

Digital interventions to improve healthy lifestyle behaviors among adolescents: A systematic review

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ABSTRACT

Introduction: Unhealthy lifestyle behaviours in adolescence are major risk factors for non-communicable diseases. Digital interventions may provide age-appropriate support for preventive health efforts in this population. This review aimed to evaluate the effectiveness of digital interventions in improving adolescent lifestyle behaviours related to non-communicable disease prevention, particularly physical activity, dietary behaviour, sedentary behaviour, and weight-related lifestyle outcomes.

Methods: A systematic search was conducted in PubMed, Scopus, Web of Science, and ScienceDirect to identify randomised controlled trials evaluating digital health interventions in adolescents. Two reviewers independently performed study selection and data extraction in accordance with PRISMA guidelines. Data on intervention characteristics, technological platforms, behaviour change strategies, and reported behavioural outcomes were extracted. Methodological quality was assessed using the Joanna Briggs Institute critical appraisal checklist.

Results: Eleven randomised controlled trials were included. Interventions were delivered through mobile health applications, wearable monitoring devices, chatbot-based coaching, virtual reality, and web-based programmes. The most consistent findings were observed for physical activity and fitness-related outcomes, although effects were not uniform across studies. Evidence for dietary behaviour was generally favourable but varied, whereas evidence for sedentary behaviour and weight-related outcomes remained limited or mixed. Interventions incorporating self-monitoring, goal setting, gamification, and personalised feedback appeared more likely to support behavioural engagement.

Conclusions: Digital interventions may support improvements in adolescents' health behaviours, particularly physical activity. Future studies should prioritise longer follow-up periods, stronger engagement strategies, and the integration of digital tools within broader health promotion environments.

Keywords: adolescent, behaviour change techniques, digital intervention, health promotion technology, preventive health strategy

Introduction

Adolescent health behaviours are important determinants of health across the life course. However, many adolescents experience modifiable lifestyle risks, including insufficient physical activity, poor dietary habits, and inadequate stress management (Wang, 2024). The presence of multiple behavioural risk factors during this critical developmental period may increase vulnerability to non-communicable diseases (NCDs), including obesity, type 2 diabetes, cardiovascular disease, and mental health problems (Lloyd-Jones et al., 2022). Physical inactivity and unhealthy diet are recognised

behavioural risk factors for NCDs, while overweight and obesity are metabolic risk conditions that may begin during childhood and adolescence (World Health Organization, 2025a, 2025b).

Healthy lifestyle behaviours in adolescence refer to modifiable daily behaviours that support health and reduce the risk of non-communicable disease. In this review, these behaviours include physical activity, dietary behaviour, sedentary behaviour, and weight-related lifestyle outcomes. These domains are relevant to adolescent health promotion because physical inactivity and unhealthy diet are recognised behavioural risk factors for NCDs, whereas overweight and obesity are

important metabolic risk conditions in children and adolescents (World Health Organization, [2020](#), [2025a](#), [2025b](#)). Interventions targeting these behaviours during adolescence may therefore help reduce health risks and support healthier trajectories into adulthood.

Digital health interventions, including mobile applications, web-based platforms, wearable monitoring devices, SMS-based programmes, chatbot coaching, and virtual reality systems, may provide accessible approaches for supporting lifestyle behaviour change among adolescents. These interventions can deliver health information, self-monitoring tools, feedback, prompts, and behavioural support beyond conventional face-to-face settings. This potential is supported by adolescents' high engagement with digital technologies, which may facilitate scalable and accessible interventions aligned with their communication and technology-use patterns (Fan et al., [2026](#)). Raeside et al. ([2024](#)) further highlight that digital interventions may improve physical activity, dietary intake, and weight-related outcomes among adolescents.

Although digital interventions are increasingly used to support adolescent lifestyle behaviour change, their effects vary across platforms, target behaviours, and study designs. Existing systematic reviews have mainly examined whether these interventions work, with less attention to the specific features that may explain differences in outcomes. These features include the type of digital platform, theoretical basis, intervention duration, personalisation, engagement strategies, and behaviour change techniques (BCTs). BCTs are observable and replicable components of an intervention intended to support behaviour change, such as self-monitoring, goal setting, feedback, prompts, rewards, and personalised guidance (Mair et al., [2023](#); Krishna et al., [2025](#); Melo et al., [2025](#)). However, prior reviews have provided limited synthesis of how these components work together and relate to intervention effectiveness among adolescents.

This systematic review investigated evidence from randomised controlled trials (RCTs) conducted between 2015 and 2026 to evaluate the impact of digital technology-based interventions on adolescent health behaviours. The review combined component-level analysis, comparative effectiveness assessment across platforms and behavioural domains, and explicit attention to engagement mechanisms. The findings are expected to inform the development of effective digital health interventions and identify priorities for future research.

Materials and Methods

This systematic review was conducted in accordance with the PRISMA 2020 guidelines (Page et al., 2021). The review protocol was prospectively registered in the International Prospective Register of Systematic Reviews

(PROSPERO; registration number: CRD420251247340), and the literature search was then performed to reduce selection and reporting bias.

Eligibility Criteria

This review examined studies involving adolescents aged 10-19 years. Eligible publications were required to be published between 2015 and 2026 and written in English. This review included RCTs evaluating digital interventions that targeted at least one lifestyle behaviour domain: physical activity, dietary behaviour, sedentary behaviour, or weight-related lifestyle outcomes. Digital interventions included mobile health applications, wearable monitoring systems, web-based platforms, SMS-based programmes, chatbot or conversational agent systems, virtual reality or augmented reality platforms, and other technology-supported lifestyle interventions. Eligible comparators included usual care, no intervention, wait-list control, standard school-based health education, or non-digital health promotion programmes.

Studies focusing primarily on smoking, alcohol use, substance use, sexual behaviour, sleep disorders, or mental health treatment were excluded unless lifestyle behaviour change was a primary intervention target and outcome. To manage variability in reported outcomes, outcomes were grouped into predefined domains. Primary behavioural outcomes included physical activity, dietary behaviour, and sedentary behaviour. Secondary synthesis outcomes included body mass index (BMI), BMI z-score, body composition, and fitness indicators. Motivation, adherence, and engagement were considered as intervention-related or engagement outcomes when reported.

Information Sources and Search Strategy

The literature search was conducted across four databases: PubMed, Scopus, Web of Science, and ScienceDirect. The initial search was performed in November 2025 and updated in May 2026 before final analysis. The search strategy combined general terms related to adolescent lifestyle behaviours with specific behavioural and health-related outcome terms. General terms included "healthy lifestyle", "health behaviour", "lifestyle behaviour", "multiple health behaviour", and "behaviour change". Specific terms included physical activity, diet, sedentary behaviour, screen time, BMI, body composition, fat mass, and fitness. The complete database-specific search strategies are presented in [Table 1](#).

Study Selection, Data Extraction, and Inter-Rater Reliability

Study selection was conducted in accordance with the PRISMA 2020 guidelines using predefined eligibility criteria. After duplicate removal, two reviewers independently screened titles and abstracts. The same

Table 1. Keywords used in the database searches

| Database | Search strategy |
|-----------------------|---|
| PubMed | ((adolescent[MeSH Terms] OR adolescent*[Title/Abstract] OR teenager*[Title/Abstract] OR youth[Title/Abstract]) AND ("digital health"[Title/Abstract] OR eHealth[Title/Abstract] OR mHealth[Title/Abstract] OR "mobile app"*[Title/Abstract] OR "web-based"[Title/Abstract] OR wearable*[Title/Abstract] OR SMS[Title/Abstract] OR chatbot*[Title/Abstract] OR "virtual reality"[Title/Abstract] OR gamif*[Title/Abstract] OR "artificial intelligence"[Title/Abstract]) AND ("healthy lifestyle"[Title/Abstract] OR "health behavior"*[Title/Abstract] OR "health behaviour"*[Title/Abstract] OR "lifestyle behavior"*[Title/Abstract] OR "lifestyle behaviour"*[Title/Abstract] OR "behaviour change"[Title/Abstract] OR "physical activity"[Title/Abstract] OR diet[Title/Abstract] OR dietary[Title/Abstract] OR nutrition[Title/Abstract] OR "sedentary behavior"[Title/Abstract] OR "sedentary behaviour"[Title/Abstract] OR "screen time"[Title/Abstract] OR BMI[Title/Abstract] OR "body composition"[Title/Abstract] OR "fat mass"[Title/Abstract] OR fitness[Title/Abstract]) AND (randomized controlled trial[Publication Type] OR randomized[Title/Abstract] OR randomised[Title/Abstract] OR trial[Title/Abstract] OR RCT[Title/Abstract])) |
| Scopus | TITLE-ABS-KEY ((adolescent* OR teenager* OR youth) AND ("digital health" OR eHealth OR mHealth OR "mobile app*" OR "web-based" OR wearable* OR SMS OR chatbot* OR "virtual reality" OR gamif* OR "artificial intelligence") AND ("healthy lifestyle" OR "health behavior*" OR "health behaviour*" OR "lifestyle behavior*" OR "lifestyle behaviour*" OR "behaviour change" OR "behavior change" OR "physical activity" OR diet OR dietary OR nutrition OR "sedentary behavior" OR "sedentary behaviour" OR "screen time" OR BMI OR "body composition" OR "fat mass" OR fitness) AND ("randomized controlled trial" OR "randomised controlled trial" OR randomized OR randomised OR trial OR RCT)) |
| Web of Science | TS=((adolescent* OR teenager* OR youth) AND ("digital health" OR eHealth OR mHealth OR "mobile app*" OR "web-based" OR wearable* OR SMS OR chatbot* OR "virtual reality" OR gamif* OR "artificial intelligence") AND ("healthy lifestyle" OR "health behavior*" OR "health behaviour*" OR "lifestyle behavior*" OR "lifestyle behaviour*" OR "behaviour change" OR "behavior change" OR "physical activity" OR diet OR dietary OR nutrition OR "sedentary behavior" OR "sedentary behaviour" OR "screen time" OR BMI OR "body composition" OR "fat mass" OR fitness) AND ("randomized controlled trial" OR "randomised controlled trial" OR randomized OR randomised OR trial OR RCT)) |
| ScienceDirect | Several shorter searches were conducted because ScienceDirect limits complex Boolean queries. Example searches included: adolescent AND "digital health" ; adolescent AND "mobile app" AND "lifestyle behaviour" AND trial; adolescent AND mHealth AND diet AND trial; adolescent AND wearable AND "physical activity" AND trial; adolescent AND chatbot AND diet AND trial; adolescent AND "virtual reality" AND fitness AND trial; and adolescent AND "digital health" AND BMI AND trial. |

reviewers then assessed the full texts of potentially eligible articles.

Data extraction was performed independently by two reviewers using a standardised extraction form. Extracted data included study characteristics, such as authors, year, country, and design; participant characteristics, including age and sample size; intervention features, including type of digital technology, duration, theoretical framework, and behaviour change techniques; comparators; and reported behavioural and physiological outcomes.

To ensure consistency during screening, inter-rater agreement was assessed using Cohen's kappa coefficient based on a pilot screening of a subset of records. The resulting kappa value ($\kappa = 0.76$) indicated substantial agreement between reviewers. Discrepancies at all stages were resolved through discussion, with consultation from a third reviewer when necessary.

Risk of Bias Assessment

Risk of bias was assessed using the Joanna Briggs Institute (JBI) checklist for randomised controlled trials (RCTs). The checklist assesses key methodological aspects of trial design and reporting, including randomisation, allocation concealment, baseline comparability, blinding, follow-up completeness, consistency of outcome measurement, reliability of outcome assessment, and appropriateness of statistical analysis (Barker et al., 2023). Two reviewers independently appraised each included study. Each checklist item was rated as "yes", "no", "unclear", or "not applicable". Disagreements were resolved through discussion, and a third reviewer was consulted when consensus could not be reached. Appraisal results were

not used as exclusion criteria but were considered when interpreting the strength and credibility of the evidence.

Data Synthesis

Data were synthesised using a structured narrative synthesis approach. This approach was considered appropriate because the included studies differed in digital intervention platforms, comparator conditions, intervention duration, outcome measures, and follow-up periods; therefore, statistical pooling was not performed. The synthesis was informed by the Synthesis Without Meta-analysis (SWiM) reporting guideline to support transparent reporting (Campbell et al., 2020). First, study characteristics, intervention features, comparators, outcome domains, and key findings were extracted into a structured table. Second, outcomes were grouped into predefined domains: physical activity, dietary behaviour, sedentary behaviour, weight-related outcomes, and fitness indicators. Third, the direction of effect for each outcome domain was classified as favourable, mixed, limited, or no clear beneficial effect based on the reported findings. Finally, intervention components, including digital platform type, behaviour change strategies, theoretical basis, and duration, were compared across studies to identify patterns associated with more favourable outcomes.

Outcomes

This systematic review addressed four questions: (1) How effective are digital technology-based interventions in encouraging adolescents to change health-related behaviours? (2) Which intervention components, including technology type, theoretical framework, behaviour change strategies, and intervention duration,

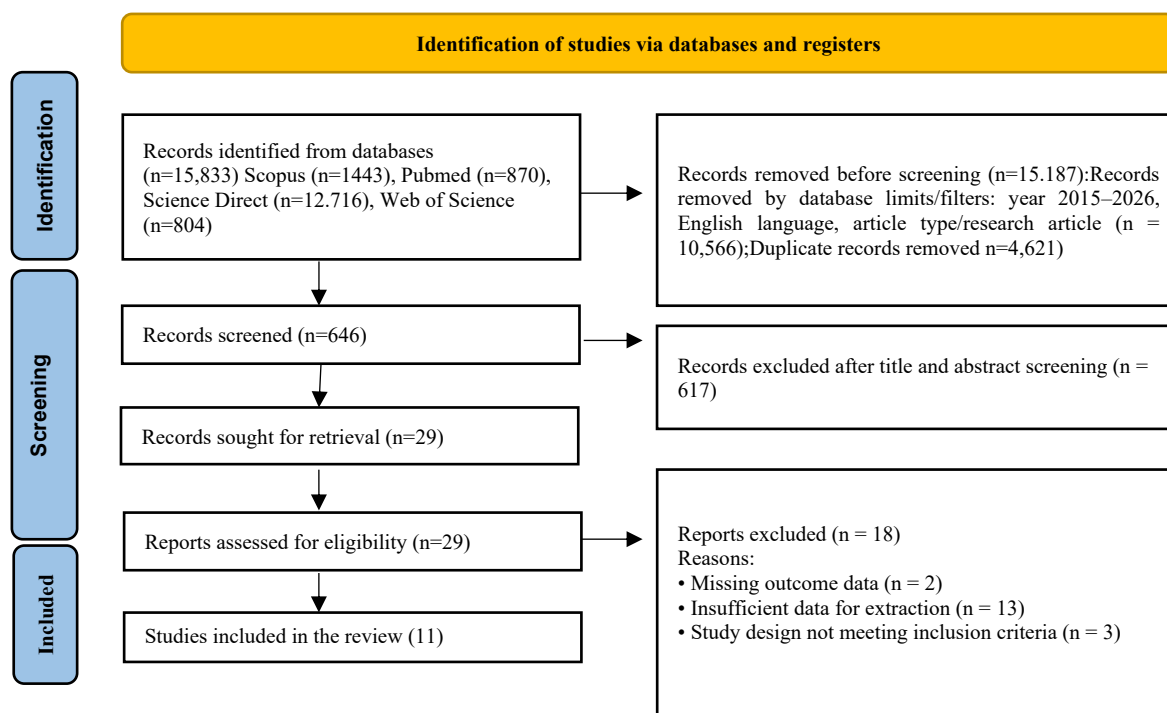


Figure 1. PRISMA Flow Diagram

are associated with effectiveness? (3) How do effectiveness profiles compare across technology platforms and health behaviour domains? (4) Which design characteristics and mechanisms encourage adolescents to sustain participation in digital health interventions?

Results

[Figure 1](#) illustrates the study selection process. The database search identified 15,833 potentially relevant publications on digital interventions for adolescent health behaviour across PubMed, Scopus, ScienceDirect, and Web of Science. Before screening, 10,566 records were removed through database limits and filters, including publication year, language, and article type. A further 4,621 duplicate records were removed, leaving 646 records for title and abstract screening. Of these, 29 reports were sought and assessed for eligibility. After full-text assessment, 18 reports were excluded because of missing outcome data ($n = 2$), insufficient data for extraction ($n = 13$), or study designs that did not meet the inclusion criteria ($n = 3$). The final synthesis included 11 RCTs.

[Table 2](#) summarises 11 randomised controlled trials involving adolescents or school-aged young people, with sample sizes ranging from 25 to 9,021 participants. The included studies were conducted across Europe, North America, Asia, Australia, and South America, showing broad international interest in digital adolescent health promotion. Although all included studies used randomised designs, they varied in sample size, setting, digital platform, comparator condition, intervention duration, and follow-up period.

The interventions used a wide range of digital technologies, including mobile health (mHealth) apps, wearable monitoring devices, short-message-service (SMS)-based communication interventions, chatbot-mediated coaching tools, gamified mobile applications, smartphone-supported personalised exercise programmes, school-based eHealth platforms, and artificial-intelligence-enhanced virtual-reality platforms. Behaviour changes methods, including self-monitoring, gamification, goal setting, and personalised feedback, were used in many interventions to improve participant engagement. Mobile application- and app-supported interventions were reported by Tugault-Lafleur et al. (2023), Gómez-Cuesta et al. (2024), Melo et al. (2023), Haşıl Korkmaz and Çoruh (2025), Seiterö et al. (2025), and Vanhelst et al. (2025). Wearable or monitoring-supported interventions were used by Ridgers et al. (2021), while Bjerregaard et al. (2024) evaluated an SMS chatbot-based nutrition programme. Stasinaki et al. (2021) assessed a conversational agent-supported mobile health intervention, and Wang et al. (2025) evaluated an adaptive artificial intelligence-based virtual reality sports system.

Intervention duration varied across studies, with active intervention periods ranging from approximately 4 weeks to 6 months and follow-up assessments extending to 18 or 24 months in some studies (Stasinaki et al., 2021; Tugault-Lafleur et al., 2023; Bjerregaard et al., 2024; Gómez-Cuesta et al., 2024; Seiterö et al., 2025; Haşıl Korkmaz and Çoruh, 2025; Vanhelst et al., 2025; O'Dean et al., 2025; Melo et al., 2023). Intervention duration ranged from 8 weeks to 18 months. Shorter interventions lasted 8-12 weeks, whereas longer interventions lasted 3-

Table 3. Risk of Bias Assessment of Included Studies Using the JBI Critical Appraisal Checklist for RCTs

| Study | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Q11 | Q12 | Q13 |
|-------------------------------|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|
| Gómez-Cuesta et al. (2024) | Y | U | Y | N | N | U | Y | Y | Y | Y | Y | Y | Y |
| Tugault-Lafleur et al. (2023) | Y | Y | Y | N | N | U | Y | Y | Y | Y | Y | Y | Y |
| Bjerregaard et al. (2024) | N | N | U | Y | Y | Y | Y | Y | Y | Y | N | N | U |
| Stasinaki et al. (2021) | Y | U | Y | N | N | U | Y | U | Y | Y | Y | Y | Y |
| J. Wang et al. (2025) | Y | Y | Y | N | N | U | Y | Y | Y | Y | Y | Y | Y |
| Ridgers et al. (2021) | Y | U | Y | N | N | U | Y | U | Y | Y | Y | Y | Y |
| A. Seiterö et al. (2025) | Y | U | Y | N | N | U | Y | Y | Y | Y | Y | Y | Y |
| O’Dean et al. (2025) | Y | U | Y | N | N | U | Y | Y | Y | Y | Y | Y | Y |
| Haşıl Korkmaz & Çoruh (2025) | Y | U | Y | N | N | U | Y | U | Y | Y | Y | Y | Y |
| Vanhelst et al. (2025) | Y | U | Y | N | N | U | Y | U | Y | Y | Y | Y | Y |
| Melo et al. (2023) | Y | U | Y | N | N | U | Y | Y | Y | Y | Y | Y | Y |

18 months and included mHealth, chatbot-supported, SMS-based, and personalised digital nutrition programmes (Stasinaki et al., 2021; Tugault-Lafleur et al., 2023; Bjerregaard et al., 2024; Seiterö et al., 2025; Melo et al., 2025). Comparator conditions included usual physical education, standard health education, wait-list control, no-SMS control, standard health programmes, physical sports or control conditions, and conventional multi-component behavioural programmes.

The most frequently assessed outcomes were physical activity, dietary behaviour, sedentary behaviour, and weight-related indicators, including BMI, BMI z-score, body composition, and fat mass. Physical activity outcomes were assessed in studies using mobile applications, wearable devices, gamification, school-based digital education, and virtual reality platforms (Ridgers et al., 2021; Gómez-Cuesta et al., 2024; Seiterö et al., 2025; Haşıl Korkmaz and Çoruh, 2025; O’Dean et al., 2025; Wang et al., 2025). Dietary outcomes were reported in interventions involving mobile health applications, SMS-based nutrition education, and tailored digital nutrition programmes (Tugault-Lafleur et al., 2023; Bjerregaard et al., 2024; Melo et al., 2023; A. Seiterö et al., 2025). Weight-related outcomes were examined in trials involving adolescents with overweight or obesity and in broader lifestyle intervention studies (Stasinaki et al., 2021; Tugault-Lafleur et al., 2023; Wang et al., 2025). Table 4 presents the behavioural outcome domains and

the overall direction of reported effects across the included studies.

Risk of Bias Results

The methodological quality of the included studies was assessed using the JBI critical appraisal checklist for RCTs. Most studies described appropriate randomisation procedures and used consistent outcome measurement. However, blinding of participants and intervention providers was generally not feasible because the interventions involved visible behavioural and digital components. Allocation concealment and follow-up completeness were also not consistently reported, indicating variability in methodological reporting.

Overall, the included studies were considered methodologically acceptable for narrative synthesis. Nevertheless, incomplete reporting of allocation concealment, blinding, and follow-up should be considered when interpreting the findings. These limitations may have contributed to differences in estimated intervention effects across studies.

Q1. How effective are digital technology-based interventions in encouraging adolescents to change their health-related behaviours?

Table 4 summarises the outcome domains addressed by the included studies according to the predefined eligibility criteria. Primary behavioural outcomes included physical activity, dietary behaviour, and

Table 4. Behavioral outcomes addressed by digital interventions in included studies

| Outcome category | Outcome domain | Number of studies | Studies | Overall direction of effect |
|-----------------------------|-------------------------|-------------------|--|--|
| Primary behavioural outcome | Physical activity | 6/11 | Ridgers et al. (2021); Seiterö et al. (2025); Tugault-Lafleur et al. (2023); Gómez-Cuesta et al. (2024); Haşıl Korkmaz and Çoruh (2025); O’Dean et al. (2025) | Mixed. Several studies reported improvements in PA engagement or PA-related intentions, but Ridgers et al. (2021) showed no beneficial effect and lower MVPA at 6-month follow-up. |
| Primary behavioural outcome | Dietary behaviour | 5/11 | Tugault-Lafleur et al. (2023); Bjerregaard et al. (2024); Melo et al. (2023); O’Dean et al. (2025); Seiterö et al. (2025) | Generally positive but varied. Improvements were more evident for dietary knowledge, dietary quality, or selected dietary behaviours than for weight-related outcomes. |
| Primary behavioural outcome | Sedentary behaviour | 2/11 | O’Dean et al. (2025); Tugault-Lafleur et al. (2023) | Limited evidence. Some short-term or selected effects were reported, but evidence was insufficient to conclude consistent benefit. |
| Secondary outcome | Weight-related outcomes | 7/11 | Stasinaki et al. (2021); Tugault-Lafleur et al. (2023); Bjerregaard et al. (2024); Gómez-Cuesta et al. (2024); Melo et al. (2023); Seiterö et al. (2025); Vanhelst et al. (2025); Wang et al. (2025) | Mixed to moderately positive. Some studies reported improvements in BMI, BMI-z, body composition, or fat mass, but effects on BMI were often modest or limited. |
| Secondary outcome | Fitness indicators | 4/11 | Stasinaki et al. (2021); Gómez-Cuesta et al. (2024); Vanhelst et al. (2025); Wang et al. (2025) | Generally positive. Improvements were reported in cardiorespiratory fitness, physical capacity, or selected fitness indicators. |

sedentary behaviour. Secondary outcomes included weight-related outcomes and fitness indicators. Psychological, cognitive, stress-related, and metabolic outcomes were not treated as separate synthesis domains to maintain consistency with the eligibility criteria and avoid broadening the scope of the review.

Across the 11 RCTs included in this review, digital interventions addressed several domains of adolescent lifestyle behaviour. Improvements in physical activity participation, PA-related intentions, or selected active behaviours were reported in trials using mobile applications, wearable monitoring, gamified platforms, school-based digital education, or mobile health programmes (Ridgers et al., 2021; Tugault-Lafleur et al., 2023; Gómez-Cuesta et al., 2024; Seiterö et al., 2025; Haşıl Korkmaz and Çoruh, 2025; O'Dean et al., 2025). However, Ridgers et al. (2021) did not find significant improvements in accelerometer-assessed MVPA or self-reported physical activity, and the intervention group showed lower MVPA than the wait-list control at 6-month follow-up. Therefore, the overall evidence for physical activity should be interpreted as heterogeneous.

Dietary behaviour was assessed in five studies. These studies examined outcomes such as diet, dietary quality index, diet quality, and nutrition-related knowledge. Improvements were generally reported in interventions using mHealth applications, SMS-based nutrition education, digital multiple health behaviour programmes, school-based digital health education, or personalised digital nutrition education, although the strength and consistency of findings varied across studies (Tugault-Lafleur et al., 2023; Bjerregaard et al., 2024; Melo et al., 2023; Seiterö et al., 2025; O'Dean et al., 2025).

Tugault-Lafleur et al. (2023) included screen time as part of a multiple lifestyle behaviour intervention, while O'Dean et al. (2025) assessed behavioural intentions

related to screen time. Therefore, evidence for sedentary behaviour remains more limited than evidence for physical activity and dietary behaviour.

Secondary outcomes included weight-related outcomes and fitness indicators. Weight-related outcomes, including BMI, BMI z-score, body composition, and fat mass, were reported in seven studies. Some studies reported improvements in body composition or fat mass, whereas changes in BMI-related indicators were generally modest or inconsistent (Stasinaki et al., 2021; Tugault-Lafleur et al., 2023; Bjerregaard et al., 2024; Gómez-Cuesta et al., 2024; Melo et al., 2023; Seiterö et al., 2025; Vanhelst et al., 2025; Wang et al., 2025). Fitness indicators were reported in four studies and generally showed favourable changes, particularly in interventions involving mobile app-based activity tracking, chatbot-supported coaching, virtual reality-based activity, or wearable-supported monitoring (Stasinaki et al., 2021; Gómez-Cuesta et al., 2024; Vanhelst et al., 2025; Wang et al., 2025).

Q2. What key components of the interventions—such as the type of technology used, the theoretical framework, behavior modification strategies, and the length of the intervention—are connected with their effectiveness?

Table 5 summarises the key components of the digital interventions across the included studies, including technology type, behaviour modification strategies, theoretical frameworks, and intervention duration. The included RCTs employed diverse digital technologies and behavioural strategies to support lifestyle behaviour change among adolescents. Mobile health applications were the most common technology and were often designed to support behaviour tracking and structured lifestyle guidance (Tugault-Lafleur et al., 2023; Seiterö et al., 2025). Wearable monitoring systems were integrated

Table 5. Summary of digital intervention characteristics

| Component | Description | Number of Studies |
|--|---|-------------------|
| Type of Technology | | |
| Mobile health applications | Smartphone-based platforms supporting lifestyle monitoring and guidance | 6 |
| Wearable monitoring systems | Activity trackers integrated with digital feedback platforms | 1 |
| SMS-based intervention | Automated messaging delivering behavioral prompts or reminders | 1 |
| Conversational chatbot system | Digital coaching using conversational agents | 1 |
| Virtual reality platform | Immersive digital environments supporting physical activity engagement | 1 |
| Multi-component digital program | Combined digital tools including apps, educational modules, or tracking systems | 1 |
| Behavior Modification Strategies | | |
| Self-monitoring | Tracking behaviors such as physical activity or diet | 6 |
| Goal setting | Digital targets or behavioral objectives | 4 |
| Gamification | Game elements such as rewards or challenges to enhance engagement | 3 |
| Personalized feedback/coaching | Tailored guidance provided through digital systems | 4 |
| Theoretical Framework | | |
| Behavior change-based frameworks | Interventions informed by behavioral change principles or structured lifestyle programs | 3 |
| Technology-supported behavioral coaching | Digital coaching approaches using interactive guidance | 1 |
| Not explicitly reported | No explicit theoretical framework is described in the article | 7 |
| Intervention Duration | | |
| ≤ 8 weeks | Short-term digital behavior change programs | 3 |
| 9–14 weeks | Moderate-duration interventions | 2 |
| 3–<6 months | Intermediate-duration interventions | 2 |
| ≥ 6 months | Longer-term lifestyle interventions | 4 |

Table 6. Comparative effectiveness technology platforms across the health behavior domain

| Technology Platform | Physical Activity | Dietary Behaviors | Weight-Related Outcomes | Evidence Pattern |
|--|---|---|---|---|
| Mobile health applications | Improvements in physical activity participation and engagement | Improvements in diet awareness and eating behaviors | Modest changes in BMI or body composition were reported in some studies | Generally favourable but heterogeneous; effects varied by intervention type and outcome |
| Wearable monitoring systems integrated with digital feedback | No significant improvement in accelerometer-assessed MVPA or self-reported PA; lower MVPA was observed at 6-month follow-up in the intervention group | Not commonly assessed | Limited evidence on BMI or body composition | No clear beneficial effect for PA in the included wearable trial |
| Conversational chatbot-based intervention | Moderate improvements in lifestyle behaviors | Some improvements in dietary guidance | Improvements in body composition and physical capacity were reported | Promising but based on limited evidence |
| SMS-based digital messaging program | Limited evidence for physical activity improvement | No clear effect on dietary habits was observed in intention-to-treat analyses | No clear effect on BMI z-score was observed in intention-to-treat analyses; modest short-term BMI-z improvement was observed only in per-protocol analyses. | Limited or mixed effectiveness; no clear benefit was observed in intention-to-treat analyses, although a modest short-term BMI-z effect was found in per-protocol analyses. |
| Virtual reality-based physical activity platform | Increased participation in structured physical activity | Not assessed | Reductions in fat mass and improvements in fitness indicators | Promising evidence from a single RCT |
| School-based digital health education platform | Increased participation in physical activity programs | Some improvements in health behavior awareness | Not clearly assessed | Mixed; short-term improvements in selected behavioural intentions but limited sustained effect |
| Smartphone-supported personalised HIIT programme | Improved cardiorespiratory fitness through app-supported personalised exercise | Not assessed | BMI was assessed, but the main positive finding related to fitness | Favourable evidence for fitness improvement from a large school-based RCT |

with digital platforms to support self-monitoring and feedback on physical activity levels (Ridgers et al., 2021). Other technological approaches included SMS-based messaging programmes (Bjerregaard et al., 2024), conversational chatbot coaching systems (Stasinaki et al., 2021), and immersive virtual reality platforms designed to promote physical activity engagement (Wang et al., 2025).

Across interventions, several behaviour change strategies were commonly implemented. Self-monitoring and goal-setting features were frequently used to help adolescents track their behaviour and progress towards health goals. Some interventions also included gamification elements or personalised digital feedback, which were intended to support user engagement and sustained participation (Gómez-Cuesta et al., 2024; Haşıl Korkmaz and Çoruh, 2025).

Theoretical frameworks were not consistently reported across studies. While several interventions were informed by behaviour change or health promotion approaches (Tugault-Lafleur et al., 2023; Seiterö et al., 2025), many studies did not explicitly describe a theoretical basis for intervention design. Intervention duration varied across studies. Active intervention periods ranged from approximately 4 weeks to 6 months, while several studies included longer follow-up assessments extending to 18 or 24 months.

Q3. How do the effectiveness profiles compare across different technology platforms and health behavior domains?

Table 6 compares the effectiveness of digital technology platforms across major adolescent health behaviour domains. Mobile health applications were the most frequently evaluated technology and showed improvements mainly in physical activity and lifestyle behaviours (Gómez-Cuesta et al., 2024; Seiterö et al., 2025; Haşıl Korkmaz and Çoruh, 2025). Some app-based interventions also reported improvements in dietary awareness, although effects on weight-related outcomes were generally modest (Tugault-Lafleur et al., 2023). In contrast, the wearable monitoring intervention did not show clear benefits for physical activity, as Ridgers et al. (2021) reported no significant improvement in accelerometer-assessed MVPA or self-reported physical activity and lower MVPA at 6-month follow-up.

Other digital approaches were evaluated in fewer studies. A conversational chatbot-based intervention reported improvements in body composition and reductions in stress indicators (Stasinaki et al., 2021), while a virtual reality-based sports platform demonstrated reductions in fat mass and improvements in physical fitness and cognitive outcomes (Wang et al., 2025). The SMS-based messaging intervention showed no clear effect on dietary habits or BMI z-score in intention-to-treat analyses, although a modest short-term BMI-z improvement was observed in per-protocol analyses (Bjerregaard et al., 2024). The virtual reality

platform and smartphone-supported personalised HIIT programme showed favourable effects on structured physical activity, fat mass, fitness, or cardiorespiratory fitness, but each was supported by a single trial (Vanhelst et al., 2025; Wang et al., 2025). Overall, intervention effectiveness varied by platform type, outcome domain, and study context rather than showing consistent benefits across all digital technologies.

Q4. What design characteristics and mechanisms encourage adolescents to sustain participation in digital health interventions?

Several design features emerged from the reviewed studies as potential supports for ongoing adolescent participation in digital health interventions. Many interventions included self-monitoring and feedback mechanisms. However, engagement features did not always translate into sustained behavioural change. For example, Ridgers et al. (2021) used Fitbit-based monitoring, app feedback, Facebook challenges, and text alerts but found no improvement in MVPA or self-reported physical activity.

Some studies integrated gamification elements, such as rewards, progress indicators, or interactive challenges, which appeared to enhance user interest and participation in digital activities (Gómez-Cuesta et al., 2024; Haşıl Korkmaz and Çoruh, 2025). Interventions providing personalised guidance or digital coaching, including chatbot-based support, were also designed to offer individualised feedback and goal-setting support (Stasinaki et al., 2021; Tugault-Lafleur et al., 2023).

In several programmes, the intervention design emphasised behavioural support features, including goal setting, lifestyle monitoring, and structured digital education modules (Tugault-Lafleur et al., 2023; Seiterö et al., 2025). Overall, sustained participation appears more likely when digital interventions combine accessible platforms with interactive monitoring, personalised feedback, progressive goals, gamification, and support from schools, families, or health professionals. Nevertheless, these features should be interpreted as potential engagement mechanisms rather than guaranteed drivers of sustained behaviour change.

Discussions

This systematic review synthesised evidence from 11 RCTs evaluating digital technology-based interventions for promoting healthy lifestyle behaviours among adolescents. The findings suggest that digital interventions may improve several behavioural outcomes, particularly physical activity (Boima et al., 2024). However, the magnitude and consistency of effects varied across behavioural outcomes, technology platforms, and intervention designs.

Across the included studies, physical activity and fitness outcomes were among the most frequently

assessed domains, but findings were not uniformly positive. Evidence for dietary behaviour and other outcomes was more heterogeneous. Overall, digital health interventions appear to have potential for supporting behavioural change among adolescents, but effectiveness differed according to intervention type, outcome measure, and duration. This suggests that digital delivery alone is not sufficient to ensure sustained lifestyle change.

Effectiveness Across Behavioural Domains

Physical activity was one of the most frequently assessed behavioural outcomes in the included trials. Interventions using mobile applications, gamified digital platforms, smartphone-supported exercise programmes, or virtual reality systems reported improvements in physical activity participation, daily step counts, activity engagement, or fitness indicators, although the wearable monitoring intervention did not show clear benefit. (Gómez-Cuesta et al., 2024; Haşıl Korkmaz and Çoruh, 2025; Vanhelst et al., 2025; Wang et al., 2025). These findings are consistent with previous reviews suggesting that digital tools can increase awareness, provide feedback, and support behavioural self-regulation among adolescents (Zheng et al., 2023; Boima et al., 2024).

For example, step-tracking mobile applications were associated with greater physical activity engagement, while wearable activity trackers combined with behavioural feedback have been reported to support adherence to physical exercise (Collado-Mateo et al., 2021). Wearable technologies may provide real-time feedback and allow users to continuously monitor health-related behaviours. From a behavioural science perspective, these mechanisms are aligned with established behaviour change techniques, such as self-monitoring and feedback, which are recognised as central components of effective health behaviour interventions (Michie S., Atkins L., and West R., 2017).

In contrast, evidence for dietary behaviour and weight-related outcomes was more heterogeneous. Although several interventions reported improvements in dietary awareness or healthier eating habits, measurable changes in anthropometric indicators such as body mass index were generally small (Jacob et al., 2021). Some mobile health interventions improved multiple lifestyle behaviours, including diet and physical activity, but changes in BMI-z scores remained relatively minor. In the SMS-based nutrition messaging trial, Bjerregaard et al. (2024) found no clear effect on dietary habits or BMI z-score in intention-to-treat analyses, although a modest short-term BMI-z improvement was observed in per-protocol analyses. This finding is more cautious than previous review evidence suggesting that digital or mobile nutrition interventions may improve dietary behaviours but often have limited effects on BMI outcomes (Zheng et al., 2023). Together, these findings suggest that digital nutrition interventions may support

selected behavioural or knowledge-related outcomes, but their effects on sustained dietary change and anthropometric indicators remain limited.

These findings are consistent with earlier research showing that digital nutrition interventions often increase knowledge and behavioural intentions but may produce smaller behavioural changes unless combined with wider environmental or family-based strategies (Duraó et al., 2020). Therefore, digital interventions that focus mainly on personal motivation may have limited capacity to address broader contextual factors affecting dietary behaviour.

Intervention Design and Behaviour Change Technique

An important pattern emerging from this review is that intervention effectiveness appears to depend less on the specific technology used and more on how behavioural support mechanisms are embedded within the intervention design. Across several trials, interventions incorporating behaviour change techniques, such as self-monitoring, goal setting, and personalised feedback, demonstrated more consistent behavioural improvements than interventions relying mainly on informational messaging (Ahmadi et al., 2023).

Digital coaching interventions that combined behavioural coaching, goal setting, and personalised feedback through conversational mobile applications reported improvements in physical capacity and body composition among adolescents with obesity. Similarly, interventions integrating digital self-monitoring tools and behavioural guidance were designed to address multiple lifestyle behaviours among adolescents. These findings are consistent with the Behaviour Change Technique framework, which identifies structured behavioural strategies as key mechanisms for promoting health behaviour change (Michie S., Atkins L., and West R., 2017). This pattern suggests that digital technologies function primarily as delivery platforms through which established behavioural strategies can be implemented.

Gamification and personalised guidance appeared particularly relevant for adolescent engagement. Rewards, progressive targets, challenges, activity missions, tailored feedback, and digital coaching may make behaviour change activities more interactive, goal-oriented, and socially engaging. However, these components should be interpreted as potential engagement mechanisms rather than guaranteed drivers of sustained behavioural change. The non-beneficial findings from Ridgers et al. (2021) indicate that even theoretically relevant features may fail to produce sustained change when engagement declines or when digital tools are not sufficiently meaningful, adaptive, or easy to use.

Theoretical Frameworks and Psychological Mechanisms

Most included studies did not explicitly state the theoretical framework guiding intervention design.

Several trials instead adopted behaviour change approaches that incorporated constructs such as self-monitoring, goal setting, and feedback (Tugault-Lafleur et al., 2023; Seiterö et al., 2025; O'Dean et al., 2025), while one study implemented a digital coaching intervention using a conversational agent to support lifestyle modification (Stasinaki et al., 2021). However, most interventions did not clearly describe an explicit theoretical basis.

Psychological mechanisms are important drivers of behavioural change in digital interventions. Several studies reported improvements in motivation, engagement, or perceived competence following the use of digital platforms incorporating gamification or personalised coaching features. These results are consistent with Self-Determination Theory, which suggests that sustained behaviour change depends on satisfying psychological needs for autonomy, competence, and relatedness (Ryan and Deci, 2017). Digital interventions that include goal tracking, feedback, or gamified elements may therefore strengthen adolescents' sense of competence and autonomy, thereby supporting intrinsic motivation for healthy behaviours.

Comparison With Traditional Face-To-Face Interventions

The comparison between digital and traditional face-to-face interventions provides important insights for adolescent health promotion. Digital platforms offer scalability, accessibility, and the capacity to provide behavioural support beyond clinical or school environments. These tools can provide automated feedback, behavioural monitoring, and flexible access to intervention content, which may facilitate engagement among adolescents who are familiar with digital environments (Singh et al., 2025). Nevertheless, digital delivery should not be viewed as a complete replacement for contextual support. For behaviours strongly influenced by social and environmental factors, such as dietary habits, screen time, and sustained physical activity, digital interventions may require additional family-, school-, peer-, or health professional support to strengthen sustainability and contextual relevance (Jacob et al., 2021). Hybrid approaches may therefore be particularly useful when digital tools support, rather than replace, broader health promotion strategies.

Implementation and Methodological Considerations

From an implementation perspective, digital platforms can support adolescent health promotion because they are scalable, accessible, and able to deliver behavioural support beyond clinical or school environments (Martín-Rodríguez et al., 2025). Nevertheless, for behaviours strongly influenced by social and environmental factors, such as dietary habits, hybrid approaches that combine digital tools with family- or

school-based interventions may produce more sustainable outcomes (Jacob et al., 2021).

Methodological limitations identified in the risk-of-bias assessment should be considered when interpreting these findings. Although most trials reported appropriate randomisation procedures, several studies provided limited information about allocation concealment or blinding. Some interventions also measured behavioural intentions or motivational outcomes rather than objectively assessed behavioural change. These methodological factors may contribute to the variability observed in intervention effectiveness.

Maintaining long-term engagement remains a major challenge. Several trials reported moderate attrition or declining adherence over time (Zheng et al., 2023). Previous reviews have also identified declining engagement as a common limitation of digital health interventions, particularly when programmes lack personalisation or adaptive feedback mechanisms (Boima et al., 2024).

In summary, the evidence synthesised in this review indicates that digital health technologies can support improvements in adolescent lifestyle behaviours. However, their effectiveness depends primarily on the integration of evidence-based behaviour change strategies rather than on the technological platform alone.

This review has several limitations. Although only randomised controlled trials were included, substantial heterogeneity remained across digital platforms, comparator conditions, intervention duration, outcome measures, and follow-up periods. This heterogeneity limited the feasibility of quantitative synthesis and required a structured narrative approach. In addition, the review was restricted to English-language publications and selected databases, which may have excluded relevant studies published elsewhere. Therefore, the findings should be interpreted as a structured synthesis of available evidence rather than as pooled estimates of intervention effectiveness.

Conclusion

This systematic review synthesised evidence from randomised controlled trials evaluating digital technology-based interventions to improve healthy lifestyle behaviours among adolescents. The findings indicate that digital interventions may support behavioural improvement, particularly in physical activity. However, evidence for dietary behaviour, sedentary behaviour, and weight-related outcomes remains less consistent. Across studies, interventions integrating behaviour change strategies, such as self-monitoring, goal setting, and personalised feedback, were more frequently associated with positive behavioural outcomes.

Digital technologies appear most effective when used as platforms for delivering behaviour change strategies rather than as standalone tools. Future research should prioritise theory-informed intervention design, longer follow-up periods, and standardised behavioural outcomes to strengthen the evidence base. Combining digital tools with broader health promotion strategies may offer opportunities for sustaining healthy habits among adolescents.

Several research gaps remain. Long-term evidence on the sustainability of behavioural change following digital interventions in adolescents is still limited. Future studies should include longer follow-up periods and examine how digital interventions can be integrated with family, school, and community-level strategies. Greater attention to theory-informed intervention design and standardised outcome measures would improve comparability among studies. Assessments of scalability, feasibility, cost, and implementation are also needed.

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Declaration Of Generative Artificial Intelligence (AI) Use

The authors declare that artificial intelligence (AI) tools were used in a limited capacity to support specific technical aspects of this study. ChatGPT was used to assist in developing and refining search queries, Rayyan was used to identify and remove duplicate articles, and SciSpace was used to support the data extraction process.

These tools were used solely to improve efficiency in the research process and did not replace critical intellectual input. All outputs were carefully reviewed, validated, and interpreted by the authors. The authors take full responsibility for the accuracy, integrity, and originality of the manuscript.

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Availability of data and materials

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Authors' contributions

All authors contributed to the development of this systematic review. ER & ET designed the study protocol, drafted the manuscript, conducted the literature search, data extraction, and risk of bias assessment. ET & RK

supervised the entire review process. All authors contributed to data interpretation and critically revised the manuscript for intellectual content. All authors have read and approved the final version of the manuscript.

Declaration of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

- Ahmadi, A. et al. (2023) 'A classification system for teachers' motivational behaviors recommended in self-determination theory interventions.', *Journal of Educational Psychology*, 115(8), pp. 1158–1176. doi: 10.1037/edu0000783.
- Barker, T. H. et al. (2023) 'The revised JBI critical appraisal tool for the assessment of risk of bias for randomized controlled trials', *JBI Evidence Synthesis*, 21(3), pp. 494–506. doi: 10.11124/JBIES-22-00430.
- Bjerregaard, A. A. et al. (2024) 'An SMS chatbot digital educational program to increase healthy eating behaviors in adolescence: A multifactorial randomized controlled trial among 7,890 participants in the Danish National Birth Cohort', *PLOS Medicine*, 21(6 June). doi:10.1371/journal.pmed.1004383.
- Boima, V. et al. (2024) 'Effectiveness of digital health interventions on blood pressure control, lifestyle behaviours and adherence to medication in patients with hypertension in low-income and middle-income countries: a systematic review and meta-analysis of randomised controlled trials', *eClinicalMedicine*, 69, p. 102432. doi: 10.1016/j.eclinm.2024.102432.
- Campbell, M. et al. (2020) 'Synthesis without meta-analysis (SWiM) in systematic reviews: reporting guideline', *BMJ*, p. l6890. doi: 10.1136/bmj.l6890.
- Cho, J.-H. and Lim, S.-T. (2025) 'Smart App and Wearable Device-Based Approaches for Contactless Public Healthcare for Adolescents in Korea', *Applied Sciences*, 15(14), p. 8084. doi: 10.3390/app15148084.
- Collado-Mateo, D. et al. (2021) 'Key Factors Associated with Adherence to Physical Exercise in Patients with Chronic Diseases and Older Adults: An Umbrella Review', *International Journal of Environmental Research and Public Health*, 18(4), p. 2023. doi: 10.3390/ijerph18042023.
- Durao, S. et al. (2020) 'Community-level interventions for improving access to food in low- and middle-income countries', *Cochrane Database of Systematic Reviews*. Edited by Cochrane Public Health Group. doi: 10.1002/14651858.CD011504.pub2.
- Fan, R. S. et al. (2026) 'Digital Health Interventions to Promote Physical Activity Among Adolescents: Systematic Review', *Journal of Medical Internet Research*, 28, p. e82395. doi: 10.2196/82395.
- Gómez-Cuesta, N. et al. (2024) 'A mobile app-based intervention improves anthropometry, body composition and fitness, regardless of previous active-inactive status: a randomized controlled trial', *Frontiers in Public Health*, 12. doi: 10.3389/fpubh.2024.1380621.
- Haşıl Korkmaz, N. and Çoruh, H. (2025) 'Time to Move: A 4-Week Gamified Mobile Application Intervention to Promote Physical Activity in Secondary School Students', *European Journal of Sport Science*, 25(8). doi:10.1002/ejsc.70027.
- Jacob, C. M. et al. (2021) 'A systematic review and meta-analysis of school-based interventions with health education to reduce body mass index in adolescents aged 10 to 19 years', *International Journal of Behavioral Nutrition and Physical Activity*, 18(1), p. 1. doi: 10.1186/s12966-020-01065-9.
- Krishna, K. et al. (2025) 'What's the "Secret Sauce"?: A Systematic Review of the Characteristics of Effective Digital Health Behaviour Change Interventions for Children and Adolescents', *Health Promotion Journal of Australia*, 36(3), p. e70051. doi: 10.1002/hpja.70051.
- Lloyd-Jones, D. M. et al. (2022) 'Life's Essential 8: Updating and Enhancing the American Heart Association's Construct of Cardiovascular Health: A Presidential Advisory From the American Heart Association', *Circulation*, 146(5). doi: 10.1161/CIR.0000000000001078.
- Mair, J. L. et al. (2023) 'Effective Behavior Change Techniques in Digital Health Interventions for the Prevention or Management of Noncommunicable Diseases: An Umbrella Review', *Annals of Behavioral Medicine*, 57(10), pp. 817–835. doi: 10.1093/abm/kaad041.
- Martín-Rodríguez, A. et al. (2025) 'Move to Remember: The Role of Physical Activity and Exercise in Preserving and Enhancing Cognitive Function in Aging—A Narrative Review', *Geriatrics*, 10(6), p. 143. doi:10.3390/geriatrics10060143.
- Melo, G. R. A. et al. (2023) 'Tailored nutritional intervention through digital technology for Brazilian adolescents', *Brazilian Journal of Education, Technology and Society*, 16(4), pp. 1098–1109. doi: 10.14571/brajets.v16.n4.p.1098-1109.
- Melo, G. L. R. et al. (2025) 'Digital dietary interventions for healthy adolescents: A systematic review of behavior change techniques, engagement strategies, and adherence', *Clinical Nutrition*, 45, pp. 176–192. doi: 10.1016/j.clnu.2025.01.012.
- Michie S., Atkins L., and West R. (2017) *The Behaviour Change Wheel: A Guide to Designing Interventions*, Silverback Publishing. Sutton: Silverback Publishing.
- O'Dean, S. et al. (2025) 'Adolescent behavioural intentions: Secondary outcomes from a cluster randomized controlled trial of the Health4Life school-based lifestyle modification intervention', *Canadian Journal of Public Health*, 116(3), pp. 432–445. doi: 10.17269/s41997-024-00955-w.
- Page, M. J. et al. (2021) 'The PRISMA 2020 statement: an updated guideline for reporting systematic reviews', *Systematic Reviews*, 10(1), p. 89. doi: 10.1186/s13643-021-01626-4.
- Raeside, R. et al. (2024) 'Are Digital Health Interventions That Target Lifestyle Risk Behaviors Effective for Improving Mental Health and Wellbeing in Adolescents? A Systematic Review with Meta-analyses', *Adolescent Research Review*, 9(2), pp. 193–226. doi: 10.1007/s40894-023-00224-w.
- Ridgers, N. D. et al. (2021) 'Effect of commercial wearables and digital behaviour change resources on the physical activity of adolescents attending schools in socio-economically disadvantaged areas: the RAW-PA cluster-randomised controlled trial', *International Journal of Behavioral Nutrition and Physical Activity*, 18(1). doi: 10.1186/s12966-021-01110-1.
- Ryan, R. M. and Deci, E. L. (eds) (2017) *Self-Determination Theory: Basic Psychological Needs in Motivation, Development, and Wellness*. Guilford Press. doi:10.1521/978.14625/28806.
- Seiterö, A. et al. (2025) 'Effectiveness of a Mobile Phone-Delivered Multiple Health Behavior Change Intervention (LIFE4YOUth) in Adolescents: Randomized Controlled Trial', *Journal of Medical Internet Research*, 27. doi: 10.2196/69425.
- Singh, B. et al. (2025) 'Lifestyle eHealth and mHealth Interventions for Children and Adolescents: Systematic Umbrella Review and Meta-Analysis', *Journal of Medical Internet Research*, 27(1). doi: 10.2196/69065.
- Stasinaki, A. et al. (2021) 'Effects of a novel mobile health intervention compared to a multi-component behaviour changing program on body mass index, physical capacities and stress parameters in adolescents with obesity: a randomized controlled trial', *BMC Pediatrics*, 21(1), p. 308. doi:10.1186/s12887-021-02781-2.
- Tugault-Lafleur, C. N. et al. (2023) 'Efficacy of the Aim2Be Intervention in Changing Lifestyle Behaviors among Adolescents with Overweight and Obesity: Randomized Controlled Trial', *Journal of Medical Internet Research*, 25. doi: 10.2196/38545.
- Vanhelst, J. et al. (2025) 'Impact of Digital School-Based Personalized High-Intensity Interval Training on Cardiorespiratory Fitness in French Adolescents: The METs-Up Programme', *Scandinavian Journal of Medicine and Science in Sports*, 35(10). doi: 10.1111/sms.70141.

- Wang, J. et al. (2025) 'An adaptive AI-based virtual reality sports system for adolescents with excess body weight: a randomized controlled trial', *Nature Medicine*, 31(7), pp. 2255–2268. doi: 10.1038/s41591-025-03724-5.
- Wang, M. L. (2024) '47. Navigating Health Misinformation on Social Media to Promote Adolescent Health', *Journal of Adolescent Health*, 74(3). doi: 10.1016/j.jadohealth.2023.11.245.
- World Health Organization (2020) WHO guidelines on physical activity and sedentary behaviour. Geneva: World Health Organization. Available at: <https://www.who.int/publications/i/item/9789240015128>.
- World Health Organization (2025a) Noncommunicable diseases, World Health Organization. Available at: https://www.who.int/news-room/factsheets/detail/noncommunicable-diseases?utm_source=chatgpt.com (Accessed: 18 May 2026).
- World Health Organization (2025b) Noncommunicable diseases: risk factors and conditions, World Health Organization. Available at: <https://www.who.int/data/gho/data/themes/topics/noncommunicable-diseases-risk-factors>.
- Zheng, S. et al. (2023) 'Effectiveness of holistic mobile health interventions on diet, and physical, and mental health outcomes: a systematic review and meta-analysis', *eClinicalMedicine*, 66, p. 102309. doi: 10.1016/j.eclinm.2023.102309.

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Table 2. Characteristics of included studies (n = 11)

| No | Author (Year) | Country / Setting | Study Design | Participants | Digital Intervention Type | Intervention Description | Comparator | Duration | Outcomes | Key Findings |
|----|-------------------------------|--------------------------|--------------|--|--|---|---|--|---|---|
| 1 | Gómez-Cuesta et al. (2024) | Spain, secondary schools | RCT | n=462 initial; n=430 completed/analyzed; adolescents aged 12–16 years | Mobile fitness apps | Step-tracking apps (Strava, MapMyWalk, Pokémon Go) integrated into PE classes with gamification and incentives | Usual physical education/no step-tracking app | 10 weeks | Physical activity level, adherence to Mediterranean diet, anthropometry, body composition, VO ₂ max/cardiorespiratory fitness, handgrip, CMJ, curl-up, push-up | Digital activity tracking improved PA engagement and cardiorespiratory fitness |
| 2 | Tugault-Lafleur et al. (2023) | Canada, community | RCT | n=214 parent–child dyads (10–17 yrs) | mHealth app | Aim2Be mobile application supporting diet, PA, screen time reduction, and behavior change | Wait-list control | 6 months | BMI-z score, diet, PA, screen time | No significant effects were found for zBMI or health behaviours at 3 months, although secondary analyses suggested greater activity outside school among adolescents receiving live coaching. |
| 3 | Bjerregaard et al. (2024) | Denmark, | RCT | ≈7,890 adolescents (~14 yrs) | SMS chatbot intervention | Automated SMS-based nutrition education and reminders promoting healthy diet behaviors | No-SMS control | 6 & 18 months | BMI-z score, dietary quality index | No clear ITT effect on dietary habits or BMI z-score; modest short-term BMI-z improvement was observed only in per-protocol analyses. |
| 4 | Stasinaki et al. (2021) | Switzerland | RCT | n=41 recruited adolescents aged 10–18 years with obesity; n=31 included at intervention start/intervention analysis. | Conversational agent app | PathMate2 mobile chatbot delivering coaching, goal setting, diet, and PA advice | Multi-component behavioural intervention | 5.5 months + 12-month follow-up | BMI-SDS, body composition, fitness, stress | Digital coaching improved physical capacity and body composition |
| 5 | Wang et al. (2025) | China | RCT | n=227 adolescents with excess weight | AI-based VR system | REVERIE VR sports system with AI-driven coaching for table tennis and soccer | Physical sports or control | 8 weeks + 6-month follow-up | Fat mass, metabolic markers, cognition, fitness | VR sports significantly reduced fat mass and improved psychological and cognitive outcomes |
| 6 | Ridgers et al (2021) | Australia | RCT | n=275 adolescents; mean age 13.7 ± 0.4 years; 50.2% female | Wearable activity tracker + digital behaviour change resources | RAW-PA combined a Fitbit Flex and app with online behaviour change resources, weekly Facebook-delivered missions/challenges, and text-message alerts. | Wait-list control | 12-week intervention plus 6-month follow-up | Accelerometer-assessed MVPA and self-reported physical activity | The intervention did not significantly improve MVPA or self-reported physical activity immediately post-intervention. At 6-month follow-up, the intervention group had lower MVPA than the wait-list control, especially among males. |
| 7 | Sejterö et al. (2025) | Sweden | RCT | n=756 high school students aged 15–20 years. | Mobile health intervention | LIFE4YOUth digital program targeting multiple lifestyle behaviors | Control group | 16-week intervention; follow-up at 2 and 4 months. | Alcohol consumption, fruit and vegetable intake, sugary drink intake, | Modest short-term effects were observed mainly for physical activity and fruit and vegetable consumption; |

| No | Author (Year) | Country / Setting | Study Design | Participants | Digital Intervention Type | Intervention Description | Comparator | Duration | Outcomes | Key Findings |
|----|------------------------------|-------------------|--|--|--|---|---|---|--|---|
| 8 | O'Dean et al (2025) | Australia | Cluster RCT; secondary outcome analysis of Health4Life | n≈6639 adolescents | School-based eHealth intervention + smartphone app | Health4Life included web-based modules and a smartphone app targeting six lifestyle risk behaviours: physical inactivity, poor diet, excessive screen time, poor sleep, alcohol use, and tobacco use. | Standard health education | Post-intervention, 12 months, and 24 months | MVPA, smoking abstinence, and BMI. Behavioural intentions related to alcohol, tobacco, physical activity, screen time, diet, and sleep | evidence for other outcomes was inconclusive. Health4Life improved some short-term behavioural intentions, especially around alcohol, tobacco, screen time, and sleep, but effects were not consistently sustained. This paper should be labelled as a secondary outcome analysis, not a separate trial from Health4Life. |
| 9 | Haşıl Korkmaz & Çoruh (2025) | Turkey | RCT | n=25 secondary school students aged 12–14 years; control group n=13 and experimental group n=12. | Gamified mobile application | Gamification-based mobile intervention encouraging PA | Control group | 1-week familiarisation, 4-week intervention, and impact assessment session. | PA behavior | Gamification increased motivation and PA |
| 10 | Vanhelst et al. (2025) | France | RCT | n=9,021 adolescents aged 10–14 years | Smartphone-supported personalized HIIT programme | METs-Up used an innovative smartphone application to deliver personalized high-intensity interval training integrated into physical education lessons. | Conventional physical education lessons | 6 weeks | Cardiorespiratory fitness and BMI | The smartphone-supported personalized HIIT programme significantly improved cardiorespiratory fitness among French adolescents. |
| 11 | Melo et al. (2023) | Brazil | RCT | n=347 senior students; mean age 18.04 ± 0.75 years. | Digital nutrition education | Personalized digital nutrition intervention | Standard education | 42 days / 6 weeks. | Food consumption, stage of change, nutritional knowledge, and self-efficacy for adopting healthy eating behaviours. | The tailored group showed increased nutritional knowledge and self-efficacy and reduced unhealthy eating scores; between-group effects were mainly observed for selected self-efficacy items. |