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REVIEW

Exergaming and obesity in youth: current perspectives

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Abstract: Although exergaming has been used as a physical activity modality among various populations, the evidence regarding its effectiveness on health-related outcomes in overweight/obese individuals remains unclear. The current study systematically reviewed literature and summarized findings of exergame-based interventions in overweight/obese populations with the goal of clarifying the current perspectives on exergaming and obesity. The initial search yielded 202 articles from six databases; 12 studies were included after evaluating for inclusion criteria and removing duplicates. Among these studies, seven were randomized controlled trials, two were control trials, and three were comparison studies. Overall, exergaming has the potential to attenuate weight gain and shows promise when used for physical activity and physical fitness promotion. Further, exergame play is positively associated with psychological well-being, but its effects on physiological outcomes are inconclusive. Finally, effects of exergaming on energy intake are not clear. Existing evidence supports that exergaming may elicit some health benefits in people who are overweight or/and obese. The limited number of available randomized controlled trials, however, restrict the ability to draw a conclusion that exergaming can trigger a change in all health-related outcomes. More research is warranted to make definitive conclusions regarding the effects of exergaming on health-related outcomes in such populations.

Keywords: active video game, weight loss, children and adolescents, systematic review

Introduction

Over the past few decades, overweight and obesity have become a global public health issue. According to the World Health Organization, worldwide, obesity has more than doubled in children and quadrupled in adolescents since 1980.[1] In fact, more than one-third of children and adolescents were overweight or obese in 2012, and an estimated 39% (more than 1.9 billion) of adults aged 18 years and over were overweight and at least 13% (over 600 million) were obese in 2014.[2] Overweight and obesity are operationally defined as "abnormal or excessive fat accumulations that may impair health".[1] Specifically, overweight refers to having excess body weight for a particular height from muscle, fat, bone, water, or a combination of these factors, while obesity means having excess body fat.[3,4] In general, overweight and obesity typically result from overeating (especially unhealthy diets) and lack of sufficient physical activity, which facilitate the development of several comorbidities such as cardiovascular disease, type 2 diabetes, and various types of cancer.[2,3]

The traditional treatments for overweight and obesity include nutritional education such as eating healthy foods and change in lifestyles by increasing physical activity

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and decreasing sedentary behaviors. Among these traditional treatments, promoting physical activity is often considered an effective avenue in treating overweight and obesity because it not only helps manage weight but also produces health benefits such as strengthening bones and muscles, promoting better sleep, improving mental health and mood, and reducing the risk of cardiovascular diseases.[2] As a result, various physical activities have been introduced and used to help lose and maintain weight (eg, running, hiking, swimming, bicycling). One of the most popular physical activities is exergaming (aka active video games). Exergaming is an emerging technology that uses interactive games to increase exercise behavior, which requires the players to physically interact with on-screen avatars through a variety of body movements such as jumping, kicking, punching, and ducking while providing players the opportunity of being physically active, thereby increasing players' physical activity levels and promoting their overall health.[5] Given the fact that increased physical activity has been proven a viable approach in preventing or lessening the risk of overweight and obesity,[2] exergaming may represent a good alternative in prompting physical activity participation and managing weight. Indeed, the positive effects of exergaming on health-related outcomes have been reported among various populations.[6–8] More recently, however, exergaming has received considerable attention from researchers as a strategic tool to solve the epidemic of childhood obesity within a generation.

A number of reviews with regard to exergaming have been published recently. Yet those systematic reviews on exergaming were mainly focused on physical activity and health promotion among healthy children and young adults.[9–14] However, none of them aimed at the overweight or/and obese populations. Without directly observing such populations, it is difficult to draw a conclusion concerning the effectiveness of exergaming on obesity. In other words, all the conclusions from previous reviews only illustrated the effects of this physical activity modality on preventing the risk of obesity instead of lessening the rate of overweight and obesity. To our knowledge, no known systematic review has specifically addressed the effects of exergaming on health-related outcomes among overweight or/and obese individuals. Given that exergaming has been prevalent among children and adults, it is necessary to synthesize research findings in relation to the effects of exergaming among overweight or/and obese populations with the goal of clarifying the current perspectives on exergaming and obesity, as well as providing meaningful practical implications for future research. Therefore, the purpose of this study was to systematically review and synthesize the exergame-based research that targets overweight or/and obese individuals as well as to discuss the effectiveness of exergaming on health-related outcomes in this population. More specifically, this review described the benefits of exergame playing for overweight or/and obese individuals and ultimately illuminated current perspectives on the topic of exergaming and obesity.

Methods

Study inclusion criteria

To be included in this review, the following inclusion criteria were used for each selected study: 1) published in English between January 2010 and May 2016 as peer-reviewed empirical research, 2) employed the use of at least one exergame (eg, Xbox Kinect, Wii, Dance Dance Revolution [DDR]), 3) sample comprised overweight/obese individuals, and 4) used quantitative measures in the assessment of at least one relevant health or behavioral outcome.

Study exclusion criteria

Due to feasibility of conducting such review, studies in languages other than English were excluded. Additionally, studies were excluded if the participants were underweight (body mass index [BMI] ≤18.5 kg /m^2), normal weight (BMI =18.5–24.9 kg /m^2), and with chronic diseases and/or physical impairments (eg, Parkinson's, impaired balance, poststroke); if the study looked at only passive exergames; if the study involved more than one intervention that may have confounded the results (eg, an intervention consisted of both exergaming and diet components); and if the outcome of interest was measured by qualitative approach.

Search strategy

To ensure inclusion of relevant literature, a comprehensive electronic search was conducted. The following databases were searched: 1) Academic Search Complete, 2) Communication and Mass Media Complete, 3) ERIC, 4) PsycINFO, 5) SportDiscus, and 6) Medline. Search terms used in combination were ("exergam" OR "active video gam*" OR "interactive video gam*" OR "wii" OR "Nintendo" OR "Xbox Kinect" OR "Playstation") and ("overweight" OR "obes*"). Titles and abstracts of potentially relevant studies were further screened by two independent reviewers (NZ and ZG). Full-text copies of studies satisfying the eligibility criteria were obtained, while relevant studies were further identified through cross-referencing the bibliographies of selected articles. Any discrepancies were discussed and resolved by the two reviewers to secure a high agreement for inclusion.

Data extraction and analysis

Data extraction was completed by one reviewer (NZ) and checked by the other (ZG) for accuracy. One reviewer (NZ) independently screened the included articles and extracted data including 1) year of publication and country of origin, 2) methodological details (eg, study design, sample characteristics, exergaming types, outcome measures, and dose of exergaming intervention), and 3) key findings with respect to the effectiveness of exergaming on prompting health-related outcomes among overweight or/and obese populations (eg, improved functional fitness, decreased BMI, reported changes in self-efficacy, heart rate, maximum volume of oxygen). The reviewers were not blinded to the journal titles and author names when extracting data.

Results

Study selection

The initial search yielded 202 articles. After removing duplicates, titles and abstracts of the remaining papers were screened against the inclusion criteria. Following a thorough review of the remaining papers, 12 studies were included in this review (Figure 1). A high inter-rater agreement (ie, 95%) was obtained between the researchers for the articles included.

Study characteristics

The characteristics of the included studies are shown in Table 1. In general, the US was the primary location for exergame-based intervention studies,[15–20] followed by three studies conducted in Canada[21–23] and one study each in New Zealand,[24] South Africa,[25] and Spain.[26] Among the 12 studies, seven were randomized controlled trials (RCTs),[17–21,23,24] two were control trials (CTs; quasi-experimental pretest–posttest design without randomization),[22,25] and three were one-group pretest–posttest design studies (pre-experimental design with pretest–posttest among same participants).[15,16,26] Notably, all the studies aimed at children and adolescents aged 8–19 years, indicating the extent to which the prevalence of obesity is currently increasing among youth; thus, childhood obesity should be paid substantial attention by researchers and policymakers. In addition, relatively large variability was seen for sample size across the studies. Specifically, the sample size varied from 13 to 332, and intervention length ranged from 6 to 24 weeks. With regard to game type, all

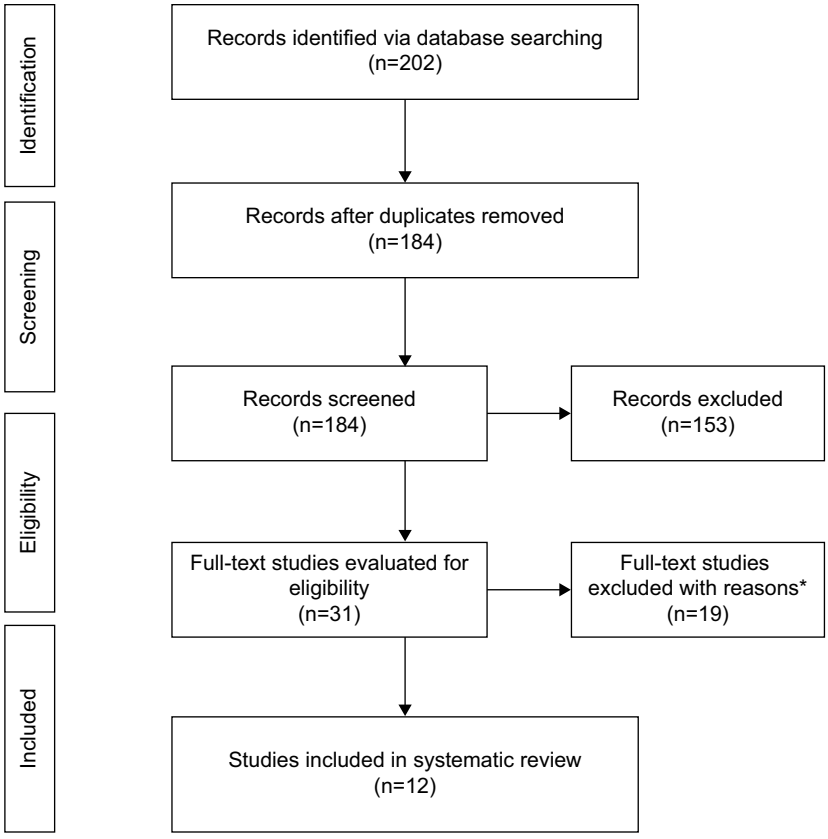

Figure 1 Flow diagram of studies through the review process.
Notes: *Reasons for study exclusion included ineligible age, ineligible populations, ineligible exergaming types, and ineligible outcomes. Many studies were excluded for multiple reasons.

Table 1 Summary of exergaming studies

Study description	Sample and design	Types of AVGs	Outcomes	Dose	Findings
To evaluate the physiologic cost, relative reinforcing value, and liking of playing Wii versus a traditional sedentary video game in lean and overweight/obese children (USA)[15]	Children aged 8–12 years (overweight/obese participants, n=11; lean participants, n=13); comparison design	Wii Sports Boxing	HR, VO_2, liking, and relative reinforcing value	All children completed four 10 min activity conditions: resting, treadmill walking, traditional SVG play, and physically interactive video game play	Average HR, VO_2, and liking were significantly greater for Nintendo Wii than all other conditions. Lean children displayed a greater peak responding for access to Wii relative to SVG, while overweight/obese children did not.
To evaluate the efficacy and feasibility of a multifaceted, community-based weight intervention program for children using exergaming technology (USA)[16]	40 overweight or obese children aged 8–16 years; pre–post test	DDR, Nintendo Wii tennis and boxing, PlayStation 2, etc.	BMI, psychological and behavioral outcomes	120 minutes per week ×10 weeks	The average BMI significantly decreased; the average Global Self-Worth score improved; screen time and soda intake reduced; and exercise hours per week increased after intervention.
To examine whether a 20-week exergame (ie, videogame that requires gross motor activity) intervention can produce weight loss and improve psychosocial outcomes (USA)[17]	African-American adolescents aged 15–19 years (competitive exergame, n=19; cooperative exergame, n=19; control, n=16); RCT	Nintendo Wii	Weight, peer support, self-efficacy, and self-esteem	30–60 minutes per school day ×20 weeks	Cooperative exergame players lost significantly more weight than the control group, which did not lose weight. The competitive exergame players did not differ significantly from the other groups. Self-efficacy of cooperative exergame players also significantly increased compared to the control group, and peer support also increased significantly in both the exergame groups compared to the control group.
To examine the influence of exergaming on adolescent girls' body composition and cardiovascular risk factors (USA)[18]	Obese girls aged 14–18 years (dance exergaming group, n=21; self-directed care control group, n=20); RCT	Xbox Kinect (Just Dance and Dance Central)	Body size and composition, blood pressure, cholesterol, triglycerides, glucose, and insulin	60 minutes per session ×3 times per week ×12 weeks	Per protocol (attended >75%), abdominal subcutaneous adiposity decreased significantly and trunk and spine BMD increased in the intervention group. Per protocol (>2600 steps/session), leg percentage of fat decreased significantly and abdominal subcutaneous and total adiposity decreased in the intervention group.
To evaluate the effects of exergaming on physical activity and weight loss in overweight and obese children (USA)[19]	Overweight and obese children aged 8–12 years (exergame + weight management group, n=31; weight management group, n=38); RCT	Xbox Kinect (Kinect Adventures and Kinect Sports)	Physical activity levels, percentage overweight, and BMI	60 minutes per day ×16 weeks	Participants in the program and active gaming group exhibited significant increases in moderate-to-vigorous and vigorous physical activity at week 16. In the program-only group, a decline or no change was observed in the moderate-to-vigorous and vigorous physical activity. Participants in both the groups exhibited significant reductions in percentage overweight and BMI at week 16. However, the program and active gaming group exhibited significantly greater reductions in percentage overweight and BMI.

(*Continued*)

Study description	Sample and design	Types of AVGs	Outcomes	Dose	Findings
To investigate the impact of dance-based exergaming on a diverse sample of obese adolescents' perceived competence to exercise, psychological adjustment, and BMI (USA)[20]	Obese adolescents aged 12–18 years (exergame group, n=20; control group, n=20); RCT	DDR	BMI, psychological adjustment, and perceived competence to exercise	3 times a week for 40 minutes in the first session and 75 min in subsequent sessions ×10 weeks	Compared with controls, participants in the dance-based exergaming group exhibited significant increase in self-reported perceived competence to exercise regularly and reported significant improvement in relationship with parents from baseline to end-of-treatment. Mothers of adolescents in the exergaming group reported significant reductions in both composite scores of internalizing and externalizing symptomatology. No pre–post differences in BMI were seen within or between groups.
To examine the efficacy of interactive video game stationary cycling in comparison with stationary cycling to music on adherence, energy expenditure measures, submaximal aerobic fitness, body composition, and cardiovascular disease risk markers in overweight and obese adolescents (Canada)[21]	Overweight or obese adolescents aged 12–17 years (interactive video game cycling group, n=13; stationary bike music group, n=13); RCT	Sony PlayStation 2	Exercise adherence, body composition, aerobic fitness, and exercise behavior	Twice per week for 60 minutes per session ×10 weeks	The music group had a higher percentage of attendance. There were no significant differences in peak HR, peak workload, time to exhaustion, body weight, BMI, fat mass, fat-free mass, waist circumference, and blood work parameters.
To examine the effects of 1-hour AVG play on lean and obese adolescents' energy expenditure (Canada)[22]	Adolescent boys aged 12–15 years (exergame group, n=19 obese; control group; n=12 lean); CT	XBOX 360 Kinect Sport Boxing	Body weight, BMI, BF, EE, HR, METs	60 minutes	Body weight, BMI, and body fat were significantly higher in obese adolescents. Absolute EE was significantly higher in obese adolescents but not when corrected for body composition. Maximal HR reached during AVG was significantly higher in lean adolescents. Time spent between three and six METs was not different between the groups but time spent above six METs was higher in lean adolescents.
To evaluate the effects of stationary cycling to music versus interactive video game cycling on psychosocial functioning in obese adolescents (Canada)[23]	Overweight or obese adolescents aged 12–17 years (interactive video game cycling group, n=13; stationary bike music group, n=13); RCT	Sony PlayStation 2	Scholastic competence, social competence, athletic competence, body image, self-esteem, aerobic fitness, and body composition	Twice per week for 60 minutes per session ×10 weeks	Although no differences emerged between the exercise groups over time, when collapsed across exercise modality, significant pre–post improvements were found for body image, perceived scholastic competence, and social competence. Changes in aerobic fitness, but not body composition, were positively associated with psychosocial functioning.

(*Continued*)

Table 1 (*Continued*)

Study description	Sample and design	Types of AVGs	Outcomes	Dose	Findings
To evaluate the effects of active video games over a 6-month period on weight, body composition, physical activity, and physical fitness (New Zealand)[24]	Overweight and obese children aged 10–14 years (exergame group, n=160; control group, n=162); RCT	Sony PlayStation EyeToy	BMI, BF, physical activity, cardiorespiratory fitness, video game play, and food snacking	60 minutes of moderate-to-vigorous PA on most days of the week ×24 weeks	The treatment effect on BMI favored the intervention group. BMI increased in the control group but remained the same in the intervention group. There was also evidence of a reduction in BF in the intervention group. The change in daily time spent playing active video games at 24 weeks increased in the intervention group accompanied by a reduction in the change in daily time spent playing non-active video games.
To investigate the effects of exergaming on overweight and obese children's functional fitness (South Africa)[25]	Overweight and obese children aged 9–12 years (exergame group, n=11; control group A, n=10; control group B, n=10); CT	Nintendo Wii	Functional fitness (ie, agility, speed, balance, reaction time, and coordination)	3 days per week for 30 minutes per session ×6 weeks	The exergame group showed significant improvement in their level of functional fitness. Specifically, coordination, reaction time, and speed and agility increased by magnitudes of 28%, 94%, and 37% respectively.
To investigate the effects of an exergaming platform on perceived exertion, self-efficacy, positive expectations, and satisfaction in overweight/obese children and adolescents as compared with normal-weight children (Spain)[26]	Children and adolescents aged 6–16 years (walking on a treadmill with the support of the videogame platform group, n=21; walking on a treadmill group, n=21); comparison design	Wii Fit	Satisfaction, self-efficacy, positive expectations, RPE, HR, VO_2, MET	In both the conditions, the treadmill program was 4 minutes in duration at a fixed speed of 4.2 km/h, with 4 additional minutes at 5.7 km/h (brisk walking speed).	The obese children scored significantly higher in expectations and satisfaction in the exergame condition but not in self-efficacy, perceived exertion, or physiological measures.

Abbreviations: AVG, active video game; BF, body fat; BMD, bone mineral density; BMI, body mass index; CT, control trial; DDR, Dance Dance Revolution; EE, energy expenditure; HR, heart rate; MET, metabolic equivalent task; PA, physical activity; RCT, randomized controlled trial; RPE, rate of perceived exertion; SVG, sedentary video game; VO_2, maximal oxygen consumption.

the studies employed commercially available exergames including, but not limited to, Nintendo Wii, Xbox Kinect, and DDR.

Data synthesis

Studies were grouped depending on if they examined, 1) adiposity outcomes (ie, if exergaming was associated with decreased BMI, percentage body fat, change in skin fold thickness, waist circumference and waist-to-hip ratio, bio-impedance, body composition), 2) physical outcomes (ie, if exergame play promoted skill-related fitness or changed habitual physical activity), 3) physiological outcomes (ie, if exergaming impacted energy expenditure, heart rate, metabolic equivalent task [MET], blood pressure, cholesterol, triglycerides, glucose, and insulin), 4) psychological outcomes (ie, if exergaming changed self-efficacy, self-esteem, body image, perceived competence, scholastic competence, social competence, athletic competence), and 5) energy intake (ie, if exergaming changed dietary behavior).

Adiposity outcomes

Seven RCTs and one comparison study examined the relationship between exergaming and adiposity. The majority of the RCTs (n=4) reported that exergaming intervention had a positive effect on BMI, body composition, or body fat.[17–19,24] In detail, Staiano et al[17] indicated that cooperative exergame players lost significantly more weight than the control group (participants performed usual daily activities such as socializing with friends, tutoring, and sports team practice), who did not lose weight after a 20-week

(30–60 minutes per school day) Nintendo Wii intervention. Staiano et al[18] also revealed decreases in leg fat percentage, abdominal subcutaneous adiposity, and total adiposity in the exergame group after a 12-week (60 minute per session ×3 times per week) dance-based intervention compared to a self-directed care control condition. Trost et al[19] suggested that participants in a weight management and exergaming group exhibited significantly greater reductions in percentage overweight and BMI over 16 weeks (60 minute per day), although the non-exergame group (weight management only) showed a decrease as well. Maddison et al[24] reported decrease in body fat in the exergame group after a 24-week, 60 minutes of moderate-to-vigorous physical activity on most days of the week intervention, compared to the control group who played normal video games.

The remaining RCTs (n=3) indicated that exergaming did not have a significant effect on adiposity outcomes.[20,21,23] Specifically, Wagener et al[20] suggested that no pre–post differences in BMI were seen after a 10-week (three times per week, 40 minutes for the first session and 75 minutes for subsequent sessions) DDR intervention in obese adolescents. Adamo et al[21] and Goldfield et al[23] found no significant differences in body weight, BMI, fat mass, fat-free mass, waist circumference, or body composition between children who were given exergaming or those who were given a traditional exercise (stationary bike) after a 10-week exercise session (twice per week and 60 minutes per session). Finally, one comparison study[16] reported that children's average BMI significantly decreased after 10 weeks (120 minutes per week) of exergame-based intervention.

Physical outcomes

This review identified two RCTs and one CT examining the effects of exergaming on physical outcomes among overweight or/and obese children (eg, habitual physical activity and functional fitness). One RCT reported that participants in the exergaming group showed significant increases in moderate-to-vigorous physical activity at week 16;[19] another RCT found an increase in daily time spent playing exergaming at week 24, indicating exergame play may increase children's physical activity thereby decreasing sedentary behavior.[24] In addition, one CT revealed that children in the exergaming group showed significant improvement in their levels of functional fitness, including coordination, reaction time, speed, and agility after a 6-week (30 minutes ×3 days per week) exergame-based intervention in comparison with control group (participants played traditional video games and continued with their everyday life activities).[25]

Physiological outcomes

Seven studies assessed whether exergaming affects one's physiological health, such as heart rate, maximal oxygen consumption, aerobic fitness, METs, and cardiovascular risk factors. Of the four RCTS, three reported that exergaming had no effect on physiological outcomes. Specifically, Staiano et al[18] found no significant changes in cardiovascular risk variables including blood pressure, cholesterol, triglycerides, glucose, and insulin, but significant increases in trunk and spine bone mineral density were seen in overweight and obese girls after intervention. Adamo et al[21] reported that there were no significant differences in peak heart rate, peak workload, time to exhaustion, and blood work parameters, suggesting exergaming may not help obese children improve aerobic fitness. Maddison et al[24] revealed that cardiovascular fitness (maximal oxygen consumption) changed but did not reach statistical significance after exergame play. On the other hand, one RCT by Goldfield et al[23] indicated that exergaming had a positive effect on aerobic fitness for participants in the exergaming group as shown by a significant decrease in peak heart rate and rate of perceived exertion after a 10-week exergame-based intervention (60 minutes × twice per week ×10 weeks) in comparison with stationary cycling to music group (non-exergaming group). In addition, one CT[22] reported that absolute energy expenditure was significantly higher in obese children but maximal heart rate was lower in comparison with lean participants during exergaming. Notably, time spent between three and six METs was not different between obese and lean groups but time spent above six METs was lower in obese adolescents. Finally, a comparison study[15] displayed that average heart rate and maximal oxygen consumption were significantly greater in Nintendo Wii condition than in treadmill walking and traditional sedentary video game; one study found no improvements in any physiological measures including heart rate, rate of perceived exertion, maximal oxygen consumption, and MET.[26]

Psychological outcomes

This review included three RCTs and two comparison studies looking at the psychological effects of exergaming. Staiano et al[17] reported that self-efficacy of cooperative exergame players significantly increased, and both cooperative and competitive exergame groups exhibited more peer support compared to control group after 20 weeks. Wagener et al[20] found that self-reported perceived competence to exercise regularly significantly increased in participants in dance-based exergaming condition. Goldfield et al[23] suggested that significant pre–post improvements were found for body image, perceived scholastic competence, and social competence

after exergame-based intervention. Moreover, a comparison study indicated that improvement was seen in global self-worth, but not in scholastic competence, social acceptance, athletic competence, and physical appearance.[16] Another study suggested that obese children scored significantly higher in expectations and satisfaction in the exergame condition but not in self-efficacy and rate of perceived exertion.[26]

Energy intake

Three studies investigated energy intake during exergaming. One of the RCTs reported that average self-reported daily total energy consumed from snack food decreased in the exergaming group (567±684 kcal/day) over a 24-week PlayStation EyeToy intervention compared to normal video game play control group (708±948 kcal/day), but such change was not statistically significant.[24] Another RCT showed no dietary changes (ie, overall energy intake or macronutrient intake) over the course of exergame-based intervention.[21] Finally, one comparison study suggested that children's soda intake significantly reduced from an average of 4.27 to 2.75 servings per day, but fast food intake did not change after a 10-week exergame play (120 minutes per week).[16]

Discussion

Given that the worldwide prevalence of obesity has increased rapidly over the past decade while exergaming is becoming an increasingly popular activity in which both children and adults are engaging, it is necessary to review and synthesize research findings in relation to exergaming and obesity. Therefore, this review synthesized the current evidence regarding the effects of exergaming on health-related outcomes among overweight or/and obese individuals, with the goal of stating the current viewpoints on the topic of exergaming and obesity as well as providing meaningful practical implications for future research. Twelve studies meet the basic eligibility criteria and were included for review.

This systematic review is the first to provide a comprehensive understanding of the influence of exergaming on multiple health and behavioral outcomes in overweight or/and obese populations. Overall, evidence concerning the effects of exergaming on adiposity outcomes is inconclusive as four RCTs indicated positive effects and three RCTs did not. However, existing evidence suggests that exergaming has the potential to attenuate weight gain for overweight or/and obese children and youth. Two RCTs that examined exergaming and physical activity levels showed that exergaming may make a significant contribution to enable children and youth to meet guidelines of 60 minutes of moderate-to-vigorous physical activity on a daily basis, as well as positively change one's exercise habits by increasing daily time spent on physical activity. In other words, exergaming shows promise as a tool to motivate and engage children and adolescents in physical activity. Also, there is evidence suggesting that exergaming can be beneficial to improve children's skill-related physical fitness. Nonetheless, evidence for exergaming and physiological outcomes is unclear as only one out of the four RCTs reported positive effects. Although literature demonstrated that exergaming alone may not be enough to stimulate physiological changes (eg, heart rate, maximal oxygen consumption, blood pressure, cholesterol) and reduce the risk of cardiovascular disease, exergame play is able to increase trunk and spine bone mineral density of overweight and obese girls. Further, all the RCTs suggest that exergaming has a positive effect on one's psychological outcomes including self-efficacy, body image, perceived scholastic competence, and social competence. Finally, evidence for energy intake from two RCTs shows that exergaming may affect one's dietary behavior, but did not reach statistical significance.

The main strength of this study is the use of high standards of developing and conducting a systematic review, which helps limit potential bias throughout the review. All the steps of the review (ie, inclusion criteria, exclusion criteria, and data extraction) were completed in duplicate to minimize error; the review focused on multiple health-related outcomes with the hope of giving a thorough understanding of the relationship between exergaming and health among overweight or/and obese populations. Although the current study provides the first known synthesis of the effects of exergame-based intervention in overweight or/and obese children and adolescents in a systematic manner, the study is not without limitations. To begin with, the current review is limited by the inclusion of only English language publications and peer-reviewed full-text despite the fact that other unpublished and non-English work may be available on the topic. Second, most studies had small sample sizes, making it difficult to illustrate the true effects of exergaming on health-related outcomes, and the relatively low quality of studies may limit the generality of findings. Since some studies were underpowered, the findings were not statistically significant, although many of them displayed a trend toward significance. Furthermore, the variety of exergames employed in intervention studies limited the ability to discern which specific games, and which aspects of those games, are most useful for overweight or/and obese individuals.

Previous literature that aimed at different populations showed similar results to ours in that some exergames: 1) can

be considered a highly relevant strategic tool for the adoption of an active and healthy lifestyle, and may be useful in preventing and lessening the risk of childhood obesity,[27] 2) have a positive effect on psychological well-being,[28–30] (3) have the potential to improve individual functional fitness,[31,32] and (4) acutely increase light- to moderate-intensity physical activity but are unable to elicit high-intensity physical activity.[33–35] Therefore, more high-quality RCT should be designed, and well-powered studies are warranted to compare exergames versus traditional physical activity, as well as contrast different types of video game consoles. Future research should aim to use larger sample sizes and diverse populations to avoid being statistically underpowered. Moreover, multiple follow-up measurements over longer time periods are required so the longitudinal effects of exergaming use can be better understood.

Conclusion

The current review supports that exergaming, as a physical activity modality, leads to a more active lifestyle by promoting physical activity, psychological well-being, motor competence, energy expenditure, and cardiorespiratory fitness and by reducing body fat and sedentary behaviors in overweight or/and obese children and youth. Nevertheless, the limited number of available RCTs and concerns with design quality of other non-RCT studies restrict the ability to discern whether, or the circumstances under which, playing an exergame results in sustained changes in weight status and physiological responses, and for how long the change occurs. High-quality research is needed, to determine how different exergames may relate to the initiation and maintenance of some health benefits and understand the effects of exergaming on health-related outcomes, to resolve such discrepancies.

Disclosure

The authors report no conflicts of interest in this work.

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