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# Effective Strategies for Promoting Physical Activity through the Use of Digital Media among School-Age Children: A Systematic Review

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**Abstract:** Digital media are widespread among school-age children, and their incorrect use may lead to an increase in sedentary levels and the consequences associated with it. There are still few studies that have investigated whether physical activity levels could be increased through their use. The aim of this study was to systematically review the scientific literature in order to identify whether digital strategies and technologies are capable of increasing the level of physical activity. A literature search was performed using the following databases: Pubmed, Scopus, and Web of Science. The main outcomes evaluated the increase in physical activity levels, the number of steps, and the reduction of sedentary behaviors. Two trained researchers independently assessed eligible studies against eligibility criteria, extracted data, and assessed the risk of bias. The Downs and Black checklist was used to assess the quality of the included studies. A total of 15 studies (1122 children) were included in this systematic review, with a mean age of 8.45 ± 0.70 years. Quality assessment of the studies observed a "moderate quality" of the included records. The results of this systematic review highlight that digital media can be applied as a way to improve the levels of physical activity in children to contrast a sedentary lifestyle. The main limitations of the study are the heterogeneity within the exercise protocols and the paucity of studies involving school-age children. More research is needed to confirm our findings also due to continuing technological progress.

**Keywords:** digital media; children; exergames; physical activity

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## 1. Introduction

Physical activity has been known as one of the most important issues related to children since a reduction in the level of physical activity can increase overweight and obesity, future cardiovascular diseases, reduced harmony in motor development, decreased motor skill competence, postural problems, and reduced bone and muscle mass [1,2]. In this vein, data from the Italian Institute of Statistics for the biennial 2017–2018 [3] report that Italian children are not active as much as recommended by the WHO, which suggests children require daily physical activity of moderate–vigorous intensity of at least 60 min a day three times a week [4]. A good percentage of children (~28.9%) do not practice any form of physical activity, and 30.4% of children age 6–10 years were overweight. These data were also confirmed by the 2019 survey from Okkio alla Salute [5] concerning Italian children ages 8 and 9, in which it was reported that 20.3% of children in 2019 did not perform any physical activity the day before the survey, 43.5% still had a TV in their bedroom, and 44.5% of children spent more than 2 h a day in front of TV/tablet/mobile. Moreover, children have been forced to stay at home due to the COVID-19 pandemic, which in turn may have negatively modified their lifestyles by increasing time spent in sedentary behaviors [6]. In this context, Dunton et al. [7] showed that American children decreased physical activity levels between the months before and during the lockdown. Therefore, school closure, lack of outdoor activities, and poor eating and sleeping habits that can be the result of this pandemic may interfere with the usual lifestyle of children [8].

Several studies have investigated strategies to increase the level of physical activity among children, in particular during this pandemic. One of the suggested alternative ways that can help to reduce physical inactivity is digital media, which are known as the set of means of communication that concentrate on digitized technologies on computers and networks. Smartphones, TVs, tablets, consoles, and video games are the most popular among school-age children (3–10 years) (Figure 1). Although the benefits and disadvantages of these devices on psychosocial function and physical health are unclear, the question has been raised regarding whether digital media can affect the mental and physical health of children and adolescents [9].

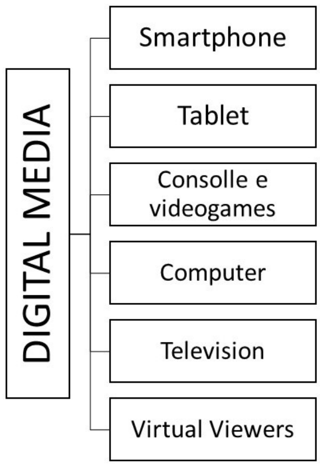


**Figure 1.** Conceptual map illustrating the main types of digital media.

Epidemiological studies have demonstrated an increase in the popularity of digital media among children and a 36% to 72% in the use of these tools in the United States from 2011 to 2013 [10]. An increase in time spent using digital media, including smartphones and TVs, has been observed, with a use of at least 60–70 min per day [11]. An increase in time spent with digital media may result in a decrease in the level of physical activity and an increment in sedentary behaviors among children. However, some studies have shown that these tools have been used successfully to increase the level of physical activity in children and adults. In this regard, Coughlin et al. [12] showed that wearable digital devices increased physical activity levels and helped users to lose weight. Rizzo et al. [13] also indicated that video games with virtual reality are equivalent to a fast walk, despite failing to reach the recommended daily amount of physical exercise; however, the participants were able to expend much more energy compared to a sedentary activity. These kinds of activities have been recently named by researchers and developers as "exergames" to indicate a new type of entertainment that combines physical activity with video games through the use of the most common consoles [14]. For this reason, according to the author, the use of exergames can reasonably be seen as a complementary activity rather than a substitute for a real form of physical activity.

Although a growing number of studies has concentrated on recognizing the effect of digital media on the level of physical activity, there has been no systematic review to critically evaluate the literature that has been published in recent years on children. Because of the continuing technological advancement involving the implementation of new video games consoles and new digital devices, a systematic review needs to be carried out to understand the effect of new digital media on the level of physical activity. Hence, the goal of this study was to summarize and critically review the scientific literature in order to identify whether digital strategies and technologies can increase the level of physical activity among children age 3–11.

## 2. Materials and Methods

This systematic review examines the effects of different types of physical exercise programs carried out through the use of digital media in children age 3 to 11. The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement was adopted to conduct the current systematic review [15].

Participants

All the analyzed participants were school-age (between 3 and 11 years) children who engaged in physical activity through the use of a digital device. A total number of 1122 children were analyzed in the studies, with a mean age of 8.44 ± 0.70 years. Adolescents and adults were not considered for analysis.

Interventions

Interventions that measured physical activity levels in participants through the use of digital media (Figure 1) described in the eligible studies were included in this review. The interventions aimed to increase physical activity levels in children and thus reduce sedentary time. Physical activity levels were measured principally through the use of accelerometers, but if the studies reported other measurements, these were also included.

Comparators

The comparators were control groups who did not engage in physical activity through digital media, but rather engaged in traditional physical activity or no activity.

Outcomes

The main outcomes examined by the various studies concern the levels of physical activity measured through the use of accelerometers, but also the number of steps, time spent in physical activity, motor skills, and time spent in sedentary behavior.

Eligibility Criteria

Studies that met the following criteria were included in this systematic review: (1) research was carried out to understand the effect of different types of physical exercise programs that were performed through the use of digital media in children age 3 to 11 years, (2) published in the last 20 years, (3) studies in which there was an intervention of at least one week or seven intervention sessions, (4) the presence of an objective pre- and post-value on physical activity levels, (5) the participation of a control group, and (6) healthy subjects without any disabling physical, neurological, or mental illness.

Studies that did not have a control or comparator group were not considered for inclusion. No reviews, systematic reviews, or meta-analyses were considered.

Search Strategy

The literature search was conducted on the following databases: Pubmed, Scopus, and Web of Science. The search strategy was conducted using the following keywords: “digital media,” “physical activity,” “exercise,” “child*,” “app,” and “mobile device.”

The Boolean operators AND–OR were used in order to correctly combine the various keywords. These keywords were used as follows: physical activity OR exercise AND child* AND digital media; physical activity OR exercise AND child* AND app; physical activity OR exercise AND child* AND mobile device.

Study Selection

Title and abstract of the articles that were generated through the databases were independently screened by the two reviewers. Next, the full texts of the retrieved studies were evaluated by the authors after removing duplicates. Any disagreement was resolved through negotiation.

Risk of Bias Assessment

For risk of bias assessment, we used the Downs and Black checklist in order to assess the methodological quality of the studies included; two independent investigators evaluated the studies. Any disparity in scores was resolved by discussion and through reevaluation.

This scale is composed of 27 items [16] designed to assess both randomized and non-randomized studies. All items were divided into 5 main sections: (1) Reporting, (2) External Validity, (3) Internal Validity, (4) Internal Validity-Confounding (selection bias), and (5) Power. Answers were scored 0 or 1, except for one item in the Reporting subscale (item 5), which was scored 0 to 2, and the single item on power, which was scored 0 to 5. The maximum score that a study can receive is 32, such that higher scores denote greater methodological quality. The studies were then divided following different quality categories suggested by Tremblay et al. (22). The studies were then separated into groups and labeled as "high quality" (score of 23–32), "moderate quality" (score of 19–22), "low quality" (score of 15–18), or "poor quality" (≤14) [17]. Risk of bias assessment is presented within the Supplementary Table S1.

Data Extraction

The following information was extracted: first author, year of publication, study design, sample size, age of participants (range, mean, and standard deviation), type of intervention, time of treatment, and main results. The information extracted from any section of the manuscript was consequently recorded in tabular format and summarized in a descriptive way.

Data Synthesis

All the data were collected and summarized in a table and were described through a narrative synthesis to specify the effect of digital media on the level of physical activity. In this vein, the data were categorized in one of the following ways: physical activity, sedentary behaviors, and steps. Moreover, since there was a methodological heterogeneity among the included studies (i.e., intervention characteristics and different study design), it was impossible to perform a meta-analysis. Hence, the results of the current review were qualitatively synthesized.

## 3. Results

Study Identification

A total of 1202 studies were identified through a preliminary database search. A total of 216 studies were selected after the inclusion/exclusion criteria. A total of 123 studies were obtained after eliminating the duplicates, and after being screened. 112 full-text articles were assessed for eligibility. Of these 112 full-text articles, 94 items were excluded with reasons. These included age of participants, protocols without physical activity, or other reasons incompatible with the inclusion criteria. Therefore, 15 studies [18–32] were included in the qualitative synthesis (Figure 2).

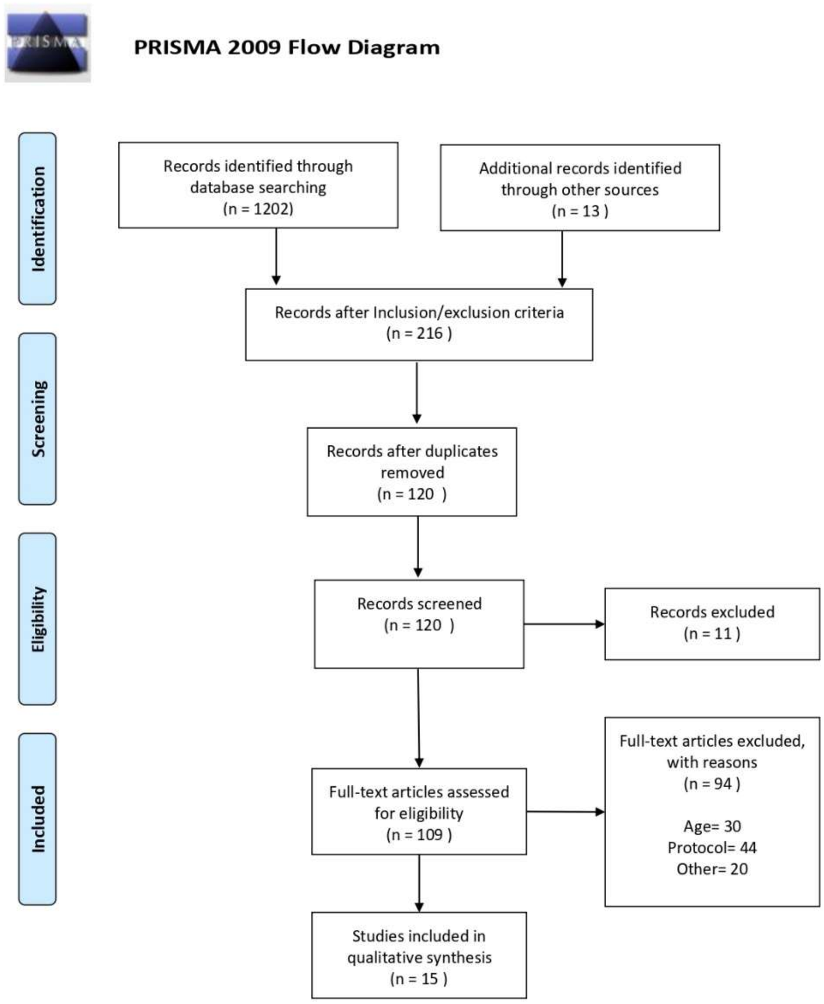


**Figure 2.** PRISMA flow diagram illustrating the different phases of study inclusion.

Study Characteristics

Amongst the included studies, the average number of participants per study was 74 and the mean duration of the studies was nine weeks. Articles differed greatly in terms of study design, intervention length, follow-up period, subjects' age, observed outcomes, and measurement of the main outcomes.

Table 1 provides a summary of the studies included in the review. In total, data from 1122 participants were pooled for this review. Studies ranged from 11 to 164 participants and the intervention periods ranged from one to 32 weeks. The included articles were published over 16 years from 2005 to 2021.

The 1122 children analyzed in the studies had a mean age of 8.45 $\pm$ 0.70 years. All 15 studies evaluated the effects of different types of digital media on physical activity levels and other variables listed in Table 1.

Some apps were considered to be coupled with activity trackers, mobile phones, tablets, and personal computers. Consoles, video games, and video chat were also used.

**Table 1.** Summary of studies included in the qualitative synthesis.

| Author | Year | Design | Sample (n) | Age | Intervention | Treatment (Time) | Outcome Measurements | Main Results |
|---|---|---|---|---|---|---|---|---|
| **Byun et al.** | 2018 | Randomized controlled trial | 93 children (48 intervention group, 45 control group) | 4.7 ± 0.7 | Technology-based physical activity monitoring system for promoting PA | 1 week | - Sedentary behavior<br>- Physical activity | - ↓ time in SB<br>- ↑ in PA |
| **Chen et al.** | 2017 | Clinical trial | 65 children (36 AVG group, 29 SPARK PE group) | Mean age 9.65 | AVG program 40 min x 3 times/week | 6 weeks | - Health-related fitness<br>- PA levels<br>- PA enjoyment | - ↑ light PA<br>- ↓ SB<br>- ↑ MVPA<br>For AVG program compared to SPARK PE |
| **Gao et al.** | 2019 | 2-arm experimental design | 56 children (20 intervention group, 36 control group) | 3–5 years (4.43) | 5 days x 20 min of exergaming intervention | 8 weeks | - PA level (monitoring PA levels via accelerometers) | - increased in MVPA |
| **Gao et al.** | 2017 | Quasi-experimental study | 164 children (85 intervention group, 79 control group) | 8.27 ± 0.7 | 25 min of exergaming sessions twice per week combined with physical education (PE) | 3 weeks (pre-test/post-test and follow up) | - SB<br>- Light PA<br>- MVPA<br>- EE | - ↓ time in SB<br>- ↑ light PA levels, MVPA, and energy expenditure (EE) |
| **Garde et al.** | 2015 | 2-group Clinical Trial | 47 children (26 game group, 21 feedback group) | 10.2 ± 1.2 | Mobile phone game as a tool to promote PA among children | 2 weeks for each group | - Activity (steps and active minutes | - ↑ numbers of steps and active minutes per day<br>- Increase PA levels among children |
| **Garde et al.** | 2018 | Randomized controlled trial | 37 children (19 intervention group, 18 control group) | Mean age (months) 127 ± 6.25 | Exergaming intervention | 4 weeks (1 week baseline, 2 weeks intervention, 1 week follow up) | - Activity (steps and active minutes) | - ↑ PA (steps/day)<br>- ↑ Active minutes |
| Gil et al. | 2018 | Clinical trial | 11 children (6 intervention group, 5 control group) | 5 years old | Practice of motor activities performed with Nintendo Wii® | 7 intervention sessions | - Balance<br>- Laterality<br>- Notion of the body<br>- Global praxis | - ↑ in all the psychomotor factors studied (global praxis, laterality, notion of the body), with the exception of balance |
| Goran et al. | 2005 | Pre–post test study | 122 children (62 intervention group, 60 control group) | 9.5 ± 0.4 | Computer-based interactive multimedia curriculum for promoting PA | 8 weeks | - Physical activity | - ↑ light physical activity levels<br>- ↑ psycosocial behaviors |

**Table 1.** *Cont.*

| Author | Year | Design | Sample (n) | Age | Intervention | Treatment (Time) | Outcome Measurements | Main Results |
|---|---|---|---|---|---|---|---|---|
| Graves et al. | 2010 | Randomized controlled trial | 42 children (22 intervention group, 20 control group) | 9.2 ± 0.5 | Active video game device for home use | 12 weeks | - Habitual physical activity (steps) | - Slight increase in PA and steps but not statistically significant |
| Lau et al. | 2016 | Randomized controlled trial | 801 children (40 intervention group, 40 control group) | Mean age 9.23 ± 0.52 | AVG program twice per week | 12 weeks | - Aerobic fitness (using the Progressive Aerobic Cardiovascular Endurance Run (PACER) 20 m shuttle-run performance test)<br>- PA levels | - ↑ Aerobic fitness (VO2max)<br>- ↑ MVPA<br>- ↑Total PA |
| Lee et al. | 2020 | Quasi-experimental study | 157 children (77 intervention group, 80 control group) | Mean age 9.7 | Effects of mobile app-integrated PE classes on children's PA | 2 weeks | - Physical activity<br>- Sedentary behavior | - No significant differences in SED<br>- ↓light PA and MVPA compared to the traditional PE lesson |
| Liang et al. | 2020 | Quasi- experimental study | 87 children (30 intervention group, 57 control group) | Mean age 10.5 | AVG program twice per week | 8 weeks | - Physical activity<br>- Sedentary behavior | - ↑ PA total<br>- ↑LPA<br>- ↑MVPA<br>- No significant differences in SED |
| Staiano et al. | 2018 | Randomized cotrolled trial | 46 children with overweight and obesity (23 intervention group, 23 control group) | 11.2 ± 0.8 | Gaming console with exergames, a gameplay curriculum, and video chat sessions with a fitness coach | 24 weeks | - Physical activity | - Reduced BMI z-score<br>- Increase in time spent in MVPA<br>- Improved cardiometabolic health |
| Trost et al. | 2021 | Randomized controlled trial | 34 parent–child dyads (17 intervention group, 17 control group) | 5.3 ± 1.1 | Use of digital application to increase FMS | 8 weeks | - Movement competence<br>- Physical activity | - ↑ object control skills<br>- ↑ locomotor skills<br>- No significant intervention effects observed for child PA |
| Ye et al. | 2019 | Longitudinal quasi-experimental study | 81 children (36 intervention group, 45 control group) | 9.23 ± 0.62 | 50 min exergaming intervention during recess | 8 months | - Physical activity<br>- Sedentary behavior<br>- Cardiorespiratory fitness | - Increased LPA in CG and MVPA in IG<br>- Reduced SB |

Abbreviations: PA= physical activity; MSC = motor skill competence; MVPA = moderate-to-vigorous physical activity; LPA = light-intensity physical activity; SB = sedentary behavior; PE = physical education.

The studies assessed the levels of physical activity through the use of accelerometers; the levels of the main motor skills through specific tests such as the Test of Gross Motor Development (TGMD-2), Movement Assessment Battery for Children (ABC), and the six-minute walk test (6 MWT); and sedentary behavior through accelerometers, activity trackers, and questionnaires such as the Physical Activity Enjoyment Scale (PACES), the Intrinsic Motivation Inventory (IMI), and the Rosenberg Self-Esteem Scale [33].

Risk of Bias Assessment

The methodological quality of the included studies was assessed based on the Downs and Black checklist, which is presented in the supplementary material. The mean Downs and Black checklist score was 22.6, with the studies ranging between 11 and 28. Out of 15 studies, 8 articles [18,21,23,26–30,34] were considered high-quality, six studies [19,20,22,25,31,32] moderate quality, and one study [24] poor quality. A breakdown of individual studies is shown in Supplementary Table S1.

Characteristics of the Interventions

Nine studies applied active video games (AVG) or exergames. Three studies [20,21,31] used both the Xbox Kinect and Wii consoles, one study [24] used only the Wii console, four investigations [19,27,29,32] used only the Xbox Kinect, and one study [26] used the Ps2, Ps3, and Wii consoles. Moreover, four studies [22,23,28,30,34] used applications for smartphone and tablets through which physical activity programs can be forwarded. Two of these apps foresaw the development of the main motor skills, another application physical activity in general, and the last referred to a game. Finally, two studies used personal computers (PC); the first study [25] used a CD-ROM in which some exercises were proposed, whereas the second [18] applied an activity tracker and the corresponding program that was connected to the PC to view real-time data regarding physical activity.

Main Outcomes

The objective of this review was to assess whether digital media can influence physical health parameters, in particular physical activity levels and those associated with it. The main parameters evaluated by this review were physical activity, sedentary behavior, and number of steps.

Physical Activity

Most studies showed improvements between pre- and post-intervention in the levels of physical activity and in the main motor skills, as well as a notable decrease in the time spent in sedentary attitudes by children. In term of the level of physical activity (PA), all studies reported an improvement in light-intensity physical activity (LPA) aside from three [26,28,30] investigations. In this vein, Trost et al. [30] demonstrated that the interactive digital application cannot improve LPA, whereas fundamental movement skills were ameliorated in response to the eight-week intervention. Lee et al. [28] also revealed a non-significant change in the LPA compared to regular physical education lessons; however, they reported a slight improvement in PA in response to the short-term app-integrated intervention. Another study by Graves et al. [26] showed no significant effect of a 12-week AVG program at home on LPA or the number of steps.

Five studies [18,19,21–23] investigated physical activity levels in general, and each of them showed an increase. The studies by Gao et al. [21] and Chen et al. [19] used an exergame program to increase physical activity levels. In the first study the exergaming lessons were performed twice a week for a duration of three weeks, whereas the second one evaluated the effect of a six-week AVG program performed three times a week for 40 min per session. The two studies by Garde [22,23] used a mobile phone game for from two to four weeks and the study by Byun et al. [18] used a tablet PC to evaluate PA levels. Five studies [20,27,29,31,32] showed an increase in moderate-to-vigorous physical activity levels (MVPA). All five studies performed physical activity through an AVG program lasting from eight weeks to eight months. To conclude, three studies [25,31,32] investigated the increase in light-intensity physical activity levels (LPA). Two of these used an AVG program, whereas the study by Goran et al. used a computer-based interactive multimedia curriculum to promote PA.

Sedentary Behaviors

Six studies [18,19,21,28,31,32] had as the main aim to investigate sedentary behaviors (SB). Four of these studies [18,19,21,31] showed a reduction in SB through the use of an AVG program except for the study by Byun et al. [18], which used a tablet PC. Two investigations [28,32] reported no significant difference in SB. The first study investigated the effects of two weeks of mobile app-integrated PE classes on children's PA, whereas the second one used an AVG program lasting eight weeks.

Steps

Three studies investigated the number of steps taken daily through the use of a pedometer. The first one was the study by Graves et al. [26], who applied an active video game device for home use for 12 weeks, which showed an incremental trend in the number of steps performed daily but was not statistically relevant. The other studies by Garde et al. [22,23] showed an increased number of steps per day through the use of an active video game program lasting four weeks.

## 4. Discussion

The aim of this study was to systematically review the scientific literature in order to identify whether digital strategies and technologies are able to increase the level of physical activity among children age 3–11 years, which in turn may lead to health promotion. Most studies demonstrated an improvement in the level of physical activity and motor skills in response to interventions carried out through active video games and smartphone apps, which were also the most common tools employed.

The most effective digital solutions, therefore, were those that involved the use of apps and active video games, especially if performed with family members or teachers. Less interest was seen in websites, games, and apps that did not involve parents or teachers. A problem related to this could be that the energy expenditure conducted in a supervised environment such as a laboratory or school is not the same when carried out in the home environment. However, digital media cannot be used as a real substitute for regular physical activity, since the benefits of exercising outdoors with peers are certainly greater, including socialization, making new friends, and breathing clean air [35]. These types of tools can assist in health promotion; in particular, children need to be active to prevent the negative consequences of sedentary behavior that may also be the result of COVID-19 restrictions [7]. In this pandemic period, sedentary behaviors among children have certainly increased, as they have been forced to stay at home due to the closure of schools and parks.

Nowadays there are more and more "inactive" pastimes characterized by spending time indoors, and for this reason it is necessary to expand the opportunities for physical activity at home. AVGs, in fact, overcome barriers linked to bad seasonal conditions, lack of transport, and unsafe neighborhoods, which often keep children away from daily physical activity [36].

It is necessary for children to participate in physical activity from infancy for harmonious physical and psychological growth [37]. In particular, the benefits of physical activity for children concern a series of aspects related to the improvement of the immune system response and the reduction of the risk of future chronic diseases [33], the promotion of growth and healthy development [38], and an increase in bone density [39], in addition to the reduction of the risk of overweight and obesity [40]; the promotion of learning motor skills; the improvement of physical ability such as muscle strength, endurance, and flexibility; and the development of motor skills [41].

Of particular interest are the results arising from the control groups, which were taken into consideration. These groups did not receive any form of digital media exergaming. None of the control groups increased the level of PA to a significantly greater extent than the intervention groups, despite all of them having an increase compared to the assessed baseline levels.

Future Research

Future studies need to consider the following: (1) whether energy expenditure will be the same in a supervised laboratory environment compared to the home environment, where children use digital devices episodically; (2) applying AVGs that encourage higher levels of physical activity by limiting the use of low-energy strategies, including systems that translate body movements directly on the screen; (3) focusing on other outcome measurements, including changes in physiological outcomes such as body mass index, but also other fitness measures, including cardiovascular and muscle endurance, muscle strength, balance, body composition, and flexibility; (4) long-term adherence and efficacy of digital media, which are still unknown; and (5) evaluating whether active video games can be an opportunity to promote physical activity in children with disabilities, who spend a lot of time alone in sedentary activities.

Limitations

The findings of this systematic review must be interpreted by considering the following limitations. One of the included studies [24] had a low quality of methodology, which could have affected the results of the investigations. Moreover, there was heterogeneity within the exercise protocols that were applied, such as duration of interventions, different sample size, and exercise intensity; in particular, those studies [18,24] used a short period of interventions of one week and seven sessions, respectively, which could not demonstrate their effectiveness over time. However, many other studies had a very different duration over time, ranging from two weeks [22,28] to eight months [31]. Another limitation concerns the statistical power of the studies included, which was insufficient in some cases [22–24]. Quantitative comparisons of activity patterns across studies were not possible to categorize due to heterogeneity in the study methods, such as study duration and outcome measures. Therefore, further studies are needed to verify these findings by applying unitary protocols of physical activity through the use of digital media compared to sedentary behaviors with longer duration and follow-up periods.

## 5. Conclusions

Physical inactivity in children is a very important health issue that could be addressed through a varied approach in order to increase physical activity. In recent years, digital media and especially AVGs are an emerging technology that represent one of the possible solutions. From the first preliminary findings, AVG play appears to be both an effective and fun means for increasing physical activity levels in children, but long-term usefulness should be demonstrated.

The results of the current systematic review show that the correct use of digital media can actually improve the level of physical activity among children between the ages of 3 and 11. Almost all the studies showed an improvement in the different forms of physical activity levels (LPA, MVPA), but also in locomotor competence and in the reduction of sedentary behaviors.

In order to confirm this trend, it is necessary to encourage motor program development and the creation of apps and video games that are truly capable of promoting physical activity. Thus, it would be advisable to stimulate children through new ways of exercising, especially in conditions in which it is difficult to carry out outdoor activities with peers. Given the continuing technological advancement involving the implementation of new console video games and new digital devices, more research is needed to establish an adequate combination of digital interventions and identify appropriate exercise parameters. This could lead to a change in the behavior of the participants, introducing new strategies to promote a healthy and physically active lifestyle in children.

**Supplementary Materials:** The following are available online at https://www.mdpi.com/article/10.3390/su132011270/s1, Table S1: Downs and black scores of each investigator; Table S2: Downs and black total scores of each study.

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## References

1. Wu, X.Y.; Han, L.H.; Zhang, J.H.; Luo, S.; Hu, J.W.; Sun, K. The influence of physical activity, sedentary behavior on health-related quality of life among the general population of children and adolescents: A systematic review. *PLoS ONE* **2017**, *12*, e0187668. [CrossRef]
2. Adank, A.M.; Van Kann, D.H.H.; Hoeboer, J.J.A.A.; de Vries, S.I.; Kremers, S.P.J.; Vos, S.B. Investigating motor competence in association with sedentary behavior and physical activity in 7-to 11-year-old children. *Int. J. Environ. Res. Public Health* **2018**, *15*, 2470. [CrossRef]
3. ISTAT. Stili di Vita di Bambini e Ragazzi: 2017–2018. 2019. Available online: https://www.istat.it/it/archivio/234930 (accessed on 11 October 2021).
4. Chaput, J.P.; Willumsen, J.; Bull, F.; Chou, R.; Ekelund, U.; Firth, J.; Jago, R.; Ortega, F.B.; Katzmarzyk, P.T. 2020 WHO guidelines on physical activity and sedentary behaviour for children and adolescents aged 5–17 years: Summary of the evidence. *Int. J. Behav. Nutr. Phys. Act.* **2020**, *17*, 141. [CrossRef]
5. Salute, O.A. Indagine Nazionale 2019: I Dati Nazionali; Coordinamento Scientifico a Cura del Centro Nazionale per la Prevenzione Delle Malattie e la Promozione della Salute, CNAPPS—ISS; 2019. Available online: https://www.epicentro.iss.it/okkioallasalute/indagine-2019-dati (accessed on 11 October 2021).
6. Lamar, L.; Craig, J.T.; Shubkin, C.D. So your patient is a gamer: An exploration of benefits and harms. *Current Opin. Pediatr.* **2021**, *33*, 530–534. [CrossRef] [PubMed]
7. Dunton, G.F.; Do, B.; Wang, S.D. Early effects of the COVID-19 pandemic on physical activity and sedentary behavior in children living in the U.S. *BMC Public Health* **2020**, *20*, 1351. [CrossRef] [PubMed]
8. Ghosh, R.; Dubey, M.J.; Chatterjee, S.; Dubey, S. Impact of COVID-19 on children: Special focus on the psychosocial aspect. *Minerva Pediatr.* **2020**, *72*, 226–235. [CrossRef] [PubMed]
9. Digital media: Promoting healthy screen use in school-aged children and adolescents. *Paediatr. Child Health* **2019**, *24*, 402–417. [CrossRef]
10. Rideout, V.S.M.; Rudd, A. Zero to Eight: Children's Media Use in America 2013. Available online: https://www.commonsensemedia.org/zero-to-eight-2013-infographic (accessed on 11 October 2021).
11. Watson, A. Daily Time Spent with Selected Devices among 0- to 8-Year-Olds in the United States in 2017, by Age. Available online: https://www.statista.com/statistics/769461/time-spent-media-devices-children-by-age/ (accessed on 11 October 2021).
12. Coughlin, S.S.; Whitehead, M.; Sheats, J.Q.; Mastromonico, J.; Smith, S. A Review of Smartphone Applications for Promoting Physical Activity. *Jacobs J. Community Med.* **2016**, *2*, 21.
13. Rizzo, A.; Requejo, P.; Winstein, C.J.; Lange, B.; Ragusa, G.; Merians, A.; Patton, J.; Banerjee, P.; Aisen, M. Virtual reality applications for addressing the needs of those aging with disability. *Stud. Health Technol. Inform.* **2011**, *163*, 510–516. [PubMed]
14. Williams, W.M.; Ayres, C.G. Can Active Video Games Improve Physical Activity in Adolescents? A Review of RCT. *Int. J. Environ. Res. Public Health* **2020**, *17*. [CrossRef]
15. Liberati, A.; Altman, D.G.; Tetzlaff, J.; Mulrow, C.; Gøtzsche, P.C.; Ioannidis, J.P.; Clarke, M.; Devereaux, P.J.; Kleijnen, J.; Moher, D. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: Explanation and elaboration. *BMJ Clin. Res. Ed.* **2009**, *339*, b2700. [CrossRef] [PubMed]
16. Downs, S.H.; Black, N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *J. Epidemiol. Community Health* **1998**, *52*, 377–384. [CrossRef] [PubMed]
17. Thomas, E.; Gentile, A.; Lakicevic, N.; Moro, T.; Bellafiore, M.; Paoli, A.; Drid, P.; Palma, A.; Bianco, A. The effect of resistance training programs on lean body mass in postmenopausal and elderly women: A meta-analysis of observational studies. *Aging Clin. Exp. Res.* **2021**, 1–12. [CrossRef]
18. Byun, W.; Lau, E.Y.; Brusseau, T.A. Feasibility and Effectiveness of a Wearable Technology-Based Physical Activity Intervention in Preschoolers: A Pilot Study. *Int. J. Environ. Res. Public Health* **2018**, *15*. [CrossRef] [PubMed]

19. Chen, H.; Sun, H. Effects of Active Videogame and Sports, Play, and Active Recreation for Kids Physical Education on Children's Health-Related Fitness and Enjoyment. *Games Health J.* **2017**, *6*, 312–318. [CrossRef] [PubMed]
20. Gao, Z.; Zeng, N.; Pope, Z.C.; Wang, R.; Yu, F. Effects of exergaming on motor skill competence, perceived competence, and physical activity in preschool children. *J. Sport Health Sci.* **2019**, *8*, 106–113. [CrossRef]
21. Gao, Z.; Pope, Z.; Lee, J.E.; Stodden, D.; Roncesvalles, N.; Pasco, D.; Huang, C.C.; Feng, D. Impact of exergaming on young children's school day energy expenditure and moderate-to-vigorous physical activity levels. *J. Sport Health Sci.* **2017**, *6*, 11–16. [CrossRef] [PubMed]
22. Garde, A.; Umedaly, A.; Abulnaga, S.M.; Robertson, L.; Junker, A.; Chanoine, J.P.; Ansermino, J.M.; Dumont, G.A. Assessment of a Mobile Game ("MobileKids Monster Manor") to Promote Physical Activity Among Children. *Games Health J.* **2015**, *4*, 149–158. [CrossRef]
23. Garde, A.; Chowdhury, M.; Rollinson, A.U.; Johnson, M.; Prescod, P.; Chanoine, J.P.; Ansermino, J.M.; Dumont, G.A. A Multi-Week Assessment of a Mobile Exergame Intervention in an Elementary School. *Games Health J.* **2018**, *7*, 1–8. [CrossRef]
24. Gil, H.; Santos, T.; Honório, S. The Contribution of Nintendo Wii® in Children's Motricity. In Proceedings of the 2018 International Symposium on Computers in Education (SIIE), Jerez, Spain, 19–21 September 2018; pp. 1–5. [CrossRef]
25. Goran, M.I.; Reynolds, K. Interactive multimedia for promoting physical activity (IMPACT) in children. *Obes. Res.* **2005**, *13*, 762–771. [CrossRef]
26. Graves, L.E.; Ridgers, N.D.; Atkinson, G.; Stratton, G. The effect of active video gaming on children's physical activity, behavior preferences and body composition. *Pediatr. Exerc. Sci.* **2010**, *22*, 535–546. [CrossRef] [PubMed]
27. Lau, P.W.; Wang, J.J.; Maddison, R. A Randomized-Controlled Trial of School-Based Active Videogame Intervention on Chinese Children's Aerobic Fitness, Physical Activity Level, and Psychological Correlates. *Games Health J.* **2016**, *5*, 405–412. [CrossRef] [PubMed]
28. Lee, J.E.; Gao, Z. Effects of the iPad and mobile application—Integrated physical education on children's physical activity and psychosocial beliefs. *Phys. Educ. Sport Pedagog.* **2020**, *25*. [CrossRef]
29. Staiano, A.E.; Beyl, R.A.; Guan, W.; Hendrick, C.A.; Hsia, D.S.; Newton, R.L., Jr. Home-based exergaming among children with overweight and obesity: A randomized clinical trial. *Pediatr. Obes.* **2018**, *13*, 724–733. [CrossRef]
30. Trost, S.G.; Brookes, D.S.K. Effectiveness of a novel digital application to promote fundamental movement skills in 3- to 6-year-old children: A randomized controlled trial. *J. Sports Sci.* **2021**, *39*, 453–459. [CrossRef]
31. Ye, S.; Pope, Z.C.; Lee, J.E.; Gao, Z. Effects of School-Based Exergaming on Urban Children's Physical Activity and Cardiorespiratory Fitness: A Quasi-Experimental Study. *Int. J. Environ. Res. Public Health* **2019**, *16*. [CrossRef]
32. Liang, Y.; Lau, P.W.C.; Jiang, Y.; Maddison, R. Getting Active with Active Video Games: A Quasi-Experimental Study. *Int. J. Environ. Res. Public Health* **2020**, *17*. [CrossRef]
33. Andersen, L.B.; Harro, M.; Sardinha, L.B.; Froberg, K.; Ekelund, U.; Brage, S.; Anderssen, S.A. Physical activity and clustered cardiovascular risk in children: A cross-sectional study (The European Youth Heart Study). *Lancet* **2006**, *368*, 299–304. [CrossRef]
34. Wong, R.S.M.; Yu, E.Y.T.; Wong, T.W.; Fung, C.S.C.; Choi, C.S.Y.; Or, C.K.L.; Liu, K.S.N.; Wong, C.K.H.; Ip, P.; Lam, C.L.K. Development and pilot evaluation of a mobile app on parent-child exercises to improve physical activity and psychosocial outcomes of Hong Kong Chinese children. *BMC Public Health* **2020**, *20*, 1544. [CrossRef]
35. McCurdy, L.E.; Winterbottom, K.E.; Mehta, S.S.; Roberts, J.R. Using nature and outdoor activity to improve children's health. *Curr. Probl. Pediatric Adolesc. Health Care* **2010**, *40*, 102–117. [CrossRef] [PubMed]
36. Biddiss, E.; Irwin, J. Active video games to promote physical activity in children and youth: A systematic review. *Arch. Pediatr. Adolesc. Med.* **2010**, *164*, 664–672. [CrossRef]
37. Janssen, I.; Leblanc, A.G. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *Int. J. Behav. Nutr. Phys. Act.* **2010**, *7*, 40. [CrossRef]
38. Faigenbaum, A.D.; McFarland, J.E.; Johnson, L.; Kang, J.; Bloom, J.; Ratamess, N.A.; Hoffman, J.R. Preliminary evaluation of an after-school resistance training program for improving physical fitness in middle school-age boys. *Percept. Mot. Ski.* **2007**, *104*, 407–415. [CrossRef]
39. Specker, B.; Binkley, T. Increased periosteal circumference remains present 12 months after an exercise intervention in preschool children. *Bone* **2004**, *35*, 1383–1388. [CrossRef] [PubMed]
40. Barbeau, P.; Johnson, M.H.; Howe, C.A.; Allison, J.; Davis, C.L.; Gutin, B.; Lemmon, C.R. Ten months of exercise improves general and visceral adiposity, bone, and fitness in black girls. *Obes. Silver Spring Md.* **2007**, *15*, 2077–2085. [CrossRef] [PubMed]
41. Jones, R.A.; Riethmuller, A.; Hesketh, K.; Trezise, J.; Batterham, M.; Okely, A.D. Promoting fundamental movement skill development and physical activity in early childhood settings: A cluster randomized controlled trial. *Pediatric Exerc. Sci.* **2011**, *23*, 600–615. [CrossRef] [PubMed]