Exergames as a tool for improving muscular fitness, cardiorespiratory fitness, and body composition in children and adolescents: a systematic review

Exergames para mejorar la condición física y la composición corporal en la niñez y adolescencia: una revisión sistemática

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Abstract

Introduction: over 80% of children and adolescents fail to meet physical activity recommendations, leading to declines in muscular and cardiorespiratory fitness and rising obesity rates. Exergames—digital games requiring physical movement—are a promising tool to promote activity in youth.
Objective: to determine the effects of exergames on muscular fitness, cardiorespiratory fitness, and body composition in children and adolescents.
Methodology: a search was conducted in Web of Science, Scopus, CINAHL, and PubMed databases, including randomized controlled trials published in the last 10 years. Studies were excluded if they involved participants with disabilities or used exergames for rehabilitation or hospital-based interventions.
Results: a total of ten studies were included: three out of five studies reported improvements in muscular fitness, seven out of nine in cardiorespiratory fitness, and five out of nine in body composition. The most effective interventions occurred 2–3 times per week, for 40–60 minutes per session, over at least 12 weeks.
Discussion: while outcomes are promising, differences in study design, duration, and assessment tools may have affected consistency across results.
Conclusion: exergames appear effective for improving health-related fitness in children and adolescents, providing a fun and accessible way to increase physical activity through technology.

Keywords

Body composition; cardiorespiratory fitness; exergames; muscular fitness.

Resumen

Introducción: más del 80% de los niños, niñas y adolescentes en el mundo no cumple con las recomendaciones diarias de actividad física, lo que contribuye a un deterioro temprano de la condición muscular y cardiorrespiratoria, junto con un aumento en las tasas de sobrepeso y obesidad. Los exergames —videojuegos con movimiento corporal— han surgido como una estrategia innovadora y atractiva para fomentar la actividad física en la población infantojuvenil.
Objetivo: determinar los efectos de los exergames sobre la capacidad cardiorrespiratoria y muscular, en conjunto con la composición corporal en niños, niñas y adolescentes.
Metodología: se realizó una búsqueda en las bases de datos Web of Science, Scopus, CINAHL y PubMed para identificar ensayos clínicos aleatorizados publicados en los últimos 10 años. Se excluyeron estudios con participantes que presentaran discapacidades, así como aquellos en los que los exergames se utilizaron en rehabilitación o en intervenciones hospitalarias.
Resultados: se incluyeron diez estudios. De ellos, 3 de 5 informaron mejoras en la condición muscular, 7 de 9 en la aptitud cardiorrespiratoria y 5 de 9 en la composición corporal. Las intervenciones más efectivas se realizaron entre 2 y 3 veces por semana, durante 40–60 minutos por sesión, por al menos 12 semanas.
Discusión: aunque los hallazgos sugieren beneficios en la condición física, la heterogeneidad en los diseños y métodos puede haber afectado la consistencia de los resultados.
Conclusiones: los exergames representan una herramienta prometedora para mejorar la condición física relacionada con la salud en población infantil y adolescente.

Palabras clave

Composición corporal; condición cardiorrespiratoria; fuerza muscular; videojuegos activos

Introduction

The obesity pandemic is a complex global problem that has been present for several decades among the population, including children and adolescents. The World Health Organization (WHO) defines it as the excessive accumulation of body fat, resulting in a significant risk to health and well-being (Jebeile et al., 2022; Mittal & Jain, 2021). It results from the imbalance between caloric intake and lack of physical activity levels, as well as other factors influenced by the environment, such as socioeconomic status, public policies, food choices, cultural eating behaviors, and genetic factors (Pinheiro, 2022; Mittal & Jain, 2021; Stabouli et al., 2021). The global prevalence of obesity and overweight in the population was over 300 million individuals aged five to 19 years in 2016 (Di Cesare et al., 2019; Fonvig et al., 2021; Stabouli et al., 2021), with 124 million of them being obese. Among children under five years old, the prevalence of overweight and obesity was around 40 million infants (Di Cesare et al., 2019; Stabouli et al., 2021). Moreover, it is estimated that by 2030, obesity in children and adolescents aged five to 19 will exceed 250 million (Jebeile et al., 2022), which will contribute to reduced physical fitness in the pediatric population (Drenowatz et al., 2022). Physical fitness is defined as the ability to carry out physical activities according to daily demands, including muscular strength, cardiorespiratory capacity, and body composition (Powers & Howley, 2015). Cardiorespiratory fitness refers to the ability to resist fatigue during prolonged activities, where it is essential to transport adequate amounts of oxygen to the muscle groups involved in ATP synthesis (Niño, 2010). This capacity can be assessed through tests that require significant cardiopulmonary effort (Secchi et al., 2013). Meanwhile, muscular strength is the fundamental conditional quality defined as the ability of a muscle group to generate tension at a specific speed against a determined resistance (García et al., 2010). Both muscular strength and cardiorespiratory fitness are strong predictors of life quality and expectancy (Appelqvist-Schmidlechner et al., 2020). It has been demonstrated that good levels of muscular strength and cardiorespiratory fitness act as protective factors against various diseases, such as cardiovascular disease and type 2 diabetes mellitus (Mandsager et al., 2018; McLeod et al., 2016; Genovesi & Parati, 2020). Therefore, evaluating muscular strength and cardiorespiratory fitness is essential not only to determine an individual's physical state but also to predict long-term health and quality of life by preventing chronic diseases.

In the school context, exergames (from exercise and games), have emerged from the need to combine technologies with physical activity (Medeiros et al., 2017) where the video game industry has incorporated the concept of natural interaction, developing peripheral controls that allow a greater immersion in the game using emerging technologies (Muñoz et al., 2013).

Exergames can promote physical activity, enhance motor competence, generate psychological and social benefits, improve physical fitness and body composition, and increase students' motivation to participate in physical education classes. Exergames can be integrated into physical education sessions in a structured manner, particularly through games inspired by dance, sports, action and adventure, or a combination of these. Their effectiveness has been demonstrated in reducing sedentary behavior and promoting participants' overall health (Marin-Suelves, Guzmán, & Ramon-Llin, 2022).

In the 1990s, the first exergames were introduced as tools to support high-performance sports training. These early games aimed to enhance athletic performance through interactive movement-based exercises. However, it was not until 1998 that Dance Dance Revolution 1st Mix emerged as one of the first exergames designed for the general population. This game featured a dance competition where players stepped on a pressure-sensitive mat, integrating physical activity with gameplay (Castro et al., 2017).

Subsequently, with advancing technology, in 2007, Nintendo launched the Wii console, and by 2010, Microsoft created the Kinect device, marking a significant development in exergames (Castro et al., 2017). These new technologies were implemented to complement individuals' sports needs during exercise (Ramirez-Granizo et al., 2020), as exergames contain tools that allow people to move within a virtual reality, promoting players to be more active through virtual sports, interactive and playful activities that are executed with movements, gestures and voices, among others (Medeiros et al., 2017).

In this sense, integrating exergames into daily life could help children and adolescents meet the recommended levels of daily physical activity (Medeiros et al., 2017). However, given the wide variety of exergames that exist, it is difficult to make a standard recommendation based on this model of exercise method to improve muscular strength, cardiorespiratory fitness, and body composition. Therefore, a systematic review was conducted to determine the effect of exergames on muscular strength, cardiorespiratory fitness, and body composition in children and adolescents, based on the existing evidence from randomized clinical trials in various databases over the past 10 years.

Method

This review was conducted following the PRISMA methodology (Page, 2021) and considered the following aspects as inclusion criteria: 1) Children and adolescents with normal weight, overweight, and/or obesity, 2) The participants' age ranged between 6 and 18 years, 3) The types of articles considered were randomized controlled trials and randomized clinical trials (control group vs. intervention group), 4) At least one outcome related to muscular fitness, cardiorespiratory capacity, cardiovascular fitness (blood pressure, heart rate) physical condition and/or body composition, 5) Articles published in the last 10 years, 6) Medical intervention period between two and six months (24 weeks).

Regarding the exclusion criteria, this review considered: 1) Children and adolescents with physical, visual, auditory, or intellectual disabilities, 2) Protocols that consider exercise as a form of rehabilitation, 3) Children and adolescents with cardiovascular, respiratory, renal, or muscular diseases requiring intrahospital physical exercise.

The search was conducted on August 14, 2023, and included articles published from 2013 onwards, using the PICOT (McClinton, 2022) search method. The search strategy for PubMed, Scopus, CINAHL, and WoS were based on the PICOT strategy (population, intervention, comparison, outcome, and time or type of research/publication) (Peñaherrera Oviedo & Soria Viteri, 2015), shown in Table 1.

Table 1. PICOT Strategy

1	Population	(("children") OR ("adolescent*") OR ("teenager") OR ("teen*"))
2	Intervention	(("exergame*") OR ("exergames") OR ("Wii") OR ("kinect") OR ("active video games") OR ("video game*"))
3	Comparation	No comparation
4	Outcome	(("fitness") OR ("physical fitness") OR ("body composition") OR ("cardiovascular fitness") OR ("strength") OR ("muscular fitness") OR ("muscular power")) NOT (("rehabilitation") OR ("disability*"))
5	Time or type of research/publication	Randomized controlled trial or experimental research with control group and pre/post comparation.
6	Search Strategy	1 AND 2 AND 4

OR-AND-NOT: boolean operators

Study Selection and Data Collection

The studies were imported into the EndNote reference manager, where the first step was to remove duplicates. After that, the selection of articles based on their title and abstract was carried out. Finally, each article was read, and those that did not meet the inclusion criteria were excluded. In the identification phase, a total of 773 potentially relevant records were identified from WoS (N=247), Scopus (N=327), CINAHL (N=56), and PubMed (N=143) databases, 238 duplicate records were removed using EndNote, leaving 534 records. In the screening phase, the titles and abstracts of the selected records were reviewed, resulting in 77 articles.

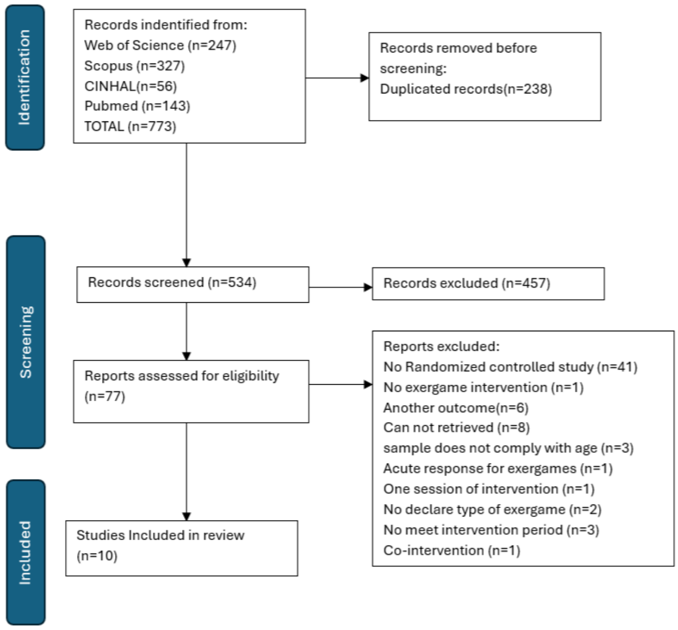
Following a full-text review, 66 articles were excluded for the following reasons:

- 41 were not clinical trials or randomized controlled trials.
- 6 did not report outcomes related to physical fitness or body composition.
- 8 could not be accessed.
- 1 did not involve exergames.
- 3 did not meet the age range of 6–18 years.
- 1 assessed only acute responses.
- 1 had only a single intervention session.

- 2 lacked a clearly defined intervention.
- 3 did not meet the intervention period requirement of at least 2 weeks.

After applying the inclusion and exclusion criteria, ten articles were included in this systematic review (figure 1).

Figure 1. Flow Chart of the Search Performed Considering the PRISMA Statement (Page, 2021)



Risk of Bias Assessment

The risk of bias assessment was performed by authors CPA and CMG using the Cochrane Collaboration's Risk of Bias 2 (RoB 2) tool to evaluate the risk of bias (Sterne et al., 2019) of the 10 studies included-Figures 2 and 3 show the RoB 2 assessment of the selected studies. For overall bias, 20% of the studies were rated as "high risk" of bias (Chen & Sun, 2017; Martínez-López et al., 2022), 30% were rated as "some concerns" (Bonny et al., 2019; Comeras-Chueca et al., 2022; Ketelhut et al., 2022), while 50% were rated as "low risk" of bias (Lau, Wang, & Maddison, 2016; Coknaz et al., 2019; Irandoust et al., 2020; Staiano et al., 2017; Staiano et al., 2018). For randomization, 20% were classified as "high risk" of bias, while 70% were rated as "low risk" of bias. For deviations from the intended interventions, 70% of the studies were classified as "low risk" of bias. Finally, for the selection of reported outcomes, 90% of the studies were rated as "high risk" of bias (Figure 1 and Figure 2).

Figure 2. ROB2 Risk of Bias by Domain Score

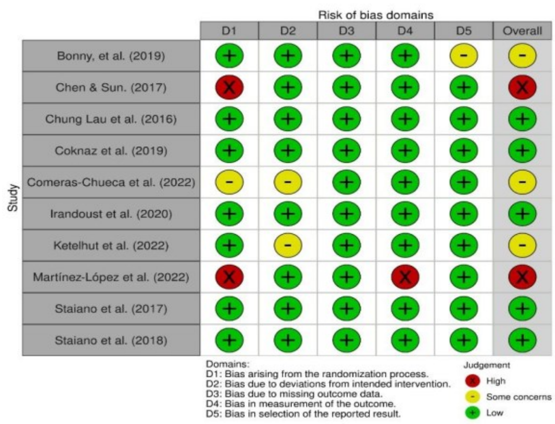
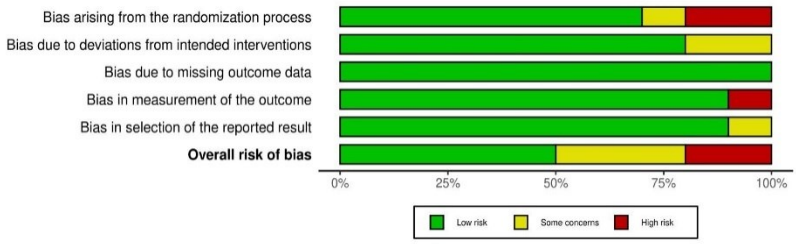


Figure 3. ROB2 Risk of Bias Based on Risk Percentage



Results

A total of ten articles focused on the use of exergames to improve muscular strength, cardiorespiratory fitness, and body composition in children and adolescents. The descriptive results of each selected study—Bonney et al. (2019); Chen & Sun (2017); Coknaz et al. (2019); Comeras-Chueca et al. (2022); Irandoust et al. (2020); Ketelhut et al. (2022); Lau, Wang, & Maddison (2016); Martínez-López et al. (2022); Staiano et al. (2017); Staiano et al. (2018); are presented in Table 2. The following coding was used to extract the data: (1) Author, (2) Population/Sample, (3) Methodology/Intervention, and (4) Outcomes (table 2).

Table 2 Summary of Major Findings on the Impact of Exergames on Physical Fitness and Body Composition in Children and Adolescents

Autor	Population/Sample	Metodology/Intervention	Outcomes
Bonney, et al. (2019)	52 females 13-16 years old. Task-based training group: n=26 Wii fit group: n=26	Wii fit. 1 session per week of 45 min for 14 weeks. jogging, slalom skiing, Hula Hoop, half-moon, obstacle course, basic steps, single leg extension, kung fu, sun salutation and Just Dance. Category: Sport, Dance. TFT (Task Oriented Functional Training) consisted of 3 components including dance to music, goal-directed activities (e.g., throwing to targets, emptying boxes, walking and running) and team activities. games (e.g., tag, relay, hide-and-seek).	*POST v/s PRE both TFT and Wii fit group: ↑Aerobic fitness (20 m out-and-back running test). ↑Knee extensor strength. ↑Anaerobic fitness (5 m sprint test straight and slalom).
Chen & Sun. (2017)	65 students of 3rd and 4th grade of 9-10 years old. Physical education group: n=29. AVG group: n=36.	Kinect. 3 sessions of 40 min for 6 weeks. Zumba Kids (used for eight sessions) and Just Dance Kids 2014 Category: Dance. SPARK Physical Education Core lesson content was drawn from the SPARK K-5 curriculum,26 including, but not limited to, snakes and lizards, builders and dozers, aerobic bowling, hospital tag, plentiful fuss, flip-flops, centipede bucket brigade, perimeter movement, capture the flag, addition tag, and blob tag.	*Group Kinect AVG v/s SPARK intervention POST intervention: ↑Aerobic fitness (increased PACER test performance). ↑MVPA. ↔ BMI ↔Performance curl-ups and push-ups.
Coknaz et al. (2019)	106 children between 3rd and 6th grade (mean age 10 years). Control group: n=53 AVG group: n=53	Nintendo wii. 3 sessions per week of 50-60 minutes for 12 weeks. (boxing, tennis, golf, baseball and bowling), balance (slalom skiing, pitching, balance bubble, ski jumping and penguin game), aerobics (rhythmic boxing, hula-hoop, cycling, step and run), station (jet-skiing, water skiing, table tennis, basketball, fencing, archery, canoeing and frisbee) and training (rhythmic kung fu, snowball, spinning ball, Segway circuit, perfect 10, skateboard, main run, obstacle course and bicycle). Category: Sports.	*AVG group v/s control group POST intervention: ↓Mean values and BMI z-score. ↓Visual and auditory RT in dominant and non-dominant hands. ↔%Body Fat
Comeras-Chueca et al. (2022)	29 boys and girls with obesity and overweight (mean age of 10 years). Control group: n=8 AVG group: n=21	3 sessions per week of 60 minutes for 5 months. Various AVG + multicomponent exercise using XBOX Kinect: “Kinect Adventures” and “Kinect Sport”. Nintendo Wii®: “Wii Sports”, “Just Dance”, and “Mario and Sonic at the Olympic Games”. Dance mats using “Dance Dance Revolution” and “Mario and Sonic at the Olympic Games” adapted from the Nintendo Wii to the dance mats.	*POST v/s PRE both AVG group and control group: ↑Total lean mass. *POST v/s PRE AVG group: ↑Knee extension maximal isometric strength. ↑Hand grip strength.

			↑Jump height (CMJ) along with the z-score of the CMJ test. ↑Motor competence. ↑Physical activity light intensity. ↔BMI
Irandoust et al. (2020)	61 obese children (mean age 9 years). VGG group: n=21 Aquatic exercise group (AEG): n=20 Control group: n=20	Kinect. 3 sessions per week of 60 minutes for 12 weeks. Wii Sports, Kinect Ultimate Sports, Wii Fit and Just Dance Category: Sports, Dance. Aquatic Exercise Jumps, high knees, punches, quick kicks, back kicks, running laps, and spinning lunges.	*POST v/s PRE both VGG group and AEG group: ↓Body weight. ↓ BMI ↑Pulmonary function (improved forced vital capacity [FVC] and forced expiratory volume in 1 second [FEV1]). *VGG and AEG group v/s control group POST intervention: ↓Body weight. ↓WHR (waist-to-hip ratio). ↓ BMI ↑Pulmonary function (improved forced vital capacity [FVC] and forced expiratory volume in 1 second [FEV1]). ↔% Body fat
Ketelhut et al. (2022)	58 students (mean age 10 years). AVG group: n=18 Control group: n=16	ExerCube. 2 sessions per week of 20 minutes for 12 weeks in addition to regular physical education classes. Control group only performs physical education classes. Sphery Racer Category: Sports.	*POST v/s PRE AVG group: ↑Jump height (CMJ). ↔ST test performance. ↑Aerobic capacity (SRT test). ↔ BMI ↔WHR (waist/hip ratio). *POST v/s PRE group GC: ↓Jump height (CMJ). ↔ST test performance ↔aerobic capacity (SRT test). ↔ BMI ↔WHR (waist/hip ratio).
Lau, Wang, & Maddison (2016)	80 children between 8 and 11 years old. AVG group: n=40 Control group: n=40	Kinect. 2 sessions per week of 60 minutes for 12 weeks. bowling, boxing, track and field, table tennis, beach volleyball, soccer, golf, darts, baseball, skiing, tennis and soccer. Category: Sports.	*Kinect group POST v/s PRE: ↑ VO_2max. ↑ BMI.
Martínez-López et al. (2022)	164 Spanish adolescents between 12 and 15 years old. Intervention group: n=78 Control group: n=86	Cellular/Smartphone. 40 minutes on average per day for 8 weeks. Pokemon GO Category: Exploring and walking games.	*POST v/s PRE intervention group: ↑ Cardiorespiratory capacity (20m run). ↔Agility test 4x10m ↔Horizontal jump test ↔%GC ↓ BMI *Intervention group v/s control POST intervention: ↑ Cardiorespiratory capacity (20m run). ↔Agility test 4x10m ↔Horizontal jump test ↔%GC ↓ BMI
Staiano et al. (2017)	41 overweight and obese girls between 14 and 18 years old. Intervention group: n=22 Control group: n=19	Kinect. 3 sessions per week of 60 minutes for 3 months. Just dance (versions 3, 4, 2014 and Greatest Hits) and Dance Central (versions 2 and 3). Category: Dance.	*Intervention group v/s control group POST intervention: ↓ Abdominal, subcutaneous and total adiposity. ↑ BMD of trunk and spine. ↔ BMI
Staiano et al. (2018)	45 overweight and obese children between 10 and 12 years old.	Kinect. 3 sessions per week of 60 min for 24 weeks. Your form: Fitness Evolved 2012, Just Dance 3, Adventures in Disneyland and Kinect Sports (Season 2).	*Intervention group v/s control group POST intervention:

Intervention group: n=22 Control group: n=23	Category: Dance, Sports.	↓BMI z-score. ↓Systolic blood pressure. ↓Diastolic blood pressure. ↓Total cholesterol ↓LDL. ↑MVPA. ↔BMD.

↑; Significant increase. ↓; Significant decrease. ↔; No significant change. %GC: Body Fat Percentage, AVG: Active Video Games, BMD: Bone Mineral Density, BMI: Body Mass Index, CMJ: Countermovement Jump, FEV1: Forced Expiratory Volume in 1 Second, FVC: Forced Vital Capacity, LDL: Low-Density Lipoproteins, MS: Muscle Strength, MVPA: Moderate-Vigorous Intensity Physical Activity, PACER: Progressive Aerobic Cardiovascular Endurance Running, RT: Reaction Time, SRT: Sitting-Rising Test, ST: Sprint Test, VO_2 max: Maximum Oxygen Consumption, WHR: Waist Hip Ratio.

Source: Prepared by the authors.

Muscular Fitness

Of the articles included for this systematic review, five reported evaluations related to muscular fitness (Bonney et al., 2019; Chen & Sun, 2017; Comeras-Chueca et al., 2022; Ketelhut et al., 2022; Martínez-López et al., 2022), where three of them reported improvements (Bonney et al., 2019; Comeras-Chueca et al., 2022; Ketelhut et al., 2022), while two did not report significant changes related to this variable (Chen & Sun, 2017; Martínez-López et al., 2022). Exergaming exercises using platforms such as Wii Fit, Xbox Kinect, and virtual reality systems that incorporate dance, sports, and multicomponent training models have been shown to enhance muscle strength-related variables in overweight or obese children and adolescents aged 9 to 16 years. These interventions performed two to three times per week over a period of three to five months, with session durations ranging from 20 to 60 minutes, have been associated with increased knee extension isometric strength (Bonney et al., 2019), handgrip strength, (Comeras-Chueca et al., 2022); and countermovement jump height (Ketelhut et al., 2022).

Cardiorespiratory Fitness

Regarding studies related to cardiorespiratory fitness, these accounted for seven studies, (Bonney et al., 2019; Chen & Sun, 2017; Irandoust et al., 2020; Ketelhut et al., 2022; Lau, Wang, & Maddison, 2016; Martínez-López et al., 2022; Staiano et al., 2018;), all of which demonstrate significant improvements in this outcome. Exergaming interventions that incorporate augmented reality models like Pokemon Go, dance, sports and virtual reality systems have been shown to enhance cardiorespiratory fitness in children and adolescents aged 8 to 16 years. These activities, performed two to three times per week over a period of 6 to 24 weeks, with session durations ranging from 40 to 60 minutes, have been associated with significant improvements in maximal oxygen consumption (VO_2max) (Lau, Wang, & Maddison, 2016,), aerobic endurance (Bonney et al., 2019; Chen & Sun, 2017; Ketelhut et al., 2022; Martínez-López et al., 2022),pulmonary function (Irandoust et al., 2020), and also decreases blood pressure (Staiano et al., 2018).

Body Composition

Another aspect considered for this review was body composition evaluation with improvements in body composition reported in six studies (Coknaz et al., 2019; Comeras-Chueca et al., 2022; Irandoust et al., 2020; Martínez-López et al., 2022; Staiano et al., 2017; Staiano et al., 2018) of nine studies that evaluated body composition. Conversely, two studies reported no changes in this outcome (Chen & Sun, 2017; Ketelhut et al., 2022;). One study showed a significant increase in body mass index (Lau, Wang, & Maddison, 2016). Exergaming interventions like Pokemon Go, dance, sports and immersive games have been shown to significantly improve body composition in children and adolescents aged 9 to 18 years. These interventions, performed two to three times per week over a period of 8 to 24 weeks, with session durations ranging from 40 to 60 minutes, have been associated with reductions in body weight (Irandoust et al., 2020), decreases in body mass index (BMI) (Irandoust et al., 2020; Staiano et al. 2018; Martínez-López et al., 2022), decreases total adiposity (Staiano et al., 2017), improves the waist-to-hip ratio (Irandoust et al., 2020) , increases lean mass (Comeras-Chueca et al., 2022) and bone mineral density (Staiano et al., 2017).

Sport and Dance-Themed Games

In the studies where the exergame intervention involved sports and dance-themed games, improvements were observed in cardiorespiratory fitness (Bonney et al., 2019; Irandoust et al., 2020; Staiano et al., 2018), muscular strength (Bonney et al., 2019; Comeras-Chueca et al.,2022), and body composition (Irandoust et al., 2020; Staiano et al., 2018; Comeras-Chueca et al.,2022). These interventions were structured with one to three sessions per week, lasting 40-60 minutes, over periods of 12 (Irandoust et al., 2020), 14 (Bonney et al., 2019), 24 weeks (Staiano et al., 2018), and five-months (Comeras-Chueca et al.,2022) respectively.

Dance Games

In studies where only dance-themed exergames (Dance) were used, improvements were found in cardiorespiratory fitness (Chen & Sun, 2017) and body composition (Staiano et al., 2017). The intervention designs consisted of three sessions of no more than 60 minutes, over periods of six weeks (Chen & Sun, 2017) and three months (Staiano et al., 2017), respectively.

Sport-Themed Games

Other studies that only used sports-themed exergames (Sports) showed improvements in cardiorespiratory fitness (Lau, Wang, & Maddison, 2016; Ketelhut et al., 2022), muscular strength (Ketelhut et al., 2022), and body composition (Coknaz et al., 2019), implementing two to three sessions per week, with durations of 20 (Ketelhut et al., 2022) and 40-60 minutes (Coknaz et al., 2019; Lau, Wang, & Maddison, 2016), all over a 12-week period.

Exploring and Walking Games

In the study by Martínez-López (2022), the Pokémon Go exergame was used, showing improvements in both cardiorespiratory fitness and body composition. The intervention design involved 40 minutes of daily exercise over an 8-week period.

Discussion

The aim of this review was to determine the effect of exergames on muscular strength, cardiorespiratory fitness, and body composition of children and adolescents, based on the existing evidence from randomized clinical trials over the past 10 years.

Of the articles considered for this systematic review, eight reported evaluations related to cardiorespiratory fitness, of which seven showed significant improvements. Regarding the studies that evaluated muscular strength, three reported improvements, while two did not show significant changes. Lastly, in terms of body composition, nine articles assessed this variable, with six showing significant improvements in some body composition parameters, and one reporting a significant increase, which the researchers suggest that this could be associated with the biological growth of the participants (Lau, Wang, & Maddison, 2016).

Based on the analyzed articles, there is evidence supporting exergames as a strategy to improve physical fitness and body composition. A trend was observed in studies using only sports-themed games, which resulted in improvements in muscular strength (Coknaz et al., 2019; Ketelhut et al., 2022), versus those using only dance-themed games, which did not show improvements in strength but did show improvements in cardiorespiratory fitness and body composition (Chen & Sun, 2017; Staiano et al., 2017). Moreover, few studies combined both types of games. However, one of these studies showed improvements in muscular fitness, cardiorespiratory capacity, and body composition (Bonney et al., 2019). Therefore, it could be suggested that, in interventions using exergames and aiming to improve cardiorespiratory fitness, muscular fitness, and body composition, it would be beneficial to combine sports and dance exergames. However, aspects such as session volume, load or intensity, and rest periods, among others, require further research.

The lack of specific details on crucial aspects, such as the heart rate reached by participants during each dance or sports-themed game, perceived exertion per session, the number of game sets performed per session, and other relevant variables make it difficult to establish specific exercise sessions aimed at improving cardiovascular fitness, muscular fitness, or body composition—resulting only in general recommendations for the use of exergames to enhance physical fitness. These aspects are essential for establishing a causal relationship between the training performed and the resulting physiological adaptations and performance (Etxebarria et al., 2019). Therefore, the lack of detailed data makes it extremely challenging to draw definitive conclusions or conduct a thorough analysis of the reasons behind the absence of improvements in these studies.

It should also be noted that the studies by Ketelhut (2022) and Comeras-Chueca (2022) faced challenges in executing the research as planned due to the COVID-19 pandemic, which caused unforeseen events and changes in the completion of the research, leading to certain biases during their development (Table 2).

Despite the above, this review highlights the effectiveness of exergames as a valuable alternative in the realm of physical exercise by merging technology and physical activity combined to improve health and body composition in school-aged populations.

Exergames enable exercise at 40% to 88% of maximum heart rate in children and youth (Maddison et al., 2007; Biddiss & Irwin, 2010; Comeras-Chueca et al., 2022), allowing moderate- to high-intensity exercise sessions based on WHO recommendations (World Health Organization, 2021).

When compared to other recent studies, such as that of Meng et al. (2022), a randomized clinical trial involving High Intensity Interval Training interventions (with a control group), which did not use exergames but conducted measurements of cardiorespiratory fitness, strength, and body composition, significant improvements in these parameters were observed, similar to those seen in exergame-based studies. These improvements not only have an immediate impact but can also act as protective and preventive factors against non-communicable chronic diseases such as type 2 diabetes mellitus and cardiovascular diseases associated with obesity and low physical fitness levels (Di Cesare et al., 2019; Valaiyapathi et al., 2020; Chung et al., 2018).

The implementation of exergames in education faces challenges related to access and economic investment. Research highlights that the digital divide extends beyond unequal device and internet access to include a lack of technological skills among students and teachers, exacerbating educational inequalities. Schools with fewer resources, particularly in rural and developing areas, struggle more with adopting innovative technologies, affecting educational quality and widening performance gaps. Consequently, economic and access disparities may hinder the successful integration of exergames in physical education class, limiting their use by teachers and professionals, depriving students of a valuable learning experience (Kaufman & Kumar, 2021).

Ketelhut et al. (2021) noted that exergames, by combining physical exercise with video games, are a form of information and communication technology due to their ability to promote health and physical activity. These interactive games use digital platforms to engage users, enhancing adherence to exercise programs through progress monitoring and instant feedback, which increases motivation and overall well-being. Furthermore, as Information and Communication Technology, exergames are an innovative tool for fostering healthy lifestyles. Therefore, using exergames in physical education to improve students' physical capabilities would be completely valid from this perspective. However, not having the necessary equipment would prevent exergames from being used, not as content to be evaluated, but as a didactic tool in Physical Education classes. One of the limitations of this study is that we were unable to access eight articles that could have been included in this review. This was due to paywall restrictions or the lack of institutional agreements between the authors' affiliations and the journals that published these articles.

A relevant aspect for future research is the use of more advanced instruments for data collection, such as direct oxygen consumption measurements. The studies included in this review primarily rely on field tests commonly used in schools, which are easily accessible but only provide estimations of improvements in oxygen consumption rather than direct measurements of this variable. Incorporating laboratory assessments in school could enhance our understanding of the types of energy substrates utilized during an exergame session and whether the profile of substrate utilization and oxidation changes following an exergame intervention.

Conclusions

Exergames can be a useful tool for improving muscular strength, cardiorespiratory fitness, and body composition in children and adolescents. Games derived from active sports or dance, used with a minimal dose of at least two to three sessions per week, lasting 40 to 60 minutes for a minimum of 12 weeks, have shown significant impact on cardiorespiratory fitness, muscular fitness and body composition in most studies. Sports and dance-themed games proved to be more effective in improving cardiorespiratory capacity and body composition, while sports-focused games showed improvements in muscular strength, offering an intervention that could enhance multiple aspects of physical fitness in this age group.

IA use declaration

During the preparation of this manuscript, we used ChatGPT-4 to help with the translation from Spanish to English and to review the grammar of the text. The AI tool provided support in these areas, but we carefully reviewed and edited the content to ensure that the meaning and tone were accurate. The final version reflects our revisions, and we take full responsibility for the quality and accuracy of the manuscript.

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References

Appelqvist-Schmidlechner, K., Vaara, J. P., Vasankari, T., Häkkinen, A., Mäntysaari, M., & Kyröläinen, H. (2020). Muscular and cardiorespiratory fitness are associated with health-related quality of life among young adult men. BMC Public Health, 20, 842. https://doi.org/10.1186/s12889-020-08969-y

Biddiss, E., & Irwin, J. (2010). Active video games to promote physical activity in children and youth: A systematic review. Archives of Pediatrics & Adolescent Medicine, 164(7), 664–672. https://doi.org/10.1001/archpediatrics.2010.104

Bonney, E., Ferguson, G., Burgess, T., & Smits-Engelsman, B. (2019). Benefits of activity-based interventions among female adolescents who are overweight and obese. Pediatric Physical Therapy, 31(4), 338-345. https://doi.org/10.1097/PEP.0000000000000636

Castro, M., Chacón, R., & Padial, R. (2017). Exergames y discapacidad. ESHPA - Education, Sport, Health and Physical Activity, 1(1), 2-9. http://hdl.handle.net/10481/48956

Chen, H., & Sun, H. (2017). Effects of active videogame and sports, play, and active recreation for kids physical education on children's health-related fitness and enjoyment. Games for Health Journal, 6(5), 312-318. https://doi.org/10.1089/g4h.2017.0001

Chung, S. T., Onuzuruike, A. U., & Magge, S. N. (2018). Cardiometabolic risk in obese children. Annals of the New York Academy of Sciences, 1411(1), 166–183. https://doi.org/10.1111/nyas.13602

Coknaz, D., Mirzeoglu, A. D., Atasoy, H. I., Alkoy, S., Coknaz, H., & Goral, K. (2019). A digital movement in the world of inactive children: Favourable outcomes of playing active video games in a pilot randomized trial. European Journal of Pediatrics, 178(10), 1567-1576. https://doi.org/10.1007/s00431-019-03457-x

Comeras-Chueca, C., Villalba-Heredia, L., Perez-Lasierra, J. L., Marín-Puyalto, J., Lozano-Berges, G., Matute-Llorente, Á., Vicente-Rodríguez, G., Gonzalez-Aguero, A., & Casajús, J. A. (2022). Active video games improve muscular fitness and motor skills in children with overweight or obesity. International Journal of Environmental Research and Public Health, 19(5), 2642. https://doi.org/10.3390/ijerph19052642

Di Cesare, M., Sorić, M., Bovet, P., Miranda, J. J., Bhutta, Z., Stevens, G. A., Laxmaiah, A., Kengne, A. P., & Bentham, J. (2019). The epidemiological burden of obesity in childhood: A worldwide epidemic

requiring urgent action. BMC Medicine, 17(1), 212. https://doi.org/10.1186/s12916-019-1449-8
Drenowatz, C., Chen, S.-T., Cocca, A., Ferrari, G., Ruedl, G., & Greier, K. (2022). Association of body weight and physical fitness during the elementary school years. International Journal of Environmental Research and Public Health, 19(6), 3441. https://doi.org/10.3390/ijerph19063441
Fonvig, C. E., Kloppenborg, J. T., Nielsen, T. R. H., et al. (2021). Obesity in children and adolescents is a chronic disease. Ugeskrift for Laeger, 183(31), V01210082. PMID: 34378524.
García, O., Serrano, V., Martínez, I., & Cancela, J. (2010). La fuerza: ¿una capacidad al servicio del proceso de enseñanza-aprendizaje de las habilidades motoras básicas y las habilidades deportivas específicas? Revista de Investigación en Educación, 8, 108-116.
Genovesi, S., & Parati, G. (2020). Cardiovascular risk in children: Focus on pathophysiological aspects. International Journal of Molecular Sciences, 21(18), 6612. https://doi.org/10.3390/ijms21186612
Irandoust, K., Taheri, M., H'mida, C., Neto, G. R., Trabelsi, K., Ammar, A., Souissi, N., Chtourou, H., Nikolaidis, P. T., Rosemann, T., & Knechtle, B. (2021). Exergaming and aquatic exercises affect lung function and weight loss in obese children. International Journal of Sports Medicine, 42(6), 566-572. https://doi.org/10.1055/a-1289-9307
Jebeile, H., Kelly, A. S., O'Malley, G., & Baur, L. A. (2022). Obesity in children and adolescents: Epidemiology, causes, assessment, and management. The Lancet. Diabetes & Endocrinology, 10(5), 351–365. https://doi.org/10.1016/S2213-8587(22)00047-X
Kaufman, T., & Kumar, S. (2021). Equity and Technology in Education: The Global Challenge of Digital Divide. International Journal of Education, 7(4), 1-10.
Ketelhut, S., Martin-Niedecken, A. L., Zimmermann, P., & Nigg, C. R. (2021). Physical activity and health promotion in esports and gaming: Discussing unique opportunities for an unprecedented cultural phenomenon. Frontiers in Sports and Active Living, 3, 693700. https://doi.org/10.3389/fspor.2021.693700
Ketelhut, S., Röglin, L., Martin-Niedecken, A. L., Nigg, C. R., & Ketelhut, K. (2022). Integrating regular exergaming sessions in the ExerCube into a school setting increases physical fitness in elementary school children: A randomized controlled trial. Journal of Clinical Medicine, 11(6), 1570. https://doi.org/10.3390/jcm11061570
Lau, P. W., Wang, J. J., & Maddison, R. (2016). A randomized-controlled trial of school-based active videogame intervention on Chinese children's aerobic fitness, physical activity level, and psychological correlates. Games for Health Journal, 5(6), 405-412. https://doi.org/10.1089/g4h.2016.0057
Maddison, R., Mhurchu, C. N., Jull, A., Jiang, Y., Prapavessis, H., & Rodgers, A. (2007). Energy expended playing video console games: An opportunity to increase children's physical activity?. Pediatric Exercise Science, 19(3), 334–343. https://doi.org/10.1123/pes.19.3.334
Mandsager, K., Harb, S., Cremer, P., Phelan, D., Nissen, S. E., & Jaber, W. (2018). Association of cardiorespiratory fitness with long-term mortality among adults undergoing exercise treadmill testing. JAMA Network Open, 1(6), e183605. https://doi.org/10.1001/jamanetworkopen.2018.3605
Marín, D., Ramon-Llin, J., & Guzman, J. F. (2022). Exergame en educación: mapeando la investigación. *Retos, 44,* 64–76. https://doi.org/10.47197/retos.v44i0.90127
Martínez-López, E. J., López-Serrano, S., De La Torre-Cruz, M., & Ruiz-Ariza, A. (2022). Effects of the augmented reality game Pokémon GO on fitness and fatness in secondary school students. Health Education Journal, 81(1), 54-68. https://doi.org/10.1177/00178969211047800
McLeod, M., Breen, L., Hamilton, D. L., & Philp, A. (2016). Live strong and prosper: The importance of skeletal muscle strength for healthy ageing. Biogerontology, 17(3), 497–510. https://doi.org/10.1007/s10522-015-9631-7
Medeiros, P., Capistrano, R., Zequinão, M. A., Silva, S. A. D., Beltrame, T. S., & Cardoso, F. L. (2017). Exergames as a tool for the acquisition and development of motor skills and abilities: A systematic review. Revista Paulista de Pediatria, 35(4), 464–471. https://doi.org/10.1590/1984-0462/2017/35/4/00013
Meng, C., Yucheng, T., Shu, L., & Yu, Z. (2022). Effects of school-based high-intensity interval training on body composition, cardiorespiratory fitness and cardiometabolic markers in adolescent boys

with obesity: A randomized controlled trial. BMC Pediatrics, 22(1), 112. https://doi.org/10.1186/s12887-021-03079-z

McClinton T. D. (2022). A guided search: Formulating a PICOT from assigned areas of inquiry. Worldviews on evidence-based nursing, 19(5), 426–427. https://doi.org/10.1111/wvn.12598

Mittal, M., & Jain, V. (2021). Management of obesity and its complications in children and adolescents. Indian Journal of Pediatrics, 88(12), 1222–1234. https://doi.org/10.1007/s12098-021-03913-3

Muñoz, J., Villada, F., & Giraldo, J. (2013). Exergames: una herramienta tecnológica para la actividad física. Revista Médica Risaralda, 19(2), 126-130.

Niño Hernández, C. (2010). Evaluación de la aptitud cardio respiratoria. Movimiento Científico, 4(1), 68-72.

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... & Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. BMJ, 372, n71. https://doi.org/10.1136/bmj.n71

Peñaherrera Oviedo, C., & Soria Viteri, J. (2015). Pregunta de investigación y estrategia PICOT. Medicina, 19(1), 66-69. https://doi.org/10.23878/medicina.v19i1.647

Pinheiro, A. C., Quintiliano-Scarpelli, D., Araneda-Flores, J., Oliveira, R. A., Pizarro, T., Suarez-Reyes, M., & Marques de Oliveira, M. R. (2022). Food insecurity and its determinants in a vulnerable area of Santiago, Chile. Frontiers in Sustainable Food Systems, 6, 924921. https://doi.org/10.3389/fsufs.2022.924921

Powers, S. K., & Howley, E. T. (2015). Exercise physiology: Theory and application to fitness and performance (10th ed.). McGraw Hill Educación.

Ramírez-Granizo, I. A., Ubago-Jiménez, J. L., González-Valero, G., Puertas-Molero, P., & San Román-Mata, S. (2020). The effect of physical activity and the use of active video games: Exergames in children and adolescents: A systematic review. International Journal of Environmental Research and Public Health, 17(12), 4243. https://doi.org/10.3390/ijerph17124243

Secchi, J. D., & García, G. C. (2013). Aptitud física cardiorrespiratoria y riesgo cardiometabólico en personas adultas jóvenes. Revista Española de Salud Pública, 87(1), 35-48.

Sterne, J. A. C., Savović, J., Page, M. J., Elbers, R. G., Blencowe, N. S., Boutron, I., et al. (2019). RoB 2: A revised tool for assessing risk of bias in randomized trials. BMJ, 366, l4898. https://doi.org/10.1136/bmj.l4898

Staiano, A. E., Beyl, R. A., Guan, W., Hendrick, C. A., Hsia, D. S., & Newton, R. L. Jr. (2018). Home-based exergaming among children with overweight and obesity: A randomized clinical trial. Pediatric Obesity, 13(11), 724-733. https://doi.org/10.1111/ijpo.12438

Staiano, A. E., Marker, A. M., Beyl, R. A., Hsia, D. S., Katzmarzyk, P. T., & Newton, R. L. (2017). A randomized controlled trial of dance exergaming for exercise training in overweight and obese adolescent girls. Pediatric Obesity, 12(2), 120-128. https://doi.org/10.1111/ijpo.12117

Stabouli, S., Erdine, S., Suurorg, L., Jankauskienė, A., & Lurbe, E. (2021). Obesity and eating disorders in children and adolescents: The bidirectional link. Nutrients, 13(12), 4321. https://doi.org/10.3390/nu13124321

Valaiyapathi, B., Gower, B., & Ashraf, A. P. (2020). Pathophysiology of type 2 diabetes in children and adolescents. Current Diabetes Reviews, 16(3), 220–229.

World Health Organization. (2021). Directrices de la OMS sobre actividad física y comportamientos sedentarios. Ginebra: Organización Mundial de la Salud. https://www.ncbi.nlm.nih.gov/books/NBK581973/

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