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European Journal of Physical Education and Sport Science
ISSN: 2501 - 1235
ISSN-L: 2501 - 1235
Available on-line at: www.oapub.org/edu

DOI: 10.46827/ejpe.v8i4.4335 Volume 8 | Issue 4 | 2022

THE EFFECT OF VIDEO GAMING ON NUTRITIONAL BEHAVIORS: A SYSTEMATIC STUDY

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Abstract:
This review article aims to synthesize all the observational studies that examined the effects of video gaming on nutritional behaviors. In addition, it is aimed to draw the attention of field academicians and researchers to the issue related to video gaming and to shed light on future observational studies in the field of sports sciences. All peer-reviewed observational studies on the nutritional behaviors of video gamers have been systematically examined and collected. Playing video games or playing them for a long time can have significant consequences on the health of those who play. While interest in video games or online digital games is increasing rapidly, studies focusing on understanding the health risks and benefits associated with them are long overdue. There

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is a need to develop and evaluate preventive interventions that address the harms video games can cause. Similarly, there are gaps in the evidence on ways to encourage safe and healthy digital gaming among the ever-growing video gamer population. In order to develop evidence-based guidelines and intervention strategies that include nutritional behaviors, these gaps need to be filled with scientific research.

Keywords: video games, nutrition, behavior, sugar-sweetened beverage

1. Introduction

Since video gaming, by its very nature, require a long period of sedentary screen time, there is a need to maintain and improve the health of individuals (Rudolf et al. 2020). Prolonged screen time, accompanied by prolonged sedentary behavior are considered to be risk factors for numerous chronic diseases (Bailey et al. 2019) and deaths due to these chronic diseases (Biswas et al. 2015). Weight gain caused by inactivity is among the commonly documented negative health problems of video gaming up till today (Vandewater et al. 2004; Bayrakdar et al. 2020). It is also noted that more than 40% of video gamers do not do any physical activity (DiFrancisco-Donoghue et al. 2019). But with regard to energy expenditure, there is some evidence that active video gamers (e.g. exercise games) tend to increase energy expenditure or physical activity levels (Anderson & Bushman, 2001; Prescott et al. 2018). And this suggests that video gamers who focus on fitness or exercise can contribute to health-promoting physical activities.

The literature on nutritional behaviors in digital gaming is insufficient (Yin et al. 2020; Pelletier et al. 2020). There is not enough evidence in the literature to determine if there is a link investigating the relationship between video gaming and nutritional behaviors (Pelletier et al. 2020). In video games, the importance of healthy and active lifestyle choices that play an important role in reducing sitting time and unhealthy nutritional behaviors (Rezende et al. 2016), and balanced food consumption are emphasized (Shi et al. 2019). It is indicated that proper nutrition helps to improve mental and physical performance, two components that are vital for professional video gamers (Tartar et al. 2019). These key performance features are affected by five main factors. These are the types of food consumed, the duration of consumption, the amount consumed, the blood sugar level, and the hydration status. Firstly, processed foods with artificial ingredients will not provide the nutrients needed by the body and brain (Quinlan & Johanson, 2017). Foods high in saturated fat, sodium, and added sugar should not be consumed. When choosing food, preference should be given to fruits, vegetables, cereals, dairy products, and meat (Huth et al. 2013). These foods boost your reflexes for optimal performance. Secondly, as in traditional sports, in sports competitions, nutrition should be completed 2-3 hours before (Coyle, 1991). Thirdly, it is necessary to take about 60% of calories from carbohydrates, 10-15% from protein, and 25-30% from fats (Wu et al. 2009). The fourth factor is indicated as consuming foods with a high glycemic index (Howard & Wylie-Rosett, 2002). Finally, hydration is the most important aspect of nutrition that is often unregarded. Hydration has a huge impact on our health and

performance, especially when it comes to cognitive function (Wilson &Morley, 2003). It is greatly stated in the literature that dehydration has a negative effect on both physical and mental performance (Adan, 2012; Benton, 2011; Kempton et al. 2011; Castagna et al. 2007; Maughan et al. 2007; Benelam & Wyness, 2010; Masento et al. 2014). In a study, it was stated that performance was impaired in tasks requiring attention, motor function, and immediate memory skills in individuals due to the fact that only 2% of water loss was experienced. All brain functions are necessary for optimal game performance (Adan, 2012).

In recent years, the number of research on the relationship between nutrition and cognitive performance has increased (Meeusen, 2014). Consuming a sufficient amount of essential nutrients such as omega-3 fatty acids and a wide variety of polyphenols can have a beneficial effect on brain health and cognitive performance (Meeusen, 2014; Dyall, 2015). It would be a good strategy to consume 2-3 servings of fatty fish such as salmon, sardine, or tuna fish per week to get an adequate amount of omega-3 (Jordan, 2010; Psota et al. 2006) and to consume 2-3 pieces of fruit as well as various vegetables in term of polyphenols (Sakakibara et al. 2003; Abbas et al. 2017). The strategic consumption of carbohydrates and adequate doses of caffeine during certain training sessions and tournaments are also excellent nutritional strategies to improve cognitive performance (Stevenson et al. 2009). As video gaming continues to grow and evolve, nutrition will become more important for video game programs (Rothwell & Shaffer, 2019).

Therefore, the aim of the study is to decisively review the potential relationships between video gaming and nutrition by examining recently published observational studies and interventions.

Accordingly, the answer to the following main question will be sought: What is the current status of observational evidence (cross-sectional data published between 2016 and 2021) of the relationship between video gaming and nutritional behaviors?

2. Methodology

The aim of this study is to decisively review the potential relationships between video gaming and nutrition by examining recently published observational studies and interventions. Given that video games began to appear after they were played online against other people, surveys have been made starting from 2016. The data includes all the studies published between January 2016 and December 2021. The literature review was conducted in the Google Scholar, Science & Direct, PubMed, and Web of Knowledge databases. The following keywords were used in the related search engines. "video game+nutrition", "video game+health", "video game+obesity", "video game+diet", "video game+food", "video game+BMI" and "video game+overweight". Observational studies evaluating the relationship between eSports and nutrition were also included. Each and all reviews have been conducted not only in the titles of articles but also in abstracts -in cases where this option is available- for the following reasons: (1) titles can sometimes be limited and may not include the words video games and nutrition; (2) authors may use a variety of different terms or synonyms corresponding to the concept of video games and

nutrition. Studies were not included if they were conducted on individuals with a chronic disorder (autism) or if a non-observational study design was used (such as case intervention, qualitative or systematic studies).

Two authors (AB and PA) independently reviewed the abstracts taken from the first review. The full-text articles of the selected abstracts were evaluated independently by the same authors. Any disagreement on the issue of eligibility after the abstract or full-text process has been resolved by the third and fourth authors (GK and EZ). The reference lists of the included articles have been scanned for eligibility. The data were extracted into a form in terms of study type, population characteristics (age, race, environment, and country), study methodology, video games, and nutrition.

3. Results

The selection of the studies is described in detail in Figure 1. 470 articles were identified, including 447 articles from the initial review and 23 articles through the reference lists of the included articles. After the first review, 198 articles were eliminated and 249 articles remained. 121 articles were not included in the review since they include chronic disorders (n=21), interventions or qualitative studies (n=33), systematic reviews or meta-analyses (n=27), and conducted on very small age groups (aged 3-7) and adults (n=40).

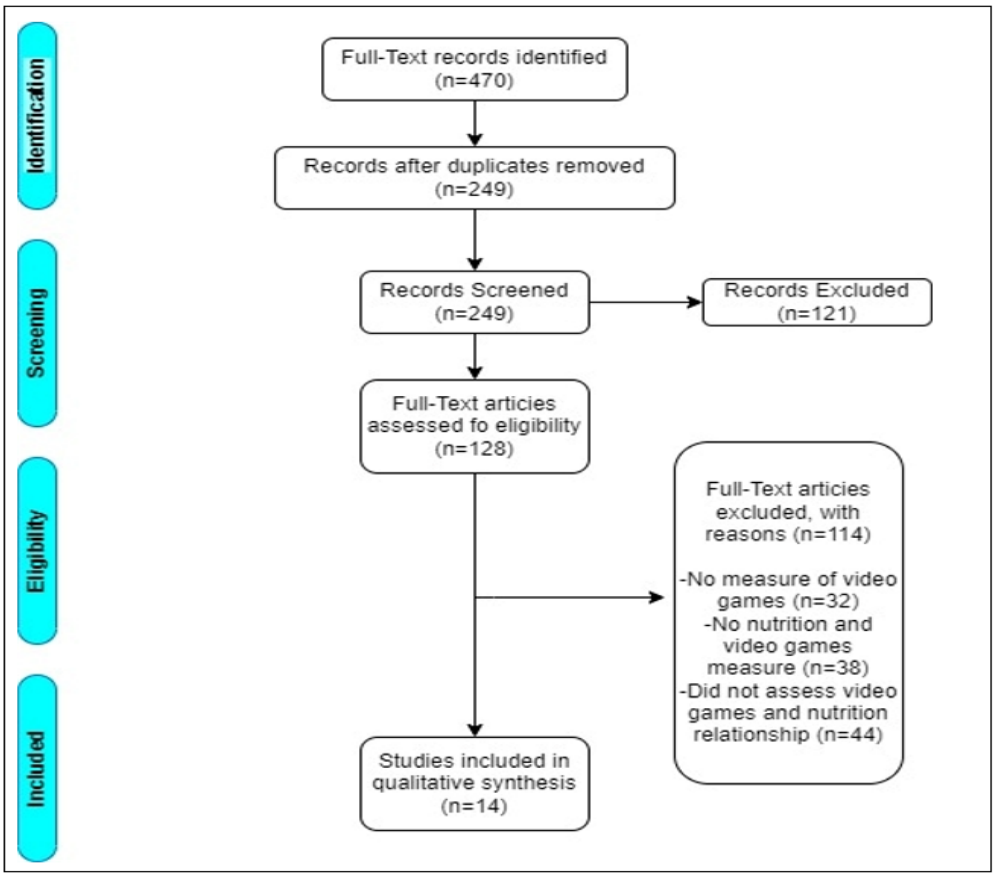

Figure 1: Selection of included research

Table 1: Descriptive characteristics of included studies (n = 14)

	Author, Year and Country	**Sample and Participant**	**Research questions**	**Findings**
1	Rudolf et al. 2020 Germany	- n=1066 - Age mean: 20 - eSports players and video gamers	The relationship between duration of video gaming and health behaviors	The average consumption of vegetables and fruits is 2.7 servings per day. 11% of the participants followed the recommendation of five servings per day. It has been found that the vast majority of them do not follow these recommendations. There is a negative relationship between the duration of video gaming and the consumption of vegetables and fruit.
2	Brooks et al. 2016 England	- n=4404 - aged 11-15	The effect of playing video games on the frequency of going to bed hungry	For men, spending more time with video gaming on weekdays is associated with a high probability of going to bed hungry.
3	Cemelli et al. 2016	- n=292	Lifestyles of those who play video games and those who do not	Those who play video games have been reported to eat less fat and consume more high-sugar sweetened beverages (such as juice and soft drinks).
4	Delfino et al. 2020 Brazil	- n=1011 -aged 10-17	Associating sedentary behaviors (eating habits) with digital devices	Excessive use of digital devices has been associated with a high content of snacks, fried food, sweets, and physical inactivity in adolescents.
5	Chaput et al. 2016 France	- n=24 (obese=12, lean=12) - aged 12-15	The effect of weight status on nutritional responses (energy intake, food preferences, and appetite) to active and seated video gaming	No difference in energy intake was found in the sample groups. Obese adolescents ate significantly more than leans, and considering kcal intake, a tendency to overeat was indicated.
6	Merelle et al. 2017 Netherlands	- n=21053 - age mean 14.4	The relationship of problematic video gaming with whether or not to have breakfast	A significant relationship between problematic video gaming and not having breakfast has not been found.
7	Puolitaiv et al. 2020 Finland	- n=796 - age mean 17.8	Worse dietary habits of adolescents who play excessive video games on weekdays compared to their peers who play less	Those who play video games for more than 3 hours a day have been reported as having high levels of poor dietary habits. It has also been reported that those with high screen time consume lower amounts of vegetables and fruits.
8	Allsop et al. 2016 England	- n=22 - aged 8-11	Similarities in energy intake and appetite during active and seated video gaming	It is noted that men consume significantly more nutrients during seated video gaming compared to active video gaming. In addition, men consumed more carbohydrates and proteins during active video gaming than seated video gamers but consumed less fat.

9	Baker et al. 2020 United States of America	- n=27 - aged 9-14	The effect of 30 minutes of active video gaming before meals on appetite in children with normal weight	Despite the increase in energy expenditure during active video gaming, there has been no change in the energy balance. It is noted that low-intensity short-term physical activity caused by active video gaming does not affect the energy balance in children with normal weight.
10	Goodman et al. 2020 England	- n=16367 A cohort study conducted on children aged 11-14	Video game use will be positively associated with BMI, and higher sugar-sweetened beverages and junk-food consumption will mediate this relationship	It is noted that there is a small association between video gaming and BMI in early childhood, and this is mediated by the consumption of sugar-sweetened beverages.
11	Gheller et al. 2019 Canada	- n=22 - age mean 11.9	The effect of video gaming before meals on appetite and food intake in overweight and obese boys	Video gaming in overweight and obese boys did not affect food intake. However, it has been reported that appetite increases.
12	Siervo et al. 2018 England	- n=72 - aged 18-30	The appetite and food consumption of all video gamers compared to those who watch non-violent television	Video gaming in overweight/obese adult men is associated with greater food intake than non-violent television viewers. In addition, video gaming has been associated with increased food consumption during the rest period.
13	Kenney & Gortmaker, 2017 United States of America	- n=24800 - aged 14-18	The relationship between video gaming and consuming sugar-sweetened beverages	Video gaming is associated with sugar-sweetened beverage intake in both boys and girls.
14	Cha et al. 2018 United States of America	- n=659288 - age mean 15	The effect of increased media use and video gaming on unhealthy eating behaviors	Those who use media for more than 6 hours daily and play video games have a high rate of eating at night. 37.2% of adolescents eat at night. In general, hours of media use and video gaming are positively associated with unhealthy nutritional behaviors and night eating.

The articles excluded from the scope (n=114) include evaluations that do not have measurements related to video gaming (n=32), do not have measurements related to nutrition and video gaming (n=38), and have no relationship between video gaming and nutrition (n=44). One hundred and twenty-eight articles remain for the full-text survey. Since most articles (n=44) were evaluated without specifically reporting on video gaming and the relationship between nutrition, one hundred and fourteen articles were not included in the full-text survey. And consequently, the data of fourteen articles

determined in accordance with the purpose of the study were evaluated (Rudolf et al. 2020; Brooks et al. 2016; Cemelli et al. 2016; Delfino et al. 2020; Chaput et al. 2016; Merelle et al. 2017; Puolitaival et al. 2020; Allsop et al. 2016; Baker et al. 2020; Goodman et al. 2020; Gheller et al. 2019; Siervo et al. 2018; Kenney & Gortmaker, 2017; Cha et al. 2018).

The descriptive characteristics of the included articles are given in Table 1. The sample sizes of the included studies range from 22 to 659288. The vast majority of the research was conducted in the United States and England. The sample age range in the studies ranges from 8 to 30.

When the selected articles were examined, answers have been sought to the questions and hypotheses of the duration of video gaming and health behaviors (Rudolf et al. 2020), the effect of playing video games on the frequency of going to bed hungry (Brooks et al. 2016), lifestyles of those who play video games and those who do not (Cemelli et al. 2016), associating eating habits with digital devices (Delfino et al. 2020), the effect of weight status on nutritional responses to active and seated video gaming (Merelle et al. 2017), worse dietary habits of adolescents who play video games on weekdays compared to their peers who play less (Puolitaiv et al. 2020), similarities in energy intake and appetite during active and seated video gaming (Allsop et al. 2016), the effect of 30 minutes of active video game playing before meals on appetite in children with normal weight (Baker et al. 2020), video game use will be positively associated with BMI, and higher sugar-sweetened beverages and junk-food consumption will mediate this relationship (Goodman et al. 2020), the effect of video game playing before meals on appetite and food intake in overweight and obese boys (Gheller et al. 2019), appetite and food consumption of video gamers compared television viewers (Siervo et al. 2018), the relationship between video game playing and consuming sugar-sweetened beverages (Kenney & Gortmaker, 2017), The effect of increased media use and video game playing on unhealthy eating behaviors (Cha et al. 2018).

4. Discussion

This review, it is aimed to review all observational studies examining the effects of video gaming on nutrition. In addition, it has systematically collected all published peer-reviewed observational studies on the nutrition of video gamers in order to draw the attention of scholars and researchers on the subject of video gaming and to encourage future observational studies in the field of sports sciences. However, as demonstrated via a systematic literature search few studies exist focusing on the nutrition aspects of video games. Findings of their view demonstrated that one main topic has been investigated in the health literature: (i) The effects of video games on nutritional behaviors.

It has been reported that the lack of physical activity associated with playing video games leads to poor dietary habits and promotes high energy intake (Thivel & Chaput, 2013; Puolitaival et al. 2017). The nutrition of video gamers is unbalanced (Mensink et al. 2013). A positive relationship has been reported between video gaming and the consumption of high-calorie and low-nutrients food (Pentz et al. 2011). It is indicated that 2 hours or more screen time per day is associated with increased energy intake (Shang et

al. 2015) and adolescents with high screen time consume more sugary drinks (Kenney & Gortmaker, 2017; Lowry et al. 2015). In addition, the sample rate that meets the German Nutrition Society recommendation to consume five servings of fruits and vegetables per day is seen as 11%. The researchers also suggest that those with high screen time tend to consume fewer vegetables and fruits (Christofaro et al. 2016; Kenney & Gortmaker, 2017; Shang et al. 2015; Puolitaival et al. 2020). While no difference in energy intake was noted among players who frequently play video games (Mario et al. 2014), one study indicated that playing video games was associated with increased food intake regardless of appetite (Chaput et al. 2011). Despite this statement, no correlation was found between playing video games and the consumption of fruits and vegetables (Rudolf et al. 2020). Additionally, it was indicated that there is insufficient evidence to determine if there is any relationship between the time spent playing video games and energy intake/expenditure or consumption of fruits and vegetables (Pelletier et al. 2020).

The combination of poor eating and poor exercise poses significant risks to metabolism (Chang et al. 2013). Video gamers have reported increased appetite in parallel with sedentary activities (Lyons et al. 2012). Additionally, long-term gaming sessions can hinder a healthy diet pattern by promoting malnutrition or overeating, as well as increased consumption of high-glucose and caffeinated beverages to improve performance among competitive eSports players (Bradbury et al. 2019).

Multiple studies have consistently revealed the negative impact of increased video game interaction on the consumption of more sugar-sweetened beverages and salty snacks (Cemelli et al. 2016; Coleman et al. 2014; Delfino et al. 2020; Santaliestra-Pasias et al. 2012; Tomlin et al. 2014). Consumption of sweet snacks such as fruits, vegetables, cakes, pies, and cookies tend to be associated with gaming behaviors. Meal skipping in people who are heavily focused on playing video games is a known consequence of gaming (Brooks et al. 2016). Meal skipping is common among men, and those who play video games at least four times a week are nine times more likely to skip meals than those who do not play at all (Van den Bulck & Eggermont, 2006).

Long hours of media use or video gaming are positively associated with malnutrition and nighttime eating behaviors (Cha et al. 2018). An association has been indicated between hours of video gaming and increased consumption of fast foods, snacks, and sugary drinks in adolescents (Sisson et al. 2012; Sampasa-Kanyinga et al. 2015). It is also known that video gaming is a distracting activity that suppresses the satiety and feeling of satiety (Mittal et al. 2011).

It is revealed that increased video game use is associated with more consumption of sugar-sweetened beverages (Garcia-Hermoso et al. 2019) and that many video games have in-game ads often promoting sugar-sweetened beverages (Goodman et al. 2020). These ads are reflected in different forms, such as banners and billboards that are displayed in in-game consumption of branded sugar-sweetened beverages (Lorenzon & Russell, 2012). Beverage brands invest a lot of advertising money in video games and video game events. For instance, RedBull has a strong presence in the gaming community (Goodman et al. 2020). Research has shown that in-game ads can make a strong

impression on implicit memory, which can have a subconscious impact on subsequent actions (Yang et al. 2006).

Although video gaming and active video gaming are both screen-based activities, the activity component in active video gaming has the potential to affect energy balance (Baker et al. 2020). It is noted that low-intensity short-term physical activity caused by active video gaming does not affect the energy balance in children with normal weight. The intensity of physical activity is likely to affect the subsequent calorie intake, so much so that exercise with higher intensity can suppress hunger more than low to moderate-intensity exercise. Then the intake of nutrients can be reduced (Deighton & Stensel, 2014; Alkahtani et al. 2014; Sim et al. 2014).

Rather than restricting screen time, video games are used to teach healthy eating strategies, and strengthen and involve the gamer in physical activity. As a matter of fact, video games have been studied as potential tools for losing weight and improving obesity-related behaviors in children and adolescents (Kracht et al. 2020). Lu et al. (2013) determined 28 studies published between 2005 and 2013 in a systematic review of healthy video games on childhood obesity. Three studies involve health games that were developed to promote healthy nutrition and two of them have effectively improved eating habits, including fruit and vegetable consumption. The video games in the other twenty-five studies are the dominant exercise video games studied for potential outcomes related to body weight (Lu et al. 2013).

In addition, a stress response may occur during video gaming. The idea of greater energy intake after stress exposure is underpinned (Siervo et al. 2018). It is indicated that types of food, both fatty and sweet, improve mood and reduce the effect of stress via neurotransmission of dopamine and opioids (Davis et al. 2004; Gibson, 2006). This condition promotes increased food intake (both sweet and salty) during rest (Siervo et al. 2018).

5. Conclusion

In the articles examined, different results are noticeable in relation to nutritional behaviors. The daily intake of sugar-sweetened beverages among both boys and girls is increasing along with video gaming. An increase in total screen time is also indicated as a parallel increase in sugar-sweetened beverages, fast foods, salty snacks, and total energy intake. Moreover, it is noted that the consumption of fruits and vegetables decreases with increasing video gaming time. As a result, it is thought that negative nutritional behaviors develop with increasing video gaming time.

Conflict of Interest Statement

The authors declare no conflicts of interest.

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