Review

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Carolin Knoke[1,2,3] · Alexander Woll[1] · Ingo Wagner[2]
[1] Institute of Sports and Sports Science (IfSS), Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany
[2] Institute of School Pedagogy and Didactics (ISD), Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany
[3] Institute for Sports and Sports Science (IfSS), Institute for School Pedagogy and Didactics (ISD), Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

Health promotion in physical education through digital media: a systematic literature review

Introduction

According to the World Health Organization (WHO), "health" is defined as "a state of complete physical, mental and social well-being" (Kickbusch, 1999; WHO, 1986). Thus, health promotion should influence both health and behavior (Brehm, Pahmeier, & Tiemann, 1997). Not only physical well-being but also taking responsibility and control for one's own health plays an important role in health promotion (Brehm et al., 1997). In schools, health promotion enables students and teachers to deal responsibly with their own health and reduce health-related stress factors (Loss, Warrelmann, & Lindacher, 2016; Paulus, 2002). Thus, Sallis et al. (2012) called for "health-optimizing physical education." They suggested defining it as physical education that includes curricula and lessons that focus on health-related physical activity (PA) and fitness and keep students active at least 50% of the time. It involves all students, regardless of their physical abilities, and contributes significantly to their overall PA and, thus, to improved health.

The use of digital media in physical education can support and optimize teaching and learning processes (Gómez-García et al., 2020). Teachers can apply the health promotion information provided to their teaching (Sakellari et al., 2021). Digital media as "information and communication systems" based on the Internet are becoming increasingly important in the field of education (Albrecht & Revermann, 2016). Above all, the need for computers and software, as well as the associated representations and effects of the media, distinguishes digital media from conventional media (Zorn, 2011). Digital media use is not directly associated with a decrease in PA among children and adolescents (Schmidt et al., 2020) and is often viewed as a cost-effective tool in schools (Sakellari et al., 2021). Young people's engagement with digital health technologies is often discussed in terms of risk, yet there is very little evidence on the opportunities that can arise from them (Goodyear, Armour, & Wood, 2019a).

Current state of research

The integration of new mobile technologies into physical education is gaining popularity (Yang, Hwang, & Sung, 2020). Yang et al. (2020) found that the use of digital devices in physical education (e.g., smartphones and wearable devices) facilitates physical education and can promote social aspects. However, high-tech devices, such as wearable technologies, are rare in physical education (Yang et al., 2020). While university students have often been studied in this area, more focus should be placed on school students (Yang et al., 2020).

Gil-Espinosa and colleagues (2022) identified 18 apps for promoting physical activity (PA) in physical education (the apps were particularly appropriate for fitness, health and quality of life, physical education, body expression, and outdoor PA). The apps could help teachers implement physical education in secondary schools and effectively promote PA among adolescents.

There is evidence on interventions designed to increase students' PA behavior in physical education classes (Lonsdale et al., 2013). Overall, in their review, interventions were associated with 24% more active learning time compared to usual practice. Effective intervention strategies included in-service training for teachers focused on classroom organization, management and instruction, and supplementing regular physical education with high-intensity activities.

In addition, research on health-promoting interventions at the school level does not take place specifically in physical education. In a review, school-based interventions were shown to increase adolescent PA with a low-to-moderate impact (Van de Kop, Van Kernebeek, Otten, Toussaint, & Verhoeff, 2019). Among the most effective interventions in this regard were curricula that included physical activities tailored to adolescents and school personnel. In their review of school-based interventions limited to the elementary level, Navidad et al. (2021) summarized evidence on the effectiveness of school-based interventions in preventing obesity in elementary school children. However, few studies have mentioned the impact of using new technologies in interventions.

Regarding the use of digital technologies, positive results have been observed in behavior change and acquisition of better habits, although it is not clear what type of digital media is best to use. In terms of didactic impact, Navidad et al. (2021) emphasized focusing more on the school context, which is particularly important for acquiring healthy habits. In the study by Fu et al. (2019), adopting interactive video games in the classroom could effectively reduce sedentary behavior and promote light PA; the group of students who played these interactive games performed more moderate-to-vigorous PA than the group that did not. Overall, they found that interactive video games improved motivation and interest in PA.

Villasana et al. (2020) indicated that, outside of school, health-promoting apps have a motivating effect on young people in terms of encouraging healthy eating and PA habits. In particular, the ability to monitor and use games and challenges encourages the use of mobile apps (Villasana et al., 2020). Goodyear et al. (2019b) conducted an empirical study with adolescents outside of the school context and showed that the daily data of 10,000 steps and calories burned provided by a smartwatch encouraged adolescents to be more physically active. The smartwatch encouraged adolescents to monitor and compare themselves with others. However, problems occurred when goals were not met over several weeks, when they compared themselves with others, and when PA was not accurately recorded by the device.

Meates (2020) showed the impact of digital media on education and health and that it has both benefits and risks; teachers, governments, schools, universities, ministries, and other leaders should weigh the risks when promoting digital technologies. Through their content analysis, Araújo et al. (2021) showed that some countries' curricula already recognize the growing importance of digital technologies and consider mastery and familiarity with digital and media technologies to be very important for participation in the workforce and societies of the future.

This state of research shows that some fragmentary results already exist on the topic of digital media in physical education and/or health promotion in physical education. However, a research gap in the area of health promotion using digital media in physical education is evident.

Therefore, the aim of this systematic review was to summarize the current state of knowledge in this area, identify interventions to promote students' health using digital methods in physical education, and provide useful information for teachers who want to design and implement health-promoting activities in schools.

The research questions that guided this systematic review are as follows: What types of digital media have been used to date in the context of health promotion in physical education (RQ 1) and with what results (RQ 2)?

Methodology

Search strategy and inclusion criteria

To answer the research question of what studies are currently available on digitally supported health promotion in physical education, research data on the use of digital media and health promotion in physical education were collected. To capture the current state of research in the English language, a literature search was conducted on four databases: Scopus, ERIC, Web of Science, and PubMed. This systematic review was performed in accordance with PRISMA guidelines. The available evidence-based studies were analyzed and sorted based on the inclusion and exclusion criteria. One requirement was that the study addressed at least two of the three domains—health promotion (1), digital media (2) and physical education (3)—with physical education definitely included. Studies that examined teachers in their sample were not included because this review focused on student health promotion. Studies that were not available in English were excluded. As this is one of the first reviews in this area of research, there were no restrictions on how the studies were conducted, except that they were not allowed to be a review.

For a study to be included in this systematic review, it had to meet the following criteria: (a) the study was not a review article, (b) the study examined digital media in physical education and/or health promotion in physical education, (c) the article was written in English, (d) the study was published, (e) the sample consisted of students, (f) the study was not older than 5 years (published from 2018 to 2022), and (g) the article was an empirical study. The reviewer and a research assistant reviewed the titles and abstracts for the inclusion criteria. After scanning all titles for compliance with the topic (see inclusion criterion b), the abstracts of the articles were scanned and checked for duplicates, after which the articles had to pass a full-text review. The exclusion criteria were chosen to ensure that current empirical research related to the aforementioned research questions could be found. Due to the objective of the systematic review to provide an overview of current empirical studies on the topic, unsuitable studies, such as reviews or studies that were too old and did not meet the above inclusion criteria, were filtered out to ensure the quality of this review and to be able to answer the research questions (RQ 1 and RQ 2).

Databases and search string

The search was initiated in July 2022 and the date of the last research was December 6, 2022. The databases used were Web of Science, ERIC, Scopus, and PubMed. The period during which the studies were published was limited from January 2018 to November 2022. The document type of the review articles was excluded. The following terms was used to search the literature in these information sources:

Physical Education
AND (health promotion OR health intervention)
AND (digital OR technolog* OR media OR app* OR tablet* OR smartphone* OR track* OR video*)*

Data analysis

The process of selecting studies for the systematic review was determined by the inclusion and exclusion criteria mentioned earlier. The reference management software "Citavi" was used. All studies were independently reviewed by two reviewers for the questions to be answered. The data were then compared and discursively matched. In the event of differences of opinion between the experts, consensus was sought. The selection process is shown in **Fig. 1**.

The total sample size was 1492. All titles were scanned. A total of 11 duplicates were excluded. After scanning the titles and abstracts, 82 studies were included (ERIC database $N=27$, Scopus $N=27$, Web of Science $N=19$, and PubMed $N=9$). Of these, 65 articles were excluded in two steps for failure to meet the inclusion criteria. Finally, 17 articles on the topic were retained for the systematic review.

The "Effective Public Health Practice Project" (EPHPP) tool was used to assess the included studies and the bias of the studies. The assessment using the EPHPP tool was carried out by two independent reviewers. Where the two reviewers differed in their assessments, the reasons for this were discussed and a consensus was reached. The EPHPP tool has six categories, all of which are equally included in an overall assessment of study quality. These categories are: "Selection Bias"; "Study Design"; "Confounding Factors"; "Blinding"; "Data Collection Methods"; and "Withdrawals and Drop-Outs." Each category was rated as either strong (1), moderate (2), or weak (3). This resulted in the overall rating of the study: strong (no weak ratings), moderate (one weak rating), or weak (two or more weak ratings; Effective Public Healthcare Panacea Project, 2009). The EPHPP instrument is well suited for use in systematic reviews (Armijo-Olivo, Stiles, Hagen, Biondo, & Cummings, 2012).

Results

The aim of this review was to examine and present the current state of research on health promotion with digital media in physical education. The results were guided by the following research questions: What types of digital media and their applications have been used in the context of health promotion and/or the use of digital media in physical education (RQ 1) and what are the results of these studies (RQ 2)?

The studies either dealt with health promotion in physical education, with the use of digital media in physical education, or with health promotion through digital media in physical education. In addition, the evidence of the included studies was assessed. **Table 1** provides an overview of the studies included in this systematic literature review.

Quality of the evidence

Various study designs were represented, which were assessed by the reviewers according to the 'Effective Public Health Practice Project' (EPHPP) study design tool as follows: three randomized controlled trials, four controlled clinical trials, three cohort analyses, five cohorts, and two other study designs.

With the exception of three "strong" ratings of study quality according to the EPHPP tool (Lee et al., 2021; Lonsdale et al., 2019 & Telford et al., 2020) and five "moderate" ratings (Invernizzi et al., 2019; Lee & Gao, 2020, Li et al., 2019; Rosenstiel et al., 2022 & Sinđić et al., 2021), all other studies were rated as having "weak" quality evidence. The

Abstract

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C. Knoke · A. Woll · I. Wagner

Health promotion in physical education through digital media: a systematic literature review

Abstract

Background. Digital devices and applications (apps) are already being used in various areas of sport and health. However, digital media are rarely used for the education of students and physical education teachers. The use of digital media in physical education could increase the potential for health promotion through physical activity in schoolchildren and contribute to the optimization of teaching and learning processes.
Purpose. The aim of the current systematic literature review was therefore to identify health-promoting interventions for schoolchildren through physical education using digital media. The overview also provides information for school teachers who want to use digital media in health-promoting physical education.
Methodology. To answer the research questions – what types of digital media have been used in health promotion in physical education (RQ 1) and with what results (RQ 2) – a systematic literature search was conducted in four databases (Web of Science, ERIC, Scopus and PubMed) using keywords related to physical education, health promotion and digital media according to the PRISMA guidelines and using the 'Effective Public Health Practice Project' (EPHPP) tool to assess the studies.
Results. In the original sample of 1492 articles, 17 empirical studies were included in the review. Positive results were found for the use of fitness technologies in physical education to improve motor skills, for online physical education and apps to improve physical activity, for the inclusion of digital games in physical education to increase motivation, for video feedback in physical education to improve knowledge and motor skills, and for flipped learning approaches using digital media to improve knowledge acquisition and student-teacher interactions in physical education. The studies were mostly classified as "weak" in terms of evidence using the EPHPP tool.
Discussion. The literature review shows a gap in research on the question of how health promotion can be implemented using digital media in physical education. Digital media types, such as apps, video feedback and online physical education, showed controversial results. In addition, whether physical activity is increased or decreased by digital media could not be clearly answered by the results in this review. However, these results can provide a basis for future studies in order to develop health-promoting interventions, whereby attention should be paid to the quality of the study methodology.

Keywords
Physical activity · Apps · Technology · School · Students

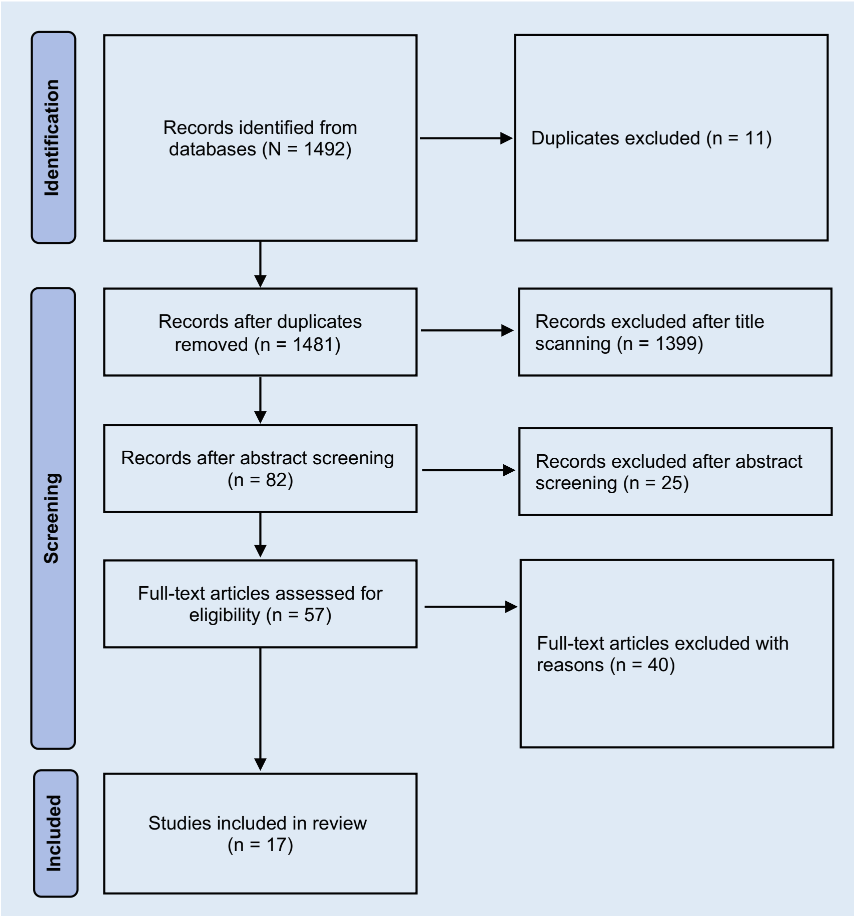

Fig. 1 ▲ Flow diagram of the study selection (based on Page et al., 2021)

worst ratings according to the EPHPP tool were found in the categories "confounders," "blinding," and "data collection methods." The reliability and validity of the data collection methods, dropout rate, and blinding were often not reported. The number of participants varied greatly from study to study, with a total of 17,473 participants included in all studies. The studies examined students aged 6–17 years.

In terms of reported outcomes, four studies were identified that covered all three areas of the research questions (physical education, digital media, and health promotion; Lee et al., 2021; Lee & Gao, 2020, Nesterchuk et al., 2021 & Papastergiou et al., 2021). Among the remaining included studies, there were eight findings on digitally supported physical education (Fernandez-Rio et al., 2020; Hinojo-Lucena et al., 2019; Kok et al., 2020; Lonsdale et al., 2019; Østerlie & Mehus, 2020; Roure et al., 2019; Trabelsi et al., 2021 & Yu & Jee, 2020) and five studies on health-promoting physical education (Invernizzi et al., 2019; Li et al., 2019; Rosenstiel et al., 2022; Sinđić et al., 2021 & Telford et al., 2020).

Fitness technologies in physical education to improve motor skills

In general, fitness technologies positively impact students' motor skill development and interest in participating in physical education (Nesterchuk et al., 2021). For example, synchronous online physical education classes may have a positive effect on improving physical parameters, such as muscle mass, ankle strength, hip strength, knee strength, and balance in adolescents, thereby improving adolescents' physical fitness (Lee et al., 2021).

Online physical education and apps in physical education to improve physical activity

Students in app-integrated physical education may experience increases in sedentary behavior and decreases in light PA and moderate-to-intense PA (Lee & Gao, 2020). In the study by Lee and Gao (2020), in the comparison group with normal physical education, children's sedentary behavior decreased, while light PA improved over time. For children in the app-integrated group, self-efficacy, social support, and enjoyment of PA improved but did not reach the significance level. By contrast, other findings have shown that school-based interventions can increase PA in adolescents with low-to-moderate effects (Van de Kop et al., 2019). Mobile apps for monitoring PA and nutrition, exergames, and an online social learning platforms can encourage students to conduct PA and nutrition monitoring (Papastergiou et al., 2021).

Online physical education showed no effect on student motivation but a positive effect on students' average MVPA during class (Lonsdale et al., 2019). Physical education in the online format has been shown to be acceptable to teachers (Lonsdale et al., 2019). Timely and high-quality feedback is important for the successful implementation of online instruction in physical education (Yu & Jee, 2020). In addition, the university should provide sufficient time and technical support, faculty should be trained in the web-based environment prior to their online teaching, and attention should be paid to student participation and assessment (Yu & Jee, 2020). Teachers should prepare well, avoid technical errors, and motivate learners continuously (Yu & Jee, 2020).

Gamification in physical education to increase students' motivation

In terms of the research questions of what types of digital media and its applications were used in physical education regarding health promotion (RQ 1) and what results they provided (RQ 2), it was found that student motivation can be

Table 1 Included studies by reference, study design, sample, main statistical results, and rating in quality assessment with the 'Effective Public Health Practice Project' (EPHPP) tool.

No.	Reference	Study design	Sample	Main findings	Quality assessment (EPHPP tool)
1	Fernandez-Rio, J., De las Heras, E., González, T., Trillo, V. & Palomares, J. (2020). Gamification and physical education. Viability and preliminary views from students and teachers	Cohort (pre-experimental, one group pre-test–post-test design; dependent variable (intrinsic motivation) measured in one group of participants before and after the intervention)	$N = 290$ students, age 6–14 years; older students ($n = 161$), younger students ($n = 126$), physical education teachers ($n = 4$)	1) To assess global pre–post differences, a *t* test was conducted, which showed a significant increase after the intervention program. Intrinsic Motivation Pre-test Global: 5.19 ± 1.24, Intrinsic Motivation Post-test Global 5.32* ± 1.27 ($p \geq 0.01$, not significant). 2) A one-way ANOVA was also conducted to assess post-test differences based on grade level: $F(2, 30.32) = 25.681$, $p < 0.01$ and revealed significant differences: $F(2, 22.78) = 16.739$, $p < 0.01$. 3) The qualitative results of the drawings produced one major theme, enjoyment, and two minor themes, friends and learning	A) Selection Bias: Weak (3) B) Study Design: Moderate (2) C) Confounders: Moderate (2) D) Blinding: Moderate (2) E) Data Collection Methods: Strong (1) F) Withdrawals and Drop-Outs: Weak (3) *Global Rating: Weak (3)*
2	Hinojo-Lucena, F., López-Belmonte, J., Cabrera, A., Torres, J. M. & Sánchez, S. (2019). Academic Effects of the Use of Flipped Learning in Physical Education	Cohort analytic (quantitative, experimental design of a descriptive and correlational nature, with control and experimental groups)	$N = 119$ students from an educational center in the Autonomous City of Ceuta (Spain). Particularly, ($n = 60$, boys = 26, girls = 34, MAGE = 12 years, SD = 1.01) subjects in the sixth year of primary education and ($n = 59$, boys = 23, girls = 36; MAGE = 16 years, SD = 1.26) subjects in the fourth year of secondary education	To determine the value of independence between the results obtained for the traditional approach and flipped learning, Student's *t* test was conducted. A standardized value of $p < 0.05$ was considered a statistically significant difference. As a corrective element for d (correlation force), a distinction for bi-serial correlation ($r = [0, 1]$) was made among small ($r = -0.1$), medium ($r = -0.3$) and large ($r = -0.5$) effect sizes. 1) The flipped learning approach improves the interaction of students with teachers and peers in both primary education ($r = -0.57$, $r = -0.62$) and secondary education ($r = 0.63$, $r = -0.6$). Statistical significance was also obtained for the variables related to motivation and autonomy in both stages, obtaining a medium-low association in primary education ($r = -0.35$, $r = -0.35$) and secondary education ($r = -0.41$, $r = -0.47$), slightly higher for the latter. 2) The results obtained for the experimental groups were analyzed to determine the value of the independence of flipped learning in physical education according to educational stage. Flipped learning was equally effective. A statistically significant difference was found only in the variable related to student autonomy (higher secondary education). However, the analysis of effect size ($r = -0.309$) determined that this association in the final reflections should be viewed with caution ($r < -0.5$)	A) Selection Bias: Moderate (2) B) Study Design: Moderate (2) C) Confounders: Weak (3) D) Blinding: Weak (3) E) Data Collection Methods: Moderate (2) F) Withdrawals and Drop-Outs: Not Applicable (NA) *Global Rating: Weak (3)*
3	Invernizzi, P., Crotti, M., Bosio, A., Cavaggioni, L., Alberti, G., & Scurati, R. (2019). Multi-Teaching Styles Approach and Active Reflection: Effectiveness in Improving Fitness Level, Motor Competence, Enjoyment, Amount of Physical Activity, and Effects on the Perception of Physical Education Lessons in Primary School Children	Controlled clinical trial (experimental design with 2 groups [intervention group (IG) and control group (CG)])	$N = 121$ fifth-grade students (age 10.5 ± 0.5 years) from three elementary schools, randomly assigned into two groups: (a) IG, which received physical education (PE) lessons based on multi-teaching styles and active reflection (MTA) provided by specifically trained PE students, and (b) CG, which received standard PE (S-PE) lessons from primary school classroom teachers; 62 pupils were allocated to the IG (29 girls, 33 boys) and 59 to the CG (35 girls, 24 boys)	Eta-squared (η^2) statistics were used to calculate the magnitude of difference between the groups. The thresholds of small, moderate, and large effects were defined as 0.01, 0.06, and 0.14, respectively. 1) Fitness level: The MFT VO_{2max} estimate increased by 1.38 mL/kg/min ± 0.88 (95% CI) more in IG than in CG, with a moderate η^2 ($p = 0.002$, $\eta^2 = 0.09$). 2) Motor competence: TGMD-2 significantly increased by 5.44 ± 2.36 AU (95% CI) more in IG compared to that in the CG, with a large η^2 ($p < 0.001$, $\eta^2 = 0.17$). 3) Enjoyment: A significant difference with a very large η^2 ($p < 0.001$, $\eta^2 = 0.96$) was found between the two groups for the PACES questionnaire results, with IG presenting a score of 0.18 ± 0.09 (95% CI) higher than that obtained by CG. This indicated a significant change in physical activity (PA) enjoyment scores in the IG (+2.92%, 4.4 ± 0.6 AU pre-intervention vs. 4.5 ± 0.4 AU post-intervention) as compared to the CG (4.3 ± 0.5 AU pre-intervention vs. 4.3 ± 0.3 AU post-intervention). 4) Amount of PA: PAQ-C scores increased by 0.35 ± 0.22 AU (95% CI) more in IG than in CG ($p = 0.002$, $2 = 0.09$). This indicated a positive change in PA volume between baseline and week 12 for IG (2.6 ± 0.5 AU pre-intervention vs. 3.2 ± 0.6 AU post-intervention) as compared to CG (2.8 ± 0.6 AU pre-intervention vs. 2.9 ± 0.6 AU post-intervention)	A) Selection Bias: Strong (1) B) Study Design: Strong (1) C) Confounders: Moderate (2) D) Blinding: Moderate (2) E) Data Collection Methods: Strong (1) F) Withdrawals and Drop-Outs: Weak (3) *Global Rating: Moderate (2)*

Table 1 (Continued)

No.	Reference	Study design	Sample	Main findings	Quality assessment (EPHPP tool)
4	Kok, M., Komen, A., van Capelleveen, L., & van der Kamp, J. (2020). The Effects of Self-Controlled Video Feedback on Motor Learning and Self-Efficacy in a Physical Education Setting: An Exploratory Study on the Shot-put	Cohort analytic (experimental design with 3 groups. Participants practiced the shot-put during four practice sessions organized during PE lessons. One class practiced self-controlled video feedback (SC-VF group, $n = 22$). A second class could not choose the timing and frequency of feedback delivery (externally controlled video feedback, EC-VF group, $n = 17$). A third group practiced in a traditional way, teacher-guided (TG) group, $n = 17$	$N = 56$ grade 1 students of a regular secondary school who practiced the shot-put during four practice sessions organized during PE lessons	1) The one-way ANOVA showed no significant differences in shot-put distance, $F(2, 53) = 0.66$, $p = 0.52$, $\eta^2_p = 0.03$ and shot-put technique, $F(2, 53) = 0.39$, $p = 0.68$, $\eta^2_p = 0.02$ between the groups at pretest. However, a main effect for groups on perceived learning effect was present: $F(2, 50) = 5.59$, $p < 0.01$, $\eta^2_p = 0.19$. 2) The one-way ANOVA did not return significant group differences in reported perceived enjoyment towards the practice sessions: $F(2, 50) = 1.42$, $p = 0.25$, $\eta^2_p = 0.06$. However, a main effect for group on perceived learning effect was present: $F(2, 50) = 5.59$, $p < 0.01$, $\eta^2_p = 0.19$. Post hoc analyses indicated that the perceived learning effect in the EC-VF group was lower than that in the SC-VF group	A) Selection Bias: Moderate (2) B) Study Design: Moderate (2) C) Confounders: Weak (3) D) Blinding: Weak (3) E) Data Collection Methods: Moderate (2) F) Withdrawals and Drop-Outs: Strong (1) *Global Rating: Weak (3)*
5	Lee, K.-J., Noh, B., & An, K.-O. (2021). Impact of Synchronous Online Physical Education Classes Using Tabata Training on Adolescents during COVID-19: A Randomized Controlled Study	Randomized controlled trial (experimental design with 2 groups, asynchronous online class group (AOCG) and synchronous online class group (SOCG) with 10 weeks of online PE classes on body composition)	$N = 48$ adolescents, assigned to either the AOCG ($n = 24$, age: 15.8 ± 0.4 years) or the SOCG ($n = 24$ age: $15.9 \pm$ 0.3 years)	1) Muscle mass showed an interaction effect between time and groups ($F = 5, 426$, $p = 0.024$), and there was a significant difference between the time points ($F = 4, 732$, $p = 0.035$) and no significant difference between the groups ($F = 0, 448$, $p = 0.507$). 2) Ankle strength (dorsiflexion) showed an interaction effect between time and group ($F = 4, 284$, $p = 0.044$) but no significant difference between the time points ($F = 3, 795$, $p = 0.058$) and between groups ($F = 1, 206$, $p = 0.278$). Hip flexion strength showed an interaction effect between time and group ($F = 9, 218$, $p = 0.004$), with a significant difference between times ($F = 4, 418$, $p = 0.041$), but there was no significant difference between the groups. Knee flexion strength showed an interaction effect between time and group ($F = 6, 220$, $p = 0.016$), but there was no significant difference between the time points ($F = 0, 691$, $p = 0.410$) or between the groups ($F = 0, 128$, $p = 0.722$). 3) The Y-balance test of composite score showed an interaction between time and group ($F =$ 6, 497, $p = 0.014$), and there was no significant difference between the time points ($F = 0, 497$, $p = 0.485$). However, there was a significant difference between the groups ($F = 6, 157$, $p =$ 0.017, $\eta^2 = 0.124$)	A) Selection Bias: Strong (1) B) Study Design: Strong (1) C) Confounders: Moderate (2) D) Blinding: Moderate (2) E) Data Collection Methods: Strong (1) F) Withdrawals and Drop-Outs: Strong (1) *Global Rating: Strong (1)*

Table 1 (Continued)

No.	Reference	Study design	Sample	Main findings	Quality assessment (EPHPP tool)
6	Lee, J. E., & Gao, Z. (2020). Effects of the iPad and Mobile Application-Integrated Physical Education on Children's Physical Activity and Psychosocial Beliefs	Cohort (pre-test post-test quasi-experimental design with convenience sample recruitment)	*N* = 157 fourth-and fifth-grade children (9–11 years old). Four PE classes from one school (*n* = 77) served as the app-integrated group, while three classes from the comparison school (*n* = 80) served as the traditional PE group	1) The changes in children's PA were significantly different between the app-integrated and comparison groups in a) Sedentary behavior, $F(1, 154) = 110.6$, $p < 0.001$, $\eta^2 = 0.42$, b) Light PA, $F(1, 154) = 97.7$, $p < 0.01$, $\eta^2 = 0.39$, and c) Moderate-to-vigorous physical activity (MVPA), $F(1, 154) = 31.4$, $p < 0.01$, $\eta^2 = 0.17$. 2) The percentage of time spent in sedentary behavior was not significantly different between the groups, $F(1, 148) = 3.89$, $p = 0.07$, $\eta^2 = 0.19$. However, significant differences existed between the app-integrated and comparison groups in the percentage of time spent in light PA, $F(1, 148) = 14.57$, $p = 0.03$, $\eta^2 = 0.82$ and MVPA, $F(1, 148) = 5.49$, $p = 0.04$, $\eta^2 = 0.35$. In particular, the app-integrated group had a higher light PA than the comparison group, whereas the comparison group had higher MVPA than the app-integrated group. 3) Three items from outcome expectancy, one from social support and one from enjoyment were removed from the original questionnaire to increase the reliability levels. There were no significant initial differences in all four beliefs, $F(1, 150) = 1.13$, $p = 0.35$, $\eta^2 = 0.03$. 4) A series of ANCOVA results indicated that the app-integrated group had a significantly greater increased sedentary time (14.8%) than the comparison group, –2.6%; $F(1, 154) = 110.6$, $p < 0.001$, $\eta^2 = 0.42$. Regarding the percentage of time spent in light PA, the percentage for the app-integrated group decreased (–6.2%), while that for the comparison group increased (4.2%). The difference between the two groups in light PA was significant, $F(1, 154) = 97.7$, $p < 0.001$, $\eta^2 = 0.39$. In terms of the percentage of time spent in MVPA, children in both groups demonstrated a decrease; however, the decrease in the app-integrated group (–8.6%) was significantly greater than that in the comparison group, –1.6%; $F(1, 154) = 31.4$, $p < 0.001$, $\eta^2 = 0.17$	A) Selection Bias: Moderate (2) B) Study Design: Moderate (2) C) Confounders: Strong (1) D) Blinding: Moderate (2) E) Data Collection Methods: Strong (1) F) Withdrawals and Drop-Outs: Weak (3) *Global Rating: Moderate (2)*
7	Li, Y., Wang, S., Yu, Y., Wu, L., Shi, Y., Zhang, M., Wu, X., & Ma, X. (2019). Associations Among Physical Education, Activity-Related Healthy Lifestyle Practices, and Cardiorespiratory Fitness of Chinese Youth	Other Specify (large-scale study, 15 min progressive aerobic cardiovascular endurance run (PACER) and questionnaire data regarding PE curriculum implementation)	*N* = 13,138 students aged 14 (boys = 7094, 54.0%) in Grade 8	β: All regressions were adjusted for potential confounding variables. First, the habitual PA, appropriate method of PA and eating breakfast every day variables were combined to create a latent variable—self-reported activity-related healthy lifestyle practices. Second, cardiorespiratory fitness was regressed on the latent variable. Finally, the latent variable was regressed on curriculum implementation, learning and practice, perceived support from PE teachers, PE facilities, PE equipment and PE interest. PE interest was regressed on perceived support from PE teachers. All regressions were adjusted for potential confounding variables, including SES, location of schools and BMI. 1) There was a statistically significant relationship between cardiorespiratory fitness and activity-related healthy lifestyle practices, which was somewhat positively impacted by skill learning and practice and perceived support from PE teachers. Together, the boy's model explained 21.8% of the variance in cardiorespiratory fitness, whereas the girl's model explained 15.9%. Self-reported activity-related healthy lifestyle practices had a direct positive association with cardiorespiratory fitness (Boys: β = 0.31, 95% CI [0.27, 0.34]; Girls: β = 0.34, 95% CI [0.30, 0.37]). 2) Perceived support from PE teachers had a direct positive (Boys: β = 0.25, 95% CI [0.20, 0.31]; Girls: β = 0.24, 95% CI [0.19, 0.30]) and an indirect positive association. Of the analyzed sample, 13.4% of boys and 13.7% of girls reached capping scores of 70 laps for boys and 42 laps for girls	A) Selection Bias: Moderate (2) B) Study Design: Weak (3) C) Confounders: Moderate (2) D) Blinding: Moderate (2) E) Data Collection Methods: Moderate (2) F) Withdrawals and Drop-Outs: Not Applicable (NA) *Global Rating: Moderate (2)*

Table 1 (Continued)

No.	Reference	Study design	Sample	Main findings	Quality assessment (EPHPP tool)
8	Lonsdale, C., Lester, A., Owen, K. B., White, R. L., Peralta, L., Kirwan, M., Diallo, T. M. O., Maeder, A. J., Bennie, A., MacMillan, F., Kolt, G. S., Ntoumanis, N., Gore, J. M., Cerin, E., Cliff, D. P., & Lubans, D. R. (2019). An Internet-Supported School Physical Activity Intervention in Low Socioeconomic Status Communities: Results from the Activity and Motivation in Physical Education (AMPED) Cluster Randomised Controlled Trial	Randomized controlled trial (with allocation at the school level, 1:1 ratio)	$N = 1421$ students from 14 schools	1) Teachers rated AMPED training as highly useful (M = 4.82 on 5-point scale, SD = 0.38). They also believed that the website was user friendly (M = 4.60 on a 5-point scale, SD = 0.48). 2) At post-intervention, the adjusted mean difference in the proportion of PE lesson time spent in MVPA was 5.66% (95% CI 4.71–6.63) in favor of the intervention group ($p < 0.001$). Students' sedentary time during PE lesson time decreased ($p \leq 0.001$), while time spent in light, moderate and vigorous PAs increased ($p < 0.01$)	A) Selection Bias: Moderate (2) B) Study Design: Strong (1) C) Confounders: Strong (1) D) Blinding: Strong (1) E) Data Collection Methods: Strong (1) F) Withdrawals and Drop-Outs: Moderate (2) *Global Rating: Strong (1)*
9	Nesterchuk, N., Rabcheniuk, S., Kuriata, A., Boreiko, H., & Skalski, D. (2021). Application of Fitness Technologies to Increase Motor Activity and Physical Fitness of Adolescents	Controlled Clinical Trial (control group was trained using the traditional methodology, intervention group was exposed to the developed fitness technologies)	$N = 124$ students of the seventh grade (12–13 years old), who were then divided into the main group and control group, each containing $N = 62$ members	As a result of the pedagogical experiment, the study discovered the positive effect of fitness technologies on the development of students' motor skills ($p < 0.05$). The study witnessed the optimization of the functional condition of the adolescents in the main group: decreased heart rate (85 ± 0.64 at the beginning and 83 ± 0.41 at the end); decreased BFOF (2580 ± 26 at the beginning and 2450 ± 0.12 ($p < 0.05$) at the end); improved results of the Ruffier–Dickson test (7.8 ± 0.43 at the beginning and 4.2 ± 0.18 ($p < 0.05$) at the end)	A) Selection Bias: Weak (3) B) Study Design: Strong (1) C) Confounders: Weak (3) D) Blinding: Moderate (2) E) Data Collection Methods: Weak (3) F) Withdrawals and Drop-Outs: Weak (3) *Global Rating: Weak (3)*
10	Østerlie & Mehus (2020). The Impact of Flipped Learning on Cognitive Knowledge Learning and Intrinsic Motivation in Norwegian Secondary Physical Education	Cohort (a 3-week-long intervention, 85 students were assigned to an intervention group (flipped learning group) and 121 students to a control group (non-flipped learning group))	$N = 206$ Norwegian students ($n = 97$ girls aged 15.34 (average); SD = 1.35 years; $n = 109$ boys aged 15.02 years (average); SD = 1.18) from secondary and upper secondary schools	Simple effects for gender showed that girls increased their HRFK from T1 (M = 53.85) to T2 (M = 55.58): $F(1, 202) = 12.76$, $p < 0.01$, partial $\eta^2 = 0.059$. Boys also increased their HRFK from T1 (M = 52.22) to T2 (M = 55.55): $F(1, 202) = 50.80$, $p < 0.01$, partial $\eta^2 = 0.200$. Simple effects for instruction groups also showed a significant increase in HRFK, with the FL group having the largest increase from T1 (M = 52.42) to T2 (M = 56.01): $F(1, 202) = 42.16$, $p < 0.01$, partial $\eta^2 = 0.173$. By contrast, the NFL (no flipped learning) group had a smaller increase from T1 (M = 53.46) to T2 (M = 55.21): $F(1, 202) = 14.73$, $p < 0.01$, partial $\eta^2 = 0.068$	A) Selection Bias: Weak (3) B) Study Design: Moderate (2) C) Confounders: Moderate (2) D) Blinding: Moderate (2) E) Data Collection Methods: Strong (1) F) Withdrawals and Drop-Outs: Weak (3) *Global Rating: Weak (3)*

Table 1 (Continued)

No.	Reference	Study design	Sample	Main findings	Quality assessment (EPHPP tool)
11	Papastergiou, M., Kanaros, D., Papamichou, A., & Vernadakis, N. (2021). Effects of a Project Based on Mobile Applications, Exergames and a Web 2.0 Social Learning Platform on Students' Physical Activity and Nutritional Criteria in the Era of COVID 19	Cohort (a year-long, student-centered physical education (PE) project, pretest/posttest design)	$N = 51$ students (aged 15–16 years, M = 15.06, SD = 0.24), 31 boys, 20 girls, split into two groups: the experimental group ($n = 25$) and the control group ($n = 26$)	1) The pairwise comparisons revealed that within Group 1 (IG), there was a statistically significant increase in perception scores from pre-test to post-test, Wilk's $\lambda = 0.31$, $F(1, 49) = 106.73$, $p < 0.001$, and the relevant effect size was large (multivariate $\eta^2 = 0.69$). 2) The conducted pairwise comparisons showed that within Group 1 (IG), the decrease in PA scores from pre-test to post-test was not statistically significant, Wilk's $\lambda = 0.96$, $F(1, 49) = 2.14$, $p = 0.15$, and the relevant effect size was small (multivariate $\eta^2 = 0.04$). 3) Regarding sedentary time, in the pre-test, Group 2 (CG) spent more time in sedentary activity than Group 1 (IG), and this difference was statistically significant, as revealed by the conducted independent samples *t* test: $t(49) = -3.33$, $p = 0.002$. The ANCOVA was also significant: $F(1, 48) = 40.22$, MSE = 0.022, $p < 0.001$	A) Selection Bias: Moderate (2) B) Study Design: Moderate (2) C) Confounders: Weak (3) D) Blinding: Weak (3) E) Data Collection Methods: Strong (1) F) Withdrawals and Drop-Outs: Weak (3) *Global Rating: Weak (3)*
12	Rosenstiel, S., Volk, C., Schmid, J., Wagner, W., Demetriou, Y., Höner, O., Thiel, A., Trautwein, U., & Sudeck, G. (2022). Promotion of Physical Activity-Related Health Competence in Physical Education: A Person-Oriented Approach for Evaluating the GEKOS Intervention within a Cluster Randomized Controlled Trial	Controlled clinical trial (person-oriented study, intervention group students received six PE lessons that combined practical and theoretical content regarding training, fitness and health. Students completed a knowledge test and a fitness test and filled out scales considering motivation and perceived control competence)	$N = 860$ ninth graders from both urban and rural areas randomly assigned to an intervention or control group. After baseline assessment of the 48 PE classes, 841 students were in the final sample (Mage = 14.20, SD = 0.51); 472 students (53.8% girls) in the IG and 369 students (47.7% girls) in the CG	From T1 to T3, compared to the CG students, the IG students transitioned significantly positively (OR = 1.58, 95% CI = 1.04–2.38) more often than not, but there were no differences between positive and negative transitions (OR = 1.39, 95% CI = 0.83–2.32). Within the CG, statistically significant transitions were shown in favor of negative transitions ($Z = -3.69$, $p = < 0.001$). This is in line with the results shown by the multinomial logistic regression, where more positive transitions remained in the IG than in the CG. Post hoc analyses showed that, based on pattern affiliation at T1, IG students compared to CG students of pattern 2 (shape: low to medium) transitioned significantly ($p < 0.001$) positively more often, for example, to pattern 3 (level: medium; 30% vs. 9%; Table 4) or pattern 4 (shape: medium to high; 11% vs. 5%). No significant differences were found for students of patterns 1, 3, 4 or 5. From T1 to T2, compared to CG students, IG students transitioned significantly positively more often than not: odds ratio (OR) = 2.00, confidence interval (95% CI) = 1.36–2.93; Table 3. However, there were no differences between positive and negative transitions (OR = 1.65, 95% CI = 0.97–2.78)	A) Selection Bias: Moderate (2) B) Study Design: Strong (1) C) Confounders: Weak (3) D) Blinding: Moderate (2) E) Data Collection Methods: Strong (1) F) Withdrawals and Drop-Outs: Strong (1) *Global Rating: Moderate (2)*

Table 1 (Continued)

No.	Reference	Study design	Sample	Main findings	Quality assessment (EPHPP tool)
13	Roure, C., Méard, J., Lentillon-Kaestner, V., Flamme, X., Devillers, Y., & Dupont, J.-P. (2019). The Effects of Video-Feedback on Students' Situational Interest in Gymnastics	Cohort analytic (experimental design with 3 groups; Teacher feedback group, video feedback group, video and teacher feedback group)	N = 361 secondary school students who practiced technical skills in gymnastics (M = 13.0, SD = 1.5, 47.3% boys, age 11–17)	A multivariate analysis of variance (MANOVA) was used to compare SI scores among the three groups. The MANOVA results revealed a significant main effect in SI and total interest scores for the three groups (teacher feedback group, video feedback group and video and teacher feedback group) Pillaï Trace = 0.40, $F(6, 350) = 14.78$, $p < 0.001$, $\eta^2 = 0.20$ Follow-up univariate ANOVA tests indicated that mean scores for SI dimensions and total interest differed significantly between the 'video and teacher FB group' and the other two groups. However, no differences were found between the 'teacher FB group' and the 'VFB group'. Post hoc tests using the Bonferroni correction revealed that the 'video and teacher FB group' received higher scores for total interest (15.61 vs. 11.45 and 11.10, $p < 0.01$), instant enjoyment (12.12 vs. 8.40 and 8.60, $p < 0.01$), exploration intention (10.21 vs. 9.43 and 8.66, $p < 0.01$) and attention demand (10.45 vs. 8.60 and 8.89, $p < 0.01$), whereas it showed lower scores for novelty (7.96 vs. 11.05 and 10.04, $p < 0.01$) and challenge (7.65 vs. 9.52 and 9.49, $p < 0.01$)	A) Selection Bias: Moderate (2) B) Study Design: Weak (3) C) Confounders: Weak (3) D) Blinding: Weak (3) E) Data Collection Methods: Moderate (2) F) Withdrawals and Drop-Outs: Weak (2) *Global Rating: Weak (3)*
14	Sinđić, M., Mačak, D., Todorović, N., Purda, B., & Batez, M. (2021). Effect of Integrated Neuromuscular Exercise in Physical Education Class on Health-Related Fitness in Female Children	Controlled clinical trial (EG and CG performed the INT program and traditional PE activities two times per week within the first ~15 min of PE class. The Fitnessgram battery tests assessed the HRF before and after the program)	*N* = 72 healthy girls who were divided into the IG (*n* = 37; mean ± SD: age = 8.17 ± 0.31) and CG (*n* = 35; age = 8.11 ± 0.31)	Both groups significantly improved the performance of almost all muscular fitness tests (curl-ups, trunk lift, push-ups); however, EG increased the push-ups more than CG ($F = 9, 01$, $p < 0.01$, $\eta^2 = 0.14$). EG additionally improved the modified pull-ups ($F = 14, 09$, $p < 0.01$, $\eta^2 = 0.19$) and flexed arm hang ($F = 28, 82$, $p < 0.01$, $\eta^2 = 0.33$) tests. After eight weeks, EG significantly reduced all fat measures, while CG decreased only triceps skinfold but to a smaller extent ($F = 5, 92$, $p < 0.02$, $\eta^2 = 0.09$). Both groups showed significant improvement in the performance on almost all muscular fitness tests (curl-ups, trunk lift, push-ups); however, EG increased the push-ups more than CG ($F = 9, 01$, $p < 0.01$, $\eta^2 = 0.14$). EG additionally improved the modified pull-ups ($F = 14, 09$, $p < 0.01$, $\eta^2 = 0.19$) and flexed arm hang ($F = 28, 82$, $p < 0.01$, $\eta^2 = 0.33$) tests. = 0.09)	A) Selection Bias: Moderate (2) B) Study Design: Strong (1) C) Confounders: Weak (3) D) Blinding: Moderate (2) E) Data Collection Methods: Moderate (2) F) Withdrawals and Drop-Outs: Strong (3) *Global Rating: Moderate (2)*

Table 1 (Continued)

No.	Reference	Study design	Sample	Main findings	Quality assessment (EPHPP tool)
15	Telford, R. M., Olive, L. S., Keegan, R. J., Keegan, S., Barnett, L. M., & Telford, R. D. (2020). Student Outcomes of the Physical Education and Physical Literacy (PEPL) Approach: A Pragmatic Cluster Randomised Controlled Trial of a Multicomponent Intervention to Improve Physical Literacy in Primary Schools	Randomized controlled trial (33-week intervention, a qualified PE teacher implemented the PEPL intervention across seven schools and another seven schools formed a control group as part of a randomized cluster-based trial)	$N = 318$ grade 5 students, age 10.4 years ± SD = 0.4. Average BMI across all schools was 19.6 ± SD 4.2	β: Intervention effects on student outcome measurements: Intervention effects were examined by fitting general linear mixed models for each variable of interest. Each model included fixed effects for study condition and sex, and to account for school clustering, a random intercept for schools was included. PA models were also adjusted for wear time. With no significant gender interactions, the PEPL approach led to enhanced object control skills (β = 1.62; SE = 0.61; $p = 0.008$), with little evidence of any other fundamental movement skill improvement in excess of those in the CG. There was also modest evidence for an effect on accelerometer-measured MVPA during school time (β = 4.50; SE = 2.39; $p = 0.058$), but this was not accompanied by any significant intervention effect over the entire week. Questionnaires indicated that students in the PEPL program became less satisfied with their own sporting ability (β = –0.20; SE = 0.08; $p = 0.013$), but qualitative data analyses suggested that they enjoyed the PEPL approach experience, becoming more motivated and confident in their physical abilities	A) Selection Bias: Strong (1) B) Study Design: Strong (1) C) Confounders: Strong (1) D) Blinding: Moderate (2) E) Data Collection Methods: Strong (1) F) Withdrawals and Drop-Outs: Strong (1) *Global Rating: Strong (1)*
16	Trabelsi, O., Gharbi, A., Souissi, M. A., Mezghanni, N., Bouchiba, M., & Mrayeh, M. (2021). Video Modeling Examples are Effective Tools for Self-Regulated Learning in Physical Education: Students Learn Through Repeated Viewing, Self-Talk, and Mental Rehearsal	Cohort (seven-week gymnastics learning unit for acquiring new motor skills and knowledge using VMEs in the absence of teacher and peer assistance)	$N = 56$ students (28 males and 28 females), aged 16–17 ($M_{age} = 16.6 \pm 0.4$)	1) Data analysis showed significant effects of sex, $F(1, 54) = 7.34$; $p < 0.01$; η^2 2 = 0.12, and learning, $F(1, 54) = 269.75$; $p < 0.001$; $\eta^2 = 0.83$. 2) Post hoc comparisons revealed that the post-test results of male students (10.97 ± 3.25 points) were significantly different ($p < 0.001$) from the pre-test results (4.54 ± 2.42 points). Similarly, the post-test results of female students (8.96 ± 4.12 points) were significantly different ($p < 0.001$) from the pre-test results (2.64 ± 2.09 points). The absence of a significant sex × learning interaction implied that the motor learning outcomes of male [Δ (Δ%) = 6.43 (144.5%)] and female students [Δ (Δ%) = 6.32 (296.4%)] were not statistically different. 3) Qualitative data analysis yielded three major learning strategies: repeated viewing and interpretation of VMEs, self-talk and mental rehearsal	A) Selection Bias: Moderate (2) B) Study Design: Moderate (2) C) Confounders: Weak (3) D) Blinding: Moderate (2) E) Data Collection Methods: Weak (3) F) Withdrawals and Drop-Outs: Moderate (2) *Global Rating: Weak (3)*
17	Yu & Jee (2020). Analysis of Online Classes in Physical Education during the COVID-19 Pandemic	Other specify (online survey questionnaire study)	$N = 75$ participants, including educators ($n = 30$) and learners ($n = 45$)	1) The learning interventions were not feasible for team projects (Educators 2.07 ± 0.98, Learners 2.53 ± 1.38, $Z = -0.776$, $p = 0.438$). 2) In the implementation phase, most learners felt that errors persisted (Educators 2.57 ± 0.90, Learners 3.33 ± 1.09, $Z = -3.02$, $p = 0.001$). 3) An appropriate level of effectiveness through online practical classes showed a significant difference between educators and learners (Educators 2.12 ± 0.86, Learners 3.18 ± 1.19, $Z = -3.814$, $p = < 0.001$)	A) Selection Bias: Moderate (2) B) Study Design: Weak (3) C) Cofounders: Weak (3) D) Blinding: Weak (3) E) Data Collection Methods: Moderate (2) F) Withdrawals and Drop-Outs: Weak (3) *Global Rating: Weak (3)*

increased through gamification with digital media in physical education classes. The results showed a significant increase in students' intrinsic motivation after the gamification experience, including extrinsic rewards (Fernandez-Rio et al., 2020). Gamification is a didactic framework that can increase students' motivation for physical education beyond the initial "novelty effect" and provide them with enjoyment (Fernandez-Rio et al., 2020).

Video feedback in physical education to improve knowledge acquisition and motor skills

The use of video feedback in physical education does not positively affect students' situational interest in physical education (Roure et al., 2019), but self-directed video feedback on movement technique without teacher instruction may lead to similar learning effects as traditional teacher instruction in physical education provided by the teacher (Kok et al., 2020). The video modeling examples provided by Trabelsi et al. (2021) also showed that by activating various metacognitive learning strategies, students could acquire motor skills and knowledge in physical education classes through self-directed learning and even without the help of teachers.

Flipped learning approaches in physical education to improve knowledge acquisition and student–teacher interactions

It has been found that the levels of, for example, health-related fitness knowledge can be improved through digital-based flipped teaching in physical education (Hinojo-Lucena et al., 2019; Østerlie & Mehus, 2020). For example, a comparative analysis between the traditional teaching method in physical education and digital-based flipped learning showed that the flipped classroom approach with digital media achieved better cognitive outcomes for students compared to the traditional method, which did not use technological resources to deliver didactic content (Hinojo-Lucena et al., 2019). The most salient variables in the study by Hinojo-Lucena et al. (2019) were students' improved interactions with the teacher and their classmates and their increased autonomy in the learning process.

Physical education as a place for teaching healthy lifestyle habits

The included studies partially demonstrated that health literacy and healthy lifestyles can be taught in physical education classes. The content of physical education classes, perceived support from physical education teachers, and sufficient physical education classes can impact students' activity-related healthy lifestyles (Li et al., 2019). In addition, a well-organized physical education program can help improve students' activity-related healthy lifestyle habits and, consequently, achieve higher levels of cardiorespiratory fitness (Li et al., 2019). Positive effects, such as improved object control skills, greater self-confidence, and increased motivation to be physically active, as well as moderate evidence of increased moderate-to-vigorous PA, could also be mediated by physical education (Telford et al., 2020). Furthermore, health-related fitness and neuromuscular control can be increased through neuromuscular training in physical education (Sinđić et al., 2021).

Heterogeneous target group for health interventions in physical education classes

However, for health-and fitness-related interventions in physical education, there are interindividual differences in the effects on students in terms of physical training, health-related fitness knowledge, physical fitness, and adolescent health-related motivation (Rosenstiel et al., 2022). Students in the intervention group were significantly more likely to exercise, but for a small proportion of students, the intervention resulted in a loss of health-related motivation. Students with low levels of control and related knowledge, skills, abilities, and motivation could benefit most from health interventions in physical education. Multi-teaching style approaches in elementary school children can increase physical fitness, motor competence, enjoyment, range of motion, and positive perceptions of instruction compared to regular physical education (Invernizzi et al., 2019).

Discussion

The main findings of this study in relation to the research question of what digital media and applications can be used to promote health in physical education indicate that there are clearly positive results for the use of fitness technologies in physical education to improve motor skills, as well as for the inclusion of gamification with digital media in physical education to increase student motivation and for digital-based flipped learning approaches to improve knowledge acquisition in physical education. All these results are novel findings in the field of physical education using digital media and could be helpful in implementing health-promoting interventions in physical education in the future. There is potential for further studies examining digitally enhanced health promotion in physical education.

Types of digital media and their results

Regarding RQ 1 and RQ 2, recommendations for the use of digital media in physical education for teachers can only be made cautiously based on this review, but physical education teachers could benefit from incorporating the following digital media into their instruction: fitness technologies, such as wearables; the principle of gamification with digital devices and learning in the setting of flipped learning with digital media. Nevertheless, these recommendations are to be reflected on pedagogically–didactically with regard to their fit to the respective lessons by a well-thought-out embedding into the (sports) lessons. The goal of the application should always be considered. Other digital media, such as apps, video feedback/video modeling, and online physical education, showed controversial results and thus no recommendation can be made.

Although students' motor skills can be improved by digital technologies (Lee et al., 2021; Nesterchuk et al., 2021), contrasting results have been obtained regarding the effects of apps on PA in physical education classes. For example, both a decrease in PA (Lee & Gao, 2020) and an increase in PA as well as a decrease in sedentary behavior have been found through apps (Papastergiou et al., 2021). This suggests that careful consideration needs to be given to how apps are used as part of educational intervention to improve students' PA in a short period.

The data obtained from the studies by Kok et al. (2020) and Trabelsi et al. (2021) may prompt physical education teachers to incorporate video-based methods of self-regulated learning into their physical education classes.

The flipped classroom approach with digital media to physical education can lead to better student knowledge acquisition compared to the traditional teaching method (Hinojo-Lucena et al., 2019; Østerlie & Mehus, 2020). However, when using digital-based methods in lessons, care must always be taken to ensure that the use is appropriately prepared and fits the teaching–learning situation so that the desired effect (e.g., increased knowledge acquisition) can occur. Online courses in physical education also require timely and high-quality feedback in order to ensure successful teaching (Yu & Jee, 2020).

Student motivation increases through gamification experiences (Fernandez-Rio et al., 2020), such as interactive video games (Fu et al., 2019). These findings are consistent with those reported by Villasana et al. (2020), who found that the use of gamification increases young people's motivation, or those of Telford et al. (2020), who found evidence of increased motivation to be physically active. Taking this motivational idea further, gamification with the use of digital media could be a good option to motivate different types of students to participate in physical education classes and not to identify classes with boring, repetitive exercises (Fernandez-Rio et al., 2020). In this way, it might be possible to engage previously unmotivated students in physical education classes. Wearables such as smartwatches can also encourage adolescents to be more physically active through tracking features (Goodyear et al., 2019b).

Recommendations for future research

Digital media are not only present in many aspects of our lives but are also part of the culture of the society in which we live, communicate, and interact with others (Araújo et al., 2021). Therefore, curricula should be able to keep pace with increasing capability and technology, the improved interaction opportunities, and the resulting increase in human performance (Araújo et al., 2021), as digital health is evolving at a rapid pace, making adult support for youth necessary and important (Goodyear et al., 2019a). The results of this review have provided preliminary evidence that digital media can improve motor skills, knowledge, and motivation in physical education.

As Meates (2020) noted, the pros and cons of digital media in schools must always be weighed. The fact that media education is already represented in the official curriculum documents of some countries shows that policy-makers recognize how important digital culture has become in education (Meates, 2020). Such political conditions enable change, new pedagogical practices, learning environments, and transformation (Meates, 2020).

Moving forward, it is important to gain a good understanding of young people's actions in digital health contexts so that important information can be incorporated to develop effective health-related pedagogy (Goodyear et al., 2019a). To achieve this goal, not only should research continue in this area, but many schools and teachers should also begin to work with digital media in physical education and adapt their teaching accordingly. This could be especially beneficial for students with low control skills (Rosenstiel et al., 2022). As Yang et al. (2020) mentioned, future research should focus more on students in schools.

The results of this review study suggest that digital media types, such as apps, videos, and online physical education, show controversial results and should be further considered in future research. This is to determine under what circumstances and for what purpose these digital tools can be used in physical education to promote health. In future it is important, with the help of high-quality studies, to determine the characteristics responsible for using digital media in physical education to increase PA and promote students' health.

Quality assessment

Most of the included studies (9 out of 17) received a "weak" rating based on the 'Effective Public Health Practice Project' (EPHPP) tool. A smaller proportion of the assessed studies (5 of 17) achieved a "moderate" rating and only 3 of the 17 studies were rated as "strong."

The results of the quality assessment for this review show that the few available studies in this area have predominantly weak evidence. However, an assessment tool such as the EPHPP may need to be adapted for the school setting, as some categories, such as blinding, are not always possible in school settings like physical education classes. An adapted tool for this context would be helpful for future systematic reviews in this area.

Study limitations

This review focuses on health promotion in physical education through digital media. Nevertheless, the pedagogical–didactic suitability of digital media use in physical education should always be critically reflected upon. The recommendations in this review should be reflected upon in terms of their suitability for the respective lessons. The objective should always be considered. In addition, when school students use media, it is always important that teachers are encouraged to teach knowledge about media in their lessons in order to protect students' health, e.g., by using digital media in a health-conscious manner or paying attention to the potential for addiction (KMK, 2016).

Since a rather low level of research on this topic was assumed, a broad search was first conducted of four common databases, both educational databases and health and medical databases. Two reviewers were independently involved in this review to minimize errors in the inclusion of the studies. Because of the aforementioned inclusion and exclusion criteria, relatively few studies could be included in this review. Some of these studies provided conflicting results, indicating the presence of a research gap. It was concerning that only four articles were identified that covered all three areas of the research questions (health promotion, digital media, and physical education). Therefore, we also looked at the surrounding areas (health promotion in physical education and digital media in physical education).

Conclusion

This literature review showed that, overall, little research has been conducted on health promotion using digital media in physical education internationally. Most existing studies have focused on increasing physical activity (PA); however, very few studies have addressed the research questions. In the areas of health promotion in physical education and digital media in physical education, initial results are already available, some of which are promising, while others are contradictory. Clearly, positive results emerged for the use of fitness technologies in physical education to increase motor skills, for incorporating gamification with digital media into physical education to increase student motivation, and for digital-based flipped learning approaches improve knowledge acquisition in physical education. The evidence from existing studies has also proven to be predominantly weak. Apps, video feedback, and online physical education showed controversial results. In addition, whether PA is increased or decreased by digital media cannot be clearly answered by the results of this review. Thus, future research must be conducted in this area to determine how digital media can be used in physical education for health promotion.

Corresponding address

Carolin Knoke
Institute for Sports and Sports Science (IfSS), Institute for School Pedagogy and Didactics (ISD), Karlsruhe Institute of Technology (KIT)
Kaiserstraße 12, Geb. 20.50, 76131 Karlsruhe, Germany
carolin.knoke@kit.edu

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Declarations

Conflict of interest. C. Knoke, A. Woll and I. Wagner declare that they have no competing interests.

All procedures performed in studies involving human participants or on human tissue were in accordance with the ethical standards of the institutional and/or national research committee and with the 1975 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

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