogenic acids, that may also exert positive mood and cognitive effects (Camfield et al., 2013). One study found that the ingestion of decaffeinated coffee improved alertness in young healthy adults (Haskell-Ramsay et al., 2018). In another investigation, the mere act of smelling coffee improved performance on an analytical reasoning task, an effect that may be attributed to the placebo effect (Madzharov, Ye, Morrin, Block, 2018).

Alcohol. Binge and heavy alcohol drinking during adolescence, a time when the brain is still maturing, is associated with significant negative brain and behavioral changes, inferior academic performance, retardation of white matter maturation, and volume reductions of specific brain areas, such as the cerebellar region and the frontal lobe (Cservenka, Brumback, 2017).

Cognition and weight status

Obesity may induce insulin resistance, promote inflammation, increase oxidative stress, and lead to endothelial dysfunction (Montero, Walther, Perez-Martin, Roche, Vinet, 2012), which can be harmful to the brain, and correlates with cortical thinning of specific brain regions, diminished integrity of white matter and reduced nerve conduction velocity in adolescents (Medic et al., 2016; Sweat, Yates, Migliaccio, Convit, 2017; Yau, Kang, Javier, Convit, 2014) and adults (Majumdar, Chaudhuri, Ghar, Rahaman, Hai, 2017; Stanek et al., 2011; Xu, Li, Lin, Sinha, Potenza, 2013). Compared with their lean counterparts, obese adolescents perform worst in various domains of cognition, such as arithmetic, working memory, spelling, mental flexibility, attention, executive functioning, cognitive processing speed, visuospatial performance, and motor skills (Liang, Matheson, Kaye, Boutelle, 2014; Sweat et al., 2017; Yau et al., 2014).

A significant percentage of esports practitioners may be overweight. In a survey conducted in Germany, involving 1,066 esports players from 18 to 38 years old, the average BMI was 24.6 (±4.8) and that only 51.9% of the sample had a normal weight, while the mean value for the population of Germany with the same age is 59.9–72.3%. Moreover, time spent playing video games was positively associated to BMI and self-reported health status (Rudolf, Bickmann, Froböse, Tholl, Wechsler, Grieben, 2020).

If obesity is linked to decreased cognitive performance, it is reasonable to theorize that weight loss could improve cognitive performance in obese. Indeed, intentional weight loss seems to enhance several aspects of cognition in overweight and obese adults, such as executive function, attention, memory, and language (Veronese et al., 2017), although some works only found cognitive benefits in obese and not in overweight individuals (Siervo et al., 2011).

Weight loss requires a negative energy balance, which has been associated with functional cognitive deficits in self-reported dieters (Green, Rogers, 1995, 1998; Kemps, Tiggemann, 2005; Kemps, Tiggemann, Marshall, 2005; Vreugdenburg, Bryan, Kemps, 2003), that seems to be more concerned with esthetics (Green, Elliman, Rogers, 1997; Green Rogers, 1998; Kemps Tiggemann, 2005; Kemps et al., 2005; Shaw,Tiggemann, 2004; Vreugdenburg et al., 2003). Such concerns can deviate cognitive resources for trivial cognitive tasks, thus diminishing the total cognitive resources available to other mental tasks (Green et al., 1997; Green, Rogers, Elliman, Gatenby, 1994; Sebastian, Williamson, Blouin, 1996). However, such association is missing or minimized when weight loss is reported or energy restriction is applied through clinical intervention (Bryan, Tiggemann, 2001; Green, Elliman, Rogers, 1995; Kretsch, Green, Fong, Elliman, Johnson, 1997; Landers, Arent, Lutz, 2001; Martin et al., 2007).

On the other hand, a too low BMI (i.e. *anorexia nervosa*) may impair cognitive flexibility and working memory. Weight recovery seems to restore these cognitive domains (Olivo, Gaudio, Schiöth, 2019). Chronic malnutrition undoubtedly hinders cognitive development and performance (Dauncey Bicknell, 1999; Kretchmer, Beard, Carlson, 1996).

Conclusions

To our knowledge, to date, no studies have evaluated the effects of dietary strategies on the cognitive performance of eSports competitors. However, there is a relatively great amount of evidence regarding nutritional strategies that may simultaneously benefit health and cognition, which may also be useful to eSports players:

1. Maintain an adequate weight for height.
2. Follow a low GI, high quality, and nutritious diet.
3. Limit the intake of fat to (20–25 total energy) an avoid saturated and trans fat.
4. Avoid and correct possible vitamin and mineral deficits.
5. Maintain a regular dietary pattern and do not skip breakfast.
6. A light meal at lunch may minimize the detrimental effects of post-lunch dip on cognition.
7. Avoid drinking alcoholic beverages.
8. Maintain an adequate hydration state, especially before competitions.
9. Consider the sensible ingestion of coffee before competitions.

Considering the currently available literature, it is not yet possible to establish specific recommendations for eSports competitors, but the information here presented may help to set a basis and identify the most viable topics which warrant further investigation. As this new world of eSports involves an increasing number of individuals over time, it is urgent to carry out further research in this area, which may ultimately lead to the establishment of nutritional and supplementation recommendations that may promote health and optimize cognitive performance.

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