

REVIEW OPEN ACCESS

What's the 'Secret Sauce'?: A Systematic Review of the Characteristics of Effective Digital Health Behaviour Change Interventions for Children and Adolescents

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ABSTRACT

Issue Addressed: Few previous reviews have identified the characteristics of effective digital health behaviour change interventions for children and/or adolescents. This systematic review aimed to identify and report the characteristics, including the theoretical bases and the incorporated behaviour change techniques (BCTs).

Methods: CINAHL Ultimate (EBSCO), MEDLINE (Ovid), PubMed, ProQuest, and Web of Science were searched to identify intervention studies published in international academic peer-reviewed journals between January 2002 and May 2024 inclusive. Only studies that used a randomised controlled trial (RCT) study design to evaluate interventions were eligible for inclusion in this review. Studies were reviewed independently by two researchers to assess the risk of bias and extract data.

Results: There were 17 study articles that met the eligibility criteria for inclusion. Twenty interventions were evaluated in the 17 articles. Ten interventions were considered to be effective and incorporated one or more of the following BCTs: (1) shaping knowledge, (2) goals and planning, (3) feedback and monitoring, (4) social support, and (5) reward. Eight effective interventions were based on one or more of the following behaviour change theories: (1) Social Cognitive Theory, (2) Theory of Planned Behaviour, (3) Transtheoretical Model–Stages of Change, (4) I-Change Model, and (5) Health Action Process Approach.

Conclusions: Effective interventions incorporated one or more BCTs and most were based on behaviour change theories.

So What? Findings can inform the selection of appropriate behaviour change theories and techniques in the development of future interventions for children and/or adolescents.

1 | Introduction

Individuals of different ages and backgrounds use digital technologies for different purposes, including communication, leisure, learning, and work [1–4]. Children and adolescents actively engage with digital technologies for electronic gaming,

social networking, and in their education [4–6], with many required to have access to tablets, laptop computers, or desktop computers for learning activities [2, 4].

Health promotion practitioners have capitalised on children and adolescents' engagement with digital technologies by developing

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and delivering digital health behaviour change interventions promoting various health behaviours [7–10]. Digital health behaviour change interventions are those that use digital technology to promote behaviour change that will maintain or improve health by preventing and managing health problems [11]. Previous literature reviews have reported the effectiveness of digital health behaviour change interventions for children and/or adolescents [8, 9]. However, only a few recent reviews [7, 12] have reported the characteristics of effective digital interventions including the incorporated behaviour change techniques (BCTs) and theoretical bases [13].

Behaviour change techniques are observable and replicable components of an intervention designed to change or redirect causal processes that influence behaviour [14]. There are currently 93 BCTs clustered hierarchically into 16 groups within the Behaviour Change Technique Taxonomy version 1 (BCTTv1) [15]. A systematic review of Internet-based health behaviour change interventions [13] reported that those with more BCTs had larger positive effects on health behaviour outcomes compared to interventions with fewer BCTs.

Behaviour change theories describe and specify the likely determinants of health behaviours that interventions can address [13]. For example, the Theory of Planned Behaviour (TPB) [16, 17] describes an individual's behavioural intention as a determinant of their behaviours, and other determinants including attitude, subjective norms, and perceived behavioural control are mediated through their behavioural intentions [16, 17]. Intervention developers can design and include specific intervention features that address the determinants specified in the behaviour change theory. This can enable the development of effective interventions, as interventions based on extensive use of behaviour change theories were associated with increased effect size for health behaviour outcomes [13].

1.1 | Aim

This systematic review aimed to review evidence about the effectiveness of digital health behaviour change interventions for children and/or adolescents, and identify and report the characteristics of the effective interventions which include the theoretical bases and incorporated behaviour change techniques.

2 | Methods

2.1 | Eligibility Criteria for Studies

2.1.1 | Types of Studies

Only intervention studies that used a randomised controlled trial (RCT), randomised clinical trial, cluster RCT, or cluster randomised clinical trial study design to evaluate digital health behaviour change interventions for children and/or adolescents were eligible for inclusion in this systematic review. The included studies had to have been published in the English language between January 2002 and May 2024 inclusive, and in an international academic peer-reviewed journal. The start year

(2002) was selected based on evidence from a bibliometric analysis and scoping review [18] that identified a clear and emerging trend in digital health behaviour change technologies after the year 2001 [18]. The included intervention studies were identified based on the population, intervention, comparator, and outcome (PICO) framework [19].

2.1.2 | Types of Participants and Settings

Intervention studies with participants of any gender, aged 6–12 years (children) and/or 13–20 years (adolescents) in any geographical location and setting were eligible for inclusion in this systematic review.

2.1.3 | Types of Interventions

Intervention studies included in this systematic review must have evaluated digital health behaviour change interventions for children and/or adolescents that included web-based interventions, smartphone applications, social media platforms, electronic/video games, email, text messages, personal digital assistants, and/or multi-modal interventions with digital components as the primary element of the intervention.

2.1.4 | Types of Comparators

Intervention studies that compared digital health behaviour change interventions for children and/or adolescents to non-digital interventions, alternative digital interventions, a combination of digital and non-digital interventions, or no interventions were eligible for inclusion in this systematic review.

2.1.5 | Types of Outcome Measures

The intervention studies in this systematic review must have measured outcomes related to any health behaviours and/or health behaviour determinants. Health behaviour determinants included, but were not limited to, knowledge, attitudes, beliefs, self-efficacy, and/or behavioural intentions. The included intervention studies must also have measured outcomes at two or more time points and where one measurement was a baseline measure.

2.2 | Search Strategy

A total of five electronic databases were searched, including CINAHL Ultimate (EBSCO), MEDLINE (Ovid), PubMed, ProQuest, and Web of Science on May 18, 2024. A three-step search strategy was used. First, an initial search of CINAHL Ultimate (EBSCO) and MEDLINE (Ovid) was conducted using search terms that represent the main concepts of this systematic review topic. Second, identification of key words in the title and abstract of the studies identified from the initial search was conducted. Finally, a second search across all five electronic databases using the key words and the original search terms was performed. The primary researcher (KK) conducted the initial

search, identified key words in the studies' titles and abstracts, and completed the second search across all five electronic databases. The full search strategy for each electronic database is in Appendix A.

The search was complemented by searching trial registries (KK) for ongoing studies. A hand search of published literature was also conducted (KK). Reference lists of all selected study articles were also screened (KK) to identify additional studies. All search results were managed using EndNote X9 software.

2.3 | Selection of Studies

Duplicate study articles were removed manually or with EndNote's duplicate identification tool. All remaining studies were screened over two phases. Phase 1 involved independently screening the titles and abstracts to exclude irrelevant studies (KK). In Phase 2, two researchers (KK and MC) independently performed full-text screening. Both followed the pre-specified eligibility criteria to include or exclude studies, and the reasons for exclusion were recorded. Disagreements in the selection process were discussed between the researchers to reach consensus. All study articles were tracked using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram [20].

2.4 | Risk of Bias Assessment

Version 2 of the Cochrane Collaboration's tool for assessing risk of bias in randomised trials (RoB 2) [21] was used to assess the risk of bias of each study. This tool consists of five risk of bias domains including (1) randomisation process, (2) deviations from the intended interventions, (3) missing outcome data, (4) measurement of the outcome(s), and (5) selection of the reported results [21]. The risk of bias in all five domains were judged as 'high risk', 'some concerns', or 'low risk' [21]. The judgements within each domain were combined to create an overall risk of bias judgement for each study [21]. Studies were judged to have a low risk of bias overall if all five domains were judged as 'low risk' [21]. Studies were judged to have some concerns overall if at least one domain was judged to have 'some concerns' but no domains were judged as 'high risk' [21]. Studies were judged to have a high risk of bias overall if any domains were judged as 'high risk' [21]. The assessment of the risk of bias was performed independently by two researchers (KK and MC). Any disagreements were discussed to reach consensus. A third researcher (LP or CH) was asked to resolve disagreements when consensus was not reached. Trial protocols of included intervention studies were checked for publication dates to confirm that they had preceded results publication. This was to identify publication bias in the included intervention studies. The risk of bias of each study is presented in Table B1 (Appendix B).

2.5 | Data Extraction and Synthesis

Data extraction from the included intervention studies was performed independently by two researchers (KK and MC) using

a standard data extraction form. Differences in extracted data were discussed to reach consensus. A third researcher (LP or CH) was asked to resolve disagreements when consensus was not reached. Characteristics of the included studies and extracted data from each of the included studies are presented in Table C1 (Appendix C).

All extracted data were synthesised and presented as a narrative synthesis due to the methodological heterogeneity of the studies. The effectiveness of each intervention was determined based on whether the intervention was deemed to be 'very promising', 'quite promising', 'possibly promising', or 'non-promising'. This was determined by changes in the health behaviour outcome/s and the overall risk of bias of each intervention study [21]. Interventions were deemed to be 'very promising' if the associated intervention study was judged as having a low risk of bias overall [21], and if there was a significant difference between the intervention group/s and the comparator/control group for one or more outcome/s post-intervention in favour of the intervention group (beneficial effect). Interventions were deemed to be 'quite promising' if the associated intervention study was judged as having some concerns overall [21], and if there was a significant difference between the intervention group/s and the comparator/control group for one or more outcome/s post-intervention in favour of the intervention group. Interventions were deemed to be 'possibly promising' if the associated intervention study was judged as having a high risk of bias overall [21], and if there was a significant difference between the intervention group/s and the comparator/control group for one or more outcome/s post-intervention in favour of the intervention group. Interventions were deemed to be 'non-promising' if there was no significant difference between the intervention group/s and the comparator/control group for any outcomes post-intervention. Adverse effects of the interventions were also identified if reported in the studies. For the purpose of this systematic review, interventions that were deemed to be 'very promising' or 'quite promising' were considered to be effective interventions.

The BCTs incorporated within the interventions were coded independently by two researchers (KK and MC) according to the 16 groups within the Behaviour Change Technique Taxonomy version 1 (BCTTv1) [15] and checked for accuracy by a third researcher (LP or CH). If the intervention studies included multiple intervention arms/groups, the behaviour change techniques were coded for each intervention arm/group. For the purpose of this systematic review, interventions within an intervention arm/group were considered to be one intervention. The theoretical bases of interventions were identified if reported in the intervention studies.

3 | Results

3.1 | Search and Selection of Studies

Following duplicates removal, 7127 articles were identified from all sources. Of these, 7089 articles were deemed irrelevant after screening titles and abstracts. A full-text screen of the remaining 38 articles identified 17 articles that met the eligibility criteria for inclusion in this systematic review; 21 were excluded having not met the eligibility criteria. Reasons for exclusion

included participants' ages ($n=6$), evaluation of non-digital interventions ($n=7$), and measurement of non-health behaviour related outcomes ($n=8$). A total of 20 interventions were evaluated in the 17 included articles. Figure 1 displays the PRISMA flow diagram [20], which summarises the process for the search, screening, and selection of study articles.

3.2 | Characteristics of Included Studies

The 17 included studies [22–38] measured health behaviour outcomes related to alcohol consumption, drug use, smoking, safe sex, diet, physical activity, oral health, sleep, and/or screen-time. Seven studies [25, 26, 30, 32, 33, 35, 36] measured outcomes related to health behaviour determinants including knowledge, self-efficacy, attitude, perceived behavioural control, subjective norms, and/or behavioural intentions. The included studies [22–38] evaluated digital health behaviour change interventions for children and/or adolescents including web-based interventions ($n=9$) [22–26, 31, 33, 36], multi-modal interventions with digital components ($n=8$) [28, 30, 32, 34, 35, 37, 38], video games ($n=1$) [27], and social media platforms ($n=2$) [29]. These interventions were compared to non-digital interventions ($n=5$) [28, 33, 34, 37, 38], alternative digital interventions

($n=6$) [23, 25–27, 32, 36], a combination of digital and non-digital interventions ($n=1$) [31], or no interventions ($n=5$) [22, 24, 29, 30, 35]. Studies were conducted in the Netherlands ($n=5$) [22, 24, 30, 33, 35], United States of America (USA; $n=7$) [23, 25–27, 31, 32, 36], Australia ($n=2$) [34, 38], United Kingdom (UK; $n=1$) [28], Iran ($n=1$) [29], and Denmark ($n=1$) [37]. The studies occurred within schools ($n=12$) [22, 24, 26, 28–30, 33–38] or the community ($n=5$) [23, 25, 27, 31, 32], and used a RCT ($n=6$) [25, 26, 31–33, 37], randomised clinical trial ($n=3$) [23, 27, 36], or cluster RCT ($n=8$) [22, 24, 28–30, 34, 35, 38] study design. Sample sizes ranged from $n=54$ to $n=3213$ and participants' ages ranged from 10 to 20 years [22–38]. Thirteen studies [22–27, 29, 30, 33, 35–38] included both male and female participants, two studies [32, 34] had male only participants, and two studies [28, 31] had female only participants. The included studies [22–38] were published between 2006 and 2022 in a total of 12 journals. Characteristics of included studies are in Table C1 (Appendix C).

3.3 | Risk of Bias

No studies were deemed as having a low risk of bias overall, 13 studies had some concerns overall, and four studies had a high

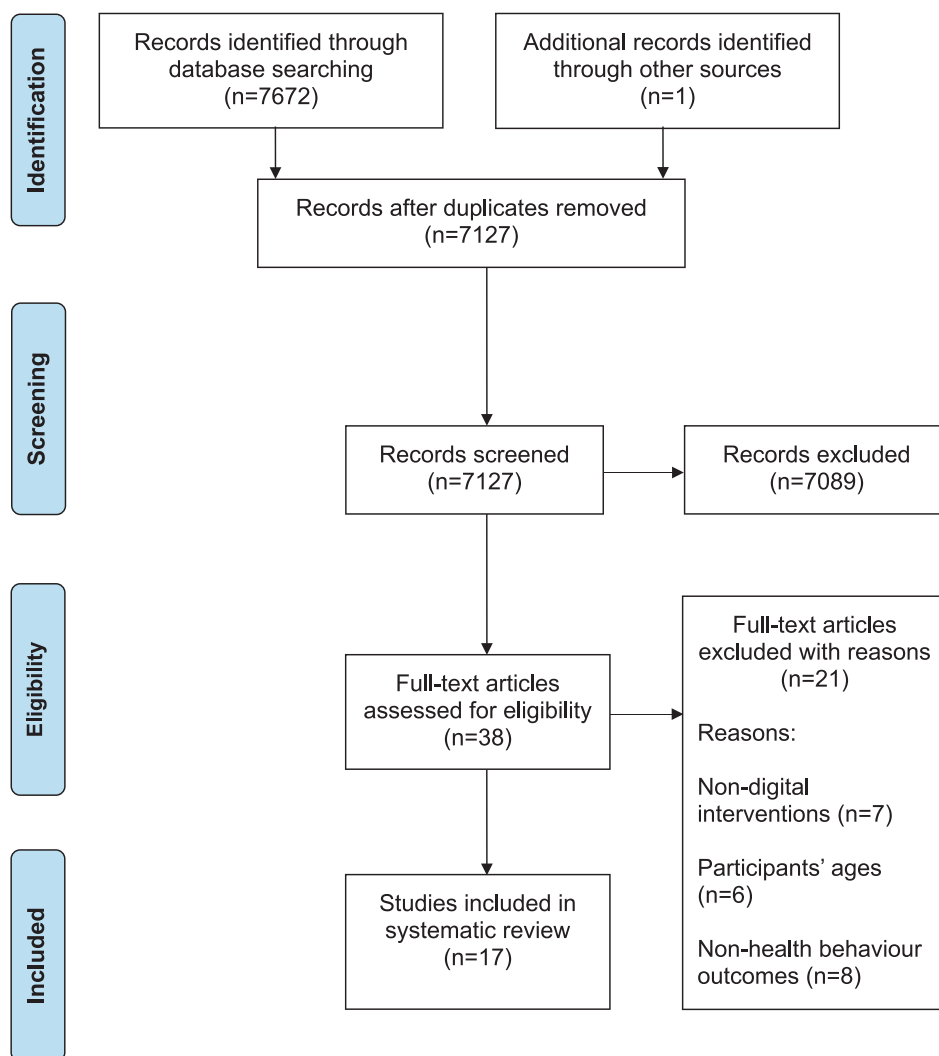


FIGURE 1 | PRISMA flow diagram of study selection [20].

risk of bias overall. Table B1 summarises the risk of bias of each study (Appendix B).

3.4 | Effectiveness of Digital Interventions

3.4.1 | Promising Interventions

No interventions were deemed ‘very promising’. Ten interventions [22–30] were deemed ‘quite promising’. In the Netherlands, a web-based intervention promoting health behaviours related to alcohol consumption, drug use, smoking, and safe sex significantly increased the frequency of safe sex behaviours of adolescents in the intervention group compared to the control group at 4-month follow-up ($p=0.001$) [22]. Another web-based intervention in the Netherlands significantly lowered smoking initiation among adolescents aged 14 to 16 years in the intervention group compared to the control group at 6-month follow-up ($p=0.05$) [24]. After completing a multi-modal intervention with digital components in the Netherlands promoting sleep, adolescents significantly increased sleep knowledge ($p<0.05$) and improved attitude ($p<0.05$) and perceived behavioural control ($p<0.05$) relating to sleep compared to the control group [30]. In the USA, a web-based program promoting healthy eating and physical activity led to a significant increase in the number of adolescents that consumed three or more servings of vegetables per day compared to the control group post-intervention ($p<0.05$) [23]. A web-based program promoting healthy lifestyles and body mass to Chinese-American adolescents significantly increased their vegetable and fruit intake ($p=0.001$), physical activity ($p=0.01$), knowledge related to physical activity ($p=0.008$), and knowledge related to nutrition ($p=0.001$) compared to the control group at follow-up [25]. Another USA web-based intervention promoting healthy food intake and physical activity to school children significantly improved their outcomes related to meal planning compared to the control group post-intervention ($p<0.001$) [26]; while another USA-based intervention that delivered two specific video games significantly increased the fruit and vegetable intake of children compared to the control group post-intervention ($p=0.018$) [27]. In the UK, a computer-generated tailored intervention leaflet promoting dietary intake of targeted food significantly increased brown bread intake of adolescent girls compared to the control group at 3-month follow-up ($p<0.05$) [28]. Finally, in Iran, an intervention delivered by an online social media platform, with and without social support, significantly increased the frequency of toothbrushing of adolescents in the intervention groups compared to the control group at follow-up ($p<0.001$) [29].

3.4.2 | Possibly Promising Interventions

There were four interventions [31–34] that were deemed to be ‘possibly promising’ interventions. In the USA, a web-based behaviour modification program for African-American adolescent girls significantly reduced their intake of fattening foods compared to the control group at follow-up ($p<0.05$) [31], while in another study, a combined in-person and web-based program for boys significantly increased their fruit juice consumption ($p=0.003$), availability of fruit juice at home ($p=0.009$), and self-efficacy related to low-fat vegetable consumption ($p=0.004$)

compared to the control group post-intervention [32]. In the Netherlands, a web-based intervention promoting physical activity among adolescents significantly increased moderate intensity physical activity of adolescent girls compared to the control group at 3-month follow-up ($p=0.04$) [33], and significantly reduced sedentary time of adolescent boys compared to the control group at 8-month follow-up ($p=0.04$) [33]. In Australia, an intervention using smartphone technology significantly reduced adolescent males’ screen-time ($p=0.03$) and sugar-sweetened beverage consumption ($p=0.01$) compared to the control group at 8-month follow-up [34].

3.4.3 | Non-Promising Interventions

There were six interventions [22, 35–38] judged as ‘non-promising’. A web-based intervention promoting health behaviours related to alcohol consumption, drug use, smoking, and safe sex to adolescents in the Netherlands delivered in addition to consultation with a health professional did not significantly improve any health behaviours of adolescents compared to the control group at follow-up [22]. An intervention that delivered computer-tailored feedback messages, with and without prompt messages, to children in the Netherlands did not significantly decrease their smoking intentions and smoking behaviour compared to the control group at follow-up [35]. In the USA, a web-based obesity prevention program for adolescents did not significantly improve their self-efficacy or any health behaviours compared to the comparison group at follow-up [36]. In Denmark, a multi-modal nutrition program with digital components did not significantly increase fruit and vegetable intake of Danish adolescents compared to the control group post-intervention [37]. Finally, a multi-modal intervention with digital components to reduce recreational screen-time of adolescents in Australia did not significantly reduce their screen-time and did not significantly increase their physical activity compared to the control group post-intervention [38].

3.4.4 | Adverse Effects

Only two intervention studies [22, 33] reported any adverse effects of the interventions.

The changes in health behaviour outcomes and adverse effects are provided in Table C1 (Appendix C).

3.5 | Characteristics of Effective Digital Interventions

In this systematic review, the 10 interventions [22–30] deemed ‘quite promising’ were considered effective interventions.

3.5.1 | Behaviour Change Techniques (BCTs)

The effective digital interventions [22–30] incorporated one or more of the following BCTs: (1) shaping knowledge ($n=10$) [15], (2) goals and planning ($n=6$) [15], (3) feedback and monitoring ($n=8$) [15], (4) social support ($n=3$) [15, 39], and (5) reward and

threat (reward) ($n = 1$) [15]. Although none of the effective interventions used threats, only rewards, these techniques are combined in the overarching BCT taxonomy group label according to the BCCTv1 [15].

3.5.2 | Theoretical Bases

Eight effective digital interventions [23–26, 28–30] were based on one or more behaviour change theories, including (1) Social Cognitive Theory [40], (2) Theory of Planned Behaviour [16, 17], (3) Transtheoretical Model–Stages of Change [41], (4) I-Change Model [42–44], and (5) Health Action Process Approach [45].

A summary of the BCTs and theoretical bases of the digital interventions is provided in Table C1 (Appendix C).

4 | Discussion

4.1 | Interpretation and Implications

This systematic review identified effective digital interventions that were based on the Social Cognitive Theory [40], and incorporated the BCT shaping knowledge [15]. These findings are consistent with a previous systematic review [12], which identified two effective digital interventions for children based on Social Cognitive Theory [40], and that the BCT shaping knowledge [15] was typically incorporated within effective digital behaviour change interventions for children. The common use of the BCT shaping knowledge could be because intervention developers sought to first ensure children and adolescents had an understanding of required knowledge, which is needed before they make changes to their attitude, decision making, and behaviours. This is consistent with McGuire's Model of Communication and Persuasion [46]. This systematic review's findings build on existing evidence for the Social Cognitive Theory [40] and the BCT shaping knowledge [15], and may be of interest to developers of future digital health behaviour change interventions for children and/or adolescents. Intervention developers can consider using Social Cognitive Theory [40] to form the theoretical basis of their interventions by addressing children and/or adolescents' knowledge related to specific health behaviours, as a likely behavioural determinant [40]. This can be done by incorporating the BCT shaping knowledge [15] into interventions via health information or education using interactive features such as tailored messages, videos, video games, text, narrated text, graphics, comics, voice overs, and/or knowledge/skill-based games.

This systematic review identified effective digital interventions that were based on Theory of Planned Behaviour [16, 17], and incorporated the BCTs goals and planning, feedback and monitoring, social support, and rewards. These findings support the findings from a systematic review and meta-analysis of Internet-based health behaviour change interventions [13], which concluded that interventions based on Theory of Planned Behaviour and incorporated more BCTs had substantial positive effects on health behaviours. However, the aforementioned systematic review and meta-analysis [13] reviewed

Internet-based health behaviour change interventions that were not specific to only children and/or adolescents. Therefore, the contribution of the current systematic review about the Theory of Planned Behaviour [16, 17] and BCTs represents new evidence to support the use of this theory and techniques in the development of future digital interventions for children and/or adolescents.

The current systematic review also identified effective digital interventions based on the Transtheoretical Model–Stages of Change [41], I-Change Model [42–44], and Health Action Process Approach [45]. To the best of the authors' knowledge, no recent reviews have identified and reported that these theories were used to form the basis of effective digital interventions for children and/or adolescents. Therefore, findings from the current systematic review about the Transtheoretical Model–Stages of Change [41], I-Change Model [42–44], and Health Action Process Approach [45] represent new contributions to the evidence to support their use in the development of future digital interventions for children and/or adolescents.

4.2 | Strengths and Limitations

A strength of this systematic review is that only intervention studies that used a RCT, randomised clinical trial, or cluster RCT study design to evaluate digital health behaviour change interventions for children and/or adolescents were included. These study designs present the lowest levels of methodological bias.

Another strength is that the BCTs within the interventions were coded independently by two researchers according to the Behaviour Change Technique Taxonomy version 1 (BCTTv1) [15] and verified by a third researcher. Using an established coding system and taxonomy helped enhance the rigour of reporting the BCTs used. The selection of studies, risk of bias assessment, and data extraction were also conducted independently by two researchers to enhance the rigour of the systematic review.

Due to the methodological heterogeneity of the studies, it was not possible to conduct a meta-analysis. Instead, all extracted data were presented as a narrative synthesis. Although the potential limitations of a narrative synthesis include a lack of transparency, replicability, and being subject to the interpretation of the authors [47], these limitations were mitigated by prospectively registering the protocol for this systematic review with specified outcomes. Guidelines on the conduct and reporting of narrative synthesis of quantitative data were followed [48].

Statistically significant differences between the intervention group/s and the comparator/control group were used to determine the effectiveness of interventions for the purpose of this review. Determining effectiveness based on effect sizes of the interventions would have been preferential; however, some included studies did not report effect sizes.

The effective digital health behaviour change interventions in this review were in studies deemed as having some concerns

overall in relation to their risk of bias [21]. Therefore, findings from this review should be interpreted cautiously.

5 | Conclusion

This systematic review has identified the behaviour change theories and techniques that can inform the development of future digital health behaviour change interventions to improve the health behaviours of children and/or adolescents.

6 | Other Information

6.1 | Registration

The protocol for this systematic review is registered in the PROSPERO international prospective register of systematic reviews (Registration number: CRD42020193494). Reporting of this systematic review was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [20].

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

References

1. M. T. Bixter, K. A. Blocker, T. L. Mitzner, A. Prakash, and W. A. Rogers, "Understanding the Use and Non-Use of Social Communication Technologies by Older Adults: A Qualitative Test and Extension of the UTAUT Model," *Geron* 18, no. 2 (2019): 70–88, <https://doi.org/10.4017/gt.2019.18.2.002.00>.
2. L. Straker, B. Maslen, R. Burgess-Limerick, P. Johnson, and J. Dennerlein, "Evidence-Based Guidelines for the Wise Use of Computers by Children: Physical Development Guidelines," *Ergonomics* 53, no. 4 (2010): 458–477, <https://doi.org/10.1080/00140130903556344>.
3. K. B. Wright, B. Abendschein, K. Wombacher, et al., "Work-Related Communication Technology Use Outside of Regular Work Hours and Work Life Conflict: The Influence of Communication Technologies on Perceived Work Life Conflict, Burnout, Job Satisfaction, and Turnover Intentions," *Management Communication Quarterly* 28, no. 4 (2014): 507–530, <https://doi.org/10.1177/0893318914533332>.
4. T. Shamir-Inbal and I. Blau, "Developing Digital Wisdom by Students and Teachers: The Impact of Integrating Tablet Computers on Learning and Pedagogy in an Elementary School," *Journal of Educational Computing Research* 54, no. 7 (2016): 967–996, <https://doi.org/10.1177/0735633116649375>.

5. Y. L. Reid Chassiakos, J. Radesky, D. Christakis, et al., "Children and Adolescents and Digital Media," *Pediatrics* 138, no. 5 (2016): e20162593, <https://doi.org/10.1542/peds.2016-2593>.
6. A. Craft, "Childhood in a Digital Age: Creative Challenges for Educational Futures," *London Review of Education* 10, no. 2 (2012): 173–190, <https://doi.org/10.1080/14748460.2012.691282>.
7. T. Rose, M. Barker, C. M. Jacob, et al., "A Systematic Review of Digital Interventions for Improving the Diet and Physical Activity Behaviors of Adolescents," *Journal of Adolescent Health* 61, no. 6 (2017): 669–677, <https://doi.org/10.1016/j.jadohealth.2017.05.024>.
8. K. E. Champion, B. Parmenter, C. McGowan, et al., "Effectiveness of School-Based eHealth Interventions to Prevent Multiple Lifestyle Risk Behaviours Among Adolescents: A Systematic Review and Meta-Analysis," *Lancet Digital Health* 1, no. 5 (2019): 206–221, [https://doi.org/10.1016/S2589-7500\(19\)30088-3](https://doi.org/10.1016/S2589-7500(19)30088-3).
9. P. W. C. Lau, E. Y. Lau, D. P. Wong, and L. Ransdell, "A Systematic Review of Information and Communication Technology-Based Interventions for Promoting Physical Activity Behavior Change in Children and Adolescents," *Journal of Medical Internet Research* 13, no. 3 (2011): e48, <https://doi.org/10.2196/jmir.1533>.
10. G. R. do Amaral e Melo, F. de Carvalho Silva Vargas, C. M. dos Santos Chagas, and N. Toral, "Nutritional Interventions for Adolescents Using Information and Communication Technologies (ICTs): A Systematic Review," *PLoS One* 12, no. 9 (2017): e0184509, <https://doi.org/10.1371/journal.pone.0184509>.
11. E. B. Hekler, S. Michie, M. Pavel, et al., "Advancing Models and Theories for Digital Behavior Change Interventions," *American Journal of Preventive Medicine* 51, no. 5 (2016): 825–832, <https://doi.org/10.1016/j.amepre.2016.06.013>.
12. A. Brigden, E. Anderson, C. Linney, et al., "Digital Behavior Change Interventions for Younger Children With Chronic Health Conditions: Systematic Review," *Journal of Medical Internet Research* 22, no. 7 (2020): e16924, <https://doi.org/10.2196/16924>.
13. T. Webb, J. Joseph, L. Yardley, and S. Michie, "Using the Internet to Promote Health Behavior Change: A Systematic Review and Meta-Analysis of the Impact of Theoretical Basis, Use of Behavior Change Techniques, and Mode of Delivery on Efficacy," *Journal of Medical Internet Research* 12, no. 1 (2010): e4, <https://doi.org/10.2196/jmir.1376>.
14. S. Michie and M. Johnston, "Behavior Change Techniques," in *Encyclopedia of Behavioral Medicine*, ed. M. D. Gellman and J. R. Turner (Springer, 2013), 182–187, https://doi.org/10.1007/978-1-4419-1005-9_1661.
15. S. Michie, M. Richardson, M. Johnston, et al., "The Behavior Change Technique Taxonomy (v1) of 93 Hierarchically Clustered Techniques: Building an International Consensus for the Reporting of Behavior Change Interventions," *Annals of Behavioral Medicine* 46, no. 1 (2013): 81–95, <https://doi.org/10.1007/s12160-013-9486-6>.
16. I. Ajzen, "The Theory of Planned Behavior," *Organizational Behavior and Human Decision Processes* 50, no. 2 (1991): 179–211, [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T).
17. I. Ajzen, "From Intentions to Actions: A Theory of Planned Behavior," in *Action Control: From Cognition to Behavior*, ed. J. Kuhl and J. Beckmann (Springer, 1985), 11–39, https://doi.org/10.1007/978-3-642-69746-3_2.
18. F. Taj, M. C. A. Klein, and A. van Halteren, "Digital Health Behavior Change Technology: Bibliometric and Scoping Review of Two Decades of Research," *Journal of Medical Internet Research Mhealth and Uhealth* 7, no. 12 (2019): 13311, <https://doi.org/10.2196/13311>.
19. M. Amir-Behghadami and A. Janati, "Population, Intervention, Comparison, Outcomes and Study (PICOS) Design as a Framework to Formulate Eligibility Criteria in Systematic Reviews," *Emergency Medicine Journal* 37, no. 6 (2020): 387, <https://doi.org/10.1136/emermj-2020-209567>.

20. M. J. Page, J. E. McKenzie, P. M. Bossuyt, et al., "The PRISMA 2020 Statement: An Updated Guideline for Reporting Systematic Reviews," *BMJ* 372 (2021): n71, <https://doi.org/10.1136/bmj.n71>.
21. J. A. C. Sterne, J. Savović, M. J. Page, et al., "RoB 2: A Revised Tool for Assessing Risk of Bias in Randomised Trials," *BMJ* 366 (2019): 14898, <https://doi.org/10.1136/bmj.14898>.
22. R. Bannink, S. Broeren, E. Joosten-van Zwanenburg, E. van As, P. van de Looij-Jansen, and H. Raat, "Effectiveness of a Web-Based Tailored Intervention (E-health4Uth) and Consultation to Promote Adolescents' Health: Randomized Controlled Trial," *Journal of Medical Internet Research* 16, no. 5 (2014): e143, <https://doi.org/10.2196/jmir.3163>.
23. K. W. Cullen, D. Thompson, C. Boushey, K. Konzelmann, and T. A. Chen, "Evaluation of a Web-Based Program Promoting Healthy Eating and Physical Activity for Adolescents: Teen Choice: Food and Fitness," *Health Education Research* 28, no. 4 (2013): 704–714, <https://doi.org/10.1093/her/cyt059>.
24. S. de Josselin Jong, M. Candel, D. Segaar, H. P. Cremers, and H. de Vries, "Efficacy of a Web-Based Computer-Tailored Smoking Prevention Intervention for Dutch Adolescents: Randomized Controlled Trial," *Journal of Medical Internet Research* 16, no. 3 (2014): e82, <https://doi.org/10.2196/jmir.2469>.
25. J. L. Chen, S. Weiss, M. B. Heyman, B. Cooper, and R. H. Lustig, "The Efficacy of the Web-Based Childhood Obesity Prevention Program in Chinese American Adolescents (Web ABC Study)," *Journal of Adolescent Health* 49, no. 2 (2011): 148–154, <https://doi.org/10.1016/j.jadohealth.2010.11.243>.
26. H. Muzaffar, D. M. Castelli, J. Scherer, and K. Chapman-Novakofski, "The Impact of Web-Based HOT (Healthy Outcomes for Teens) Project on Risk for Type 2 Diabetes: A Randomized Controlled Trial," *Diabetes Technology & Therapeutics* 16, no. 12 (2014): 846–852, <https://doi.org/10.1089/dia.2014.0073>.
27. T. Baranowski, J. Baranowski, D. Thompson, et al., "Video Game Play, Child Diet, and Physical Activity Behavior Change: A Randomized Clinical Trial," *American Journal of Preventive Medicine* 40, no. 1 (2011): 33–38, <https://doi.org/10.1016/j.amepre.2010.09.029>.
28. G. Rees, S. Bakhshi, A. Surujlal-Harry, M. Stasinopoulos, and A. Baker, "A Computerised Tailored Intervention for Increasing Intakes of Fruit, Vegetables, Brown Bread and Wholegrain Cereals in Adolescent Girls," *Public Health Nutrition* 13, no. 8 (2010): 1271–1278, <https://doi.org/10.1017/s1368980009992953>.
29. J. F. M. Scheerman, K. Hamilton, M. O. Sharif, U. Lindmark, and A. H. Pakpour, "A Theory-Based Intervention Delivered by an Online Social Media Platform to Promote Oral Health Among Iranian Adolescents: A Cluster Randomized Controlled Trial," *Psychology & Health* 35, no. 4 (2020): 449–466, <https://doi.org/10.1080/08870446.2019.1673895>.
30. M. B. M. R. Inhulsen, V. Busch, and M. M. van Stralen, "Effect Evaluation of a School-Based Intervention Promoting Sleep in Adolescents: A Cluster-Randomized Controlled Trial," *Journal of School Health* 92, no. 6 (2022): 550–560, <https://doi.org/10.1111/josh.13175>.
31. D. A. Williamson, H. M. Walden, M. A. White, et al., "Two-Year Internet-Based Randomized Controlled Trial for Weight Loss in African-American Girls," *Obesity* 14, no. 7 (2006): 1231–1243, <https://doi.org/10.1038/oby.2006.140>.
32. D. Thompson, T. Baranowski, J. Baranowski, et al., "Boy Scout 5-a-Day Badge: Outcome Results of a Troop and Internet Intervention," *Preventive Medicine* 49, no. 6 (2009): 518–526, <https://doi.org/10.1016/j.ypmed.2009.09.010>.
33. S. M. Sliotmaker, M. J. M. Chinapaw, J. C. Seidell, W. van Mechelen, and A. J. Schuit, "Accelerometers and Internet for Physical Activity Promotion in Youth? Feasibility and Effectiveness of a Minimal Intervention," *Preventive Medicine* 51, no. 1 (2010): 31–36, <https://doi.org/10.1016/j.ypmed.2010.03.015>.
34. J. J. Smith, P. J. Morgan, R. C. Plotnikoff, et al., "Smart-Phone Obesity Prevention Trial for Adolescent Boys in Low-Income Communities: The ATLAS RCT," *Pediatrics* 134, no. 3 (2014): e723–e731, <https://doi.org/10.1542/peds.2014-1012>.
35. H. P. Cremers, L. Mercken, M. Candel, H. de Vries, and A. Oenema, "A Web-Based, Computer-Tailored Smoking Prevention Program to Prevent Children From Starting to Smoke After Transferring to Secondary School: Randomized Controlled Trial," *Journal of Medical Internet Research* 17, no. 3 (2015): e59, <https://doi.org/10.2196/jmir.3794>.
36. R. Whittemore, S. Jeon, and M. Grey, "An Internet Obesity Prevention Program for Adolescents," *Journal of Adolescent Health* 52, no. 4 (2013): 439–447, <https://doi.org/10.1016/j.jadohealth.2012.07.014>.
37. T. Bech-Larsen and A. Grønhoj, "Promoting Healthy Eating to Children: A Text Message (SMS) Feedback Approach," *International Journal of Consumer Studies* 37, no. 3 (2013): 250–256, <https://doi.org/10.1111/j.1470-6431.2012.01133.x>.
38. M. J. Babic, J. J. Smith, P. J. Morgan, et al., "Intervention to Reduce Recreational Screen-Time in Adolescents: Outcomes and Mediators From the 'Switch-Off 4 Healthy Minds' (S4HM) Cluster Randomized Controlled Trial," *Preventive Medicine* 91 (2016): 50–57, <https://doi.org/10.1016/j.ypmed.2016.07.014>.
39. M. I. Hombrados-Mendieta, L. Gomez-Jacinto, J. M. Dominguez-Fuentes, P. Garcia-Leiva, and M. Castro-Travé, "Types of Social Support Provided by Parents, Teachers, and Classmates During Adolescence," *Journal of Community Psychology* 40, no. 6 (2012): 645–664, <https://doi.org/10.1002/jcop.20523>.
40. A. Bandura, *Social Foundations of Thought and Action: A Social Cognitive Theory* (Prentice-Hall, 1986), 617.
41. J. O. Prochaska and C. C. DiClemente, "The Transtheoretical Approach," in *Handbook of Psychotherapy Integration*, 2nd ed., ed. J. C. Norcross and M. R. Goldfried (Oxford University Press, 2005), 147–171, <https://doi.org/10.1093/med:psych/9780195165791.003.0007>.
42. H. de Vries, "An Integrated Approach for Understanding Health Behavior: The I-Change Model as an Example," *Psychology and Behavioral Science International Journal* 2, no. 2 (2017): 555585, <https://doi.org/10.19080/PBSIJ.2017.02.555585>.
43. H. de Vries, M. Dijkstra, and P. Kuhlman, "Self-Efficacy: The Third Factor Besides Attitude and Subjective Norm as a Predictor of Behavioural Intentions," *Health Education Research* 3, no. 3 (1988): 273–282, <https://doi.org/10.1093/her/3.3.273>.
44. H. de Vries and A. N. Mudde, "Predicting Stage Transitions for Smoking Cessation Applying the Attitude-Social Influence-Efficacy Model," *Psychology and Health* 13, no. 2 (1998): 369–385, <https://doi.org/10.1080/08870449808406757>.
45. R. Schwarzer, "Modeling Health Behavior Change: How to Predict and Modify the Adoption and Maintenance of Health Behaviors," *Applied Psychology: An International Review* 57, no. 1 (2008): 1–29, <https://doi.org/10.1111/j.1464-0597.2007.00325.x>.
46. W. J. McGuire, "Input and Output Variables Currently Promising for Constructing Persuasive Communications," in *Public Communication Campaigns*, 3rd ed., ed. R. E. Rice and C. K. Atkin (SAGE Publications, 2001), 22–48, <https://doi.org/10.4135/9781452233260>.
47. M. Campbell, S. V. Katikireddi, A. Sowden, and H. Thomson, "Lack of Transparency in Reporting Narrative Synthesis of Quantitative Data: A Methodological Assessment of Systematic Reviews," *Journal of Clinical Epidemiology* 105 (2019): 1–9, <https://doi.org/10.1016/j.jclinepi.2018.08.019>.
48. J. Popay, H. Roberts, A. Sowden, et al., *Guidance on the Conduct of Narrative Synthesis in Systematic Reviews: A Product From the ESRC Methods Programme* (Lancaster University, 2006), <https://www.lancaster.ac.uk/media/lancaster-university/content-assets/documents/fhm/dhr/chir/NSsynthesisguidanceVersion1-April2006>.

Appendix A

Search Strategy

CINAHL Ultimate (EBSCO)

("digital" OR "digital-based" OR "digital-delivered message*" OR "online" OR "online-based" OR "online-delivered message*" OR "ICT-based" OR "ICT-delivered" OR "internet" OR "internet-based" OR "web" OR "web-based" OR "website*" OR "web site*" OR "telecommunication*" OR "email" OR "e-mail" OR "electronic mail" OR "electronic reminder*" OR "electronic" OR "telephone*" OR "phone*" OR "mobile phone*" OR "cell phone*" OR "cellphone*" OR "cellular phone*" OR "smart phone*" OR "smartphone*" OR "mobile health" OR "mobile technolog*" OR "mhealth" OR "ehealth" OR "text messag*" OR "SMS" OR "short messag* service*" OR "texting" OR "messaging" OR "instant messag*" OR "mobile application*" OR "mobile app*" OR "app*" OR "application*" OR "social networking" OR "social media" OR "facebook" OR "twitter" OR "instagram" OR "snapchat" OR "new media*" OR "electronic media" OR "social marketing" OR "video game*" OR "game*" OR "gaming" OR "hand-held" OR "computer*" OR "software" OR "laptop*" OR "PDA*" OR "personal digital assistan*") AND ("health behaviour*" OR "health behaviour*" OR "healthy behaviour*" OR "healthy behaviour*" OR "behaviour* change*" OR "behaviour* change*" OR "healthy behaviour* change*" OR "healthy behavior* change*" OR "behaviour* response*" OR "healthy behaviour* response*" OR "healthy behavior* response*") AND ("intervention*" OR "intervention studies" OR "intervention study" OR "intervention tool*") AND ("child*" OR "adolescent*" OR "adolescence" OR "teen*" OR "teenager*" OR "preteen*" OR "pre-teen*" OR "preteenager*" OR "pre-teenager*" OR "youth*" OR "young people" OR "young person*") AND ("knowledge" OR "attitude*" OR "belief*" OR "intention*" OR "subjective norm*" OR "efficacy" OR "self-efficacy" OR "motivation*" OR "awareness" OR "perceived awareness") AND ("randomised control* trial*" OR "randomized control* trial*" OR "randomised clinical* trial*" OR "randomized clinical* trial*" OR "cluster randomised control* trial*" OR "cluster randomized control* trial*" OR "cluster randomised clinical trial*" OR "cluster randomized clinical trial*" OR "RCT*" OR "cluster RCT*").

MEDLINE (Ovid)

("digital" OR "digital-based" OR "digital-delivered message*" OR "online" OR "online-based" OR "online-delivered message*" OR "ICT-based" OR "ICT-delivered" OR "internet" OR "internet-based" OR "web" OR "web-based" OR "website*" OR "web site*" OR "telecommunication*" OR "email" OR "e-mail" OR "electronic mail" OR "electronic reminder*" OR "electronic" OR "telephone*" OR "phone*" OR "mobile phone*" OR "cell phone*" OR "cellphone*" OR "cellular phone*" OR "smart phone*" OR "smartphone*" OR "mobile health" OR "mobile technolog*" OR "mhealth" OR "ehealth" OR "text messag*" OR "SMS" OR "short messag* service*" OR "texting" OR "messaging" OR "instant messag*" OR "mobile application*" OR "mobile app*" OR "app*" OR "application*" OR "social networking" OR "social media" OR "facebook" OR "twitter" OR "instagram" OR "snapchat" OR "new media*" OR "electronic media" OR "social marketing" OR "video game*" OR "game*" OR "gaming" OR "hand-held" OR "computer*" OR "software" OR "laptop*" OR "PDA*" OR "personal digital assistan*") AND ("health behaviour*" OR "health behaviour*" OR "healthy behaviour*" OR "healthy behaviour*" OR "behaviour* change*" OR "behaviour* change*" OR "healthy behaviour* change*" OR "healthy behavior* change*" OR "behaviour* response*" OR "healthy behaviour* response*" OR "healthy behavior* response*") AND ("intervention*" OR "intervention studies" OR "intervention study" OR "intervention tool*") AND ("child*" OR "adolescent*" OR "adolescence" OR "teen*" OR "teenager*" OR "preteen*" OR "pre-teen*" OR "preteenager*" OR "pre-teenager*" OR "youth*" OR "young people" OR "young person*") AND ("knowledge" OR "attitude*" OR "belief*" OR "intention*" OR "subjective norm*" OR "efficacy" OR "self-efficacy" OR "motivation*" OR "awareness" OR "perceived awareness") AND ("randomised control* trial*" OR "randomized control* trial*" OR "randomised clinical* trial*" OR "randomized clinical* trial*" OR "cluster randomised control* trial*" OR "cluster randomized control* trial*" OR "cluster randomised clinical trial*" OR "cluster randomized clinical trial*" OR "RCT*" OR "cluster RCT*").

trial*" OR "randomized clinical* trial*" OR "cluster randomised control* trial*" OR "cluster randomized control* trial*" OR "cluster randomised clinical trial*" OR "cluster randomized clinical trial*" OR "RCT*" OR "cluster RCT*").

PubMed

("digital" OR "digital-based" OR "digital-delivered message*" OR "online" OR "online-based" OR "online-delivered message*" OR "ICT-based" OR "ICT-delivered" OR "internet" OR "internet-based" OR "web" OR "web-based" OR "website*" OR "web site*" OR "telecommunication*" OR "email" OR "e-mail" OR "electronic mail" OR "electronic reminder*" OR "electronic" OR "telephone*" OR "phone*" OR "mobile phone*" OR "cell phone*" OR "cellphone*" OR "cellular phone*" OR "smart phone*" OR "smartphone*" OR "mobile health" OR "mobile technolog*" OR "mhealth" OR "ehealth" OR "text messag*" OR "SMS" OR "short messag* service*" OR "texting" OR "messaging" OR "instant messag*" OR "mobile application*" OR "mobile app*" OR "app*" OR "application*" OR "social networking" OR "social media" OR "facebook" OR "twitter" OR "instagram" OR "snapchat" OR "new media*" OR "electronic media" OR "social marketing" OR "video game*" OR "game*" OR "gaming" OR "hand-held" OR "computer*" OR "software" OR "laptop*" OR "PDA*" OR "personal digital assistan*") AND ("health behaviour*" OR "health behaviour*" OR "healthy behaviour*" OR "healthy behaviour*" OR "behaviour* change*" OR "behaviour* change*" OR "healthy behaviour* change*" OR "healthy behavior* change*" OR "behaviour* response*" OR "healthy behaviour* response*" OR "healthy behavior* response*") AND ("intervention*" OR "intervention studies" OR "intervention study" OR "intervention tool*") AND ("child*" OR "adolescent*" OR "adolescence" OR "teen*" OR "teenager*" OR "preteen*" OR "pre-teen*" OR "preteenager*" OR "pre-teenager*" OR "youth*" OR "young people" OR "young person*") AND ("knowledge" OR "attitude*" OR "belief*" OR "intention*" OR "subjective norm*" OR "efficacy" OR "self-efficacy" OR "motivation*" OR "awareness" OR "perceived awareness") AND ("randomised control* trial*" OR "randomized control* trial*" OR "randomised clinical* trial*" OR "randomized clinical* trial*" OR "cluster randomised control* trial*" OR "cluster randomized control* trial*" OR "cluster randomised clinical trial*" OR "cluster randomized clinical trial*" OR "RCT*" OR "cluster RCT*").

ProQuest

("digital" AND "health behaviour* change" AND "health behaviour determinant*" AND "intervention*" AND "child*" AND "adolescent*" AND "randomized control* trial*" AND "cluster randomized control* trial*" AND "RCT" AND "cluster RCT").

Web of Science

("digital" OR "digital-based" OR "digital-delivered message*" OR "online" OR "online-based" OR "online-delivered message*" OR "ICT-based" OR "ICT-delivered" OR "internet" OR "internet-based" OR "web" OR "web-based") AND ("health behaviour*" OR "health behaviour*" OR "healthy behaviour*" OR "healthy behaviour*" OR "behaviour* change*" OR "behaviour* change*" OR "healthy behaviour* change*" OR "healthy behavior* change*" OR "behaviour* response*" OR "healthy behaviour* response*" OR "healthy behavior* response*") AND ("intervention*" OR "intervention studies" OR "intervention study" OR "intervention tool*") AND ("child*" OR "adolescent*" OR "adolescence" OR "teen*" OR "teenager*" OR "preteen*" OR "pre-teen*" OR "preteenager*" OR "pre-teenager*" OR "youth*" OR "young people" OR "young person*") AND ("knowledge" OR "attitude*" OR "belief*" OR "intention*" OR "subjective norm*" OR "efficacy" OR "self-efficacy" OR "motivation*" OR "awareness" OR "perceived awareness") AND ("randomised control* trial*" OR "randomized control* trial*" OR "randomised clinical* trial*" OR "randomized clinical* trial*" OR "cluster randomised control* trial*" OR "cluster randomized control* trial*" OR "cluster randomised clinical trial*" OR "cluster randomized clinical trial*" OR "RCT*" OR "cluster RCT*").

TABLE B1 | Risk of bias of included studies.

Study citation	Domain 1: randomisation process	Domain 2: deviations from intended intervention	Domain 3: missing outcome data	Domain 4: measurement of the outcome	Domain 5: selection of the reported results	Overall judgement
Bannink et al. [22]	Low risk	Some concerns	Low risk	Low risk	Low risk	Some concerns
Cullen et al. [23]	Low risk	Some concerns	Some concerns	Low risk	Low risk	Some concerns
de Josselin de Jong et al. [24]	Low risk	Some concerns	Low risk	Low risk	Low risk	Some concerns
Chen et al. [25]	Low risk	Some concerns	Some concerns	Some concerns	Low risk	Some concerns
Muzaffar et al. [26]	Some concerns	Some concerns	Some concerns	Low risk	Low risk	Some concerns
Baranowski et al. [27]	Some concerns	Some concerns	Low risk	Low ris	Low risk	Some concerns
Rees et al. [28]	Some concerns	Low risk	Some concerns	Low risk	Low risk	Some concerns
Scheerman et al. [29]	Low risk	Some concerns	Low risk	Low risk	Low risk	Some concerns
Inhulsen et al. [30]	Some concerns	Some concerns	Low risk	Low risk	Low risk	Some concerns
Williamson et al. [31]	Low risk	Some concerns	Low risk	High risk	Low risk	High risk
Thompson et al. [32]	Low risk	High risk	Low risk	High risk	Low risk	High risk
Sloutmaker et al. [33]	Low risk	High risk	Low risk	Some concerns	Low risk	High risk
Smith et al. [34]	Low risk	Some concerns	Low risk	High risk	Low risk	High risk
Cremers et al. [35]	Low risk	Some concerns	Low risk	Low risk	Low risk	Some concerns
Whittemore et al. [36]	Some concerns	Some concerns	Low risk	Some concerns	Low risk	Some concerns
Bech-Larsen et al. [37]	Some concerns	Some concerns	Some concerns	Low risk	Low risk	Some concerns
Babic et al. [38]	Some concerns	Some concerns	Low risk	Low risk	Low risk	Some concerns

TABLE C1 | Characteristics of included studies and extracted data.

Quite promising interventions					
Study citation	Study aim/s	Participants, setting/s, and country	Study overview	Health behaviour outcomes/adverse effects	Intervention characteristics
Author/s: Bannink et al. [22] Publication year: 2014 Journal: Journal of Medical Internet Research	Evaluate the effectiveness of two web-based tailored interventions promoting health behaviours related to alcohol consumption, drug use, smoking, and safe sex among adolescents.	Sample size: <i>N</i> = 1256. Ages: 15–16 years. Gender: Males and females. Setting: 12 secondary schools. Country: Netherlands	Study design: Cluster RCT. Intervention Group 1 (IG 1): Received web-based tailored feedback messages, with links to relevant websites for more information on specific topics. Intervention Group 2 (IG 2): Received web-based tailored feedback messages, plus consultation with a school nurse. Control Group (CG): No messages, information, or consultation received.	IG 1 reported using condoms during intercourse (safe sex) more often than the CG (4-month follow-up) (<i>p</i> = 0.001). No significant differences in behaviours related to alcohol consumption, drug use, and smoking between IG 1 and CG at follow-up. No significant differences in behaviours related to safe sex, alcohol consumption, and smoking between IG 2 and CG at follow-up. Negative effect on behaviours related to drug use among adolescent boys in IG 2 compared to the CG at follow-up (<i>p</i> = 0.04).	Behaviour change techniques (BCTs): Shaping knowledge (IG 1 and IG 2). Feedback and monitoring (IG 1 and IG 2). Social support (IG 2). Theoretical basis: Not reported.
Author/s: Cullen et al. [23] Publication year: 2013 Journal: Health Education Research	Evaluate the impact of a web-based program promoting healthy eating and physical activity for adolescents.	Sample size: <i>N</i> = 390. Ages: 12–17 years. Gender: Males and females. Setting: Community. Country: USA	Study design: Randomised clinical trial. Intervention Group (IG): Received access to a website with health information and components that include problem solving, goal setting, action planning, and self-monitoring. Control Group (CG): Received access to a website similar to the intervention website, but without the self-monitoring and problem solving components.	More of the IG reported eating three or more servings of vegetables per day in the past week compared to the CG (8 weeks post-intervention) (<i>P</i> < 0.05). Within-group increases in the IG and CG being physically active at least 60 min per day in the past week (8 weeks post-intervention) (<i>p</i> < 0.001). Within-group decreases in the IG and CG watching television for 3+ hours/day in the past week (8 weeks post-intervention) (<i>p</i> < 0.01). Adverse effects of the intervention not reported.	Behaviour change techniques (BCTs): Shaping knowledge. Goals and planning. Feedback and monitoring. Theoretical basis: Social Cognitive Theory.
Author/s: de Josselin de Jong et al. [24] Publication year: 2014 Journal: Journal of Medical Internet Research	Evaluate the effectiveness of a web-based computer-tailored smoking prevention intervention for Dutch adolescents.	Sample size: <i>N</i> = 897. Ages: 10–20 years. Gender: Males and females. Setting: 83 secondary schools. Country: Netherlands	Study design: Cluster RCT. Intervention Group (IG): Received web-based computer-tailored feedback messages. Control Group (CG): No messages received.	Smoking initiation among adolescents aged 10–20 years in the IG was not significantly lower compared to the CG (6-month follow-up) (<i>p</i> = 0.09). Smoking initiation among adolescents aged 14–16 years in the IG was lower compared to the CG (6-month follow-up) (<i>P</i> = 0.05). Adverse effects of the intervention not reported.	Behaviour change techniques (BCTs): Shaping knowledge. Feedback and monitoring. Goals and planning. Theoretical basis: I-Change Model. Social Cognitive Theory.

TABLE C1 | (Continued)

Author/s: Chen et al. [25] Publication year: 2011 Journal: Journal of Adolescent Health	Examine the efficacy and feasibility of a web-based program promoting healthy lifestyles and weights in Chinese American adolescents.	Sample size: <i>N</i> = 54. Ages: 12–15 years. Gender: Males and females. Setting: Community. Country: USA	Study design: RCT. Intervention Group (IG): Received access to a website with tailored health information and components that include problem solving, goal setting, action planning, and self-monitoring, in addition to social support from parents. Control Group (CG): Received access to a website with general health information, in addition to social support from parents.	Increase in the vegetable and fruit intake in the IG compared to the CG at follow-up (<i>p</i> = 0.001). Increase in physical activity in the IG compared to the CG at follow-up (<i>p</i> = 0.01). Increase in knowledge related to physical activity in the IG compared to the CG at follow-up (<i>p</i> = 0.008). Increase in knowledge related to nutrition in the IG compared to the CG at follow-up (<i>p</i> = 0.001). Adverse effects of the intervention not reported.	Behaviour change techniques (BCTs): Shaping knowledge. Goals and planning. Feedback and monitoring. Social support. Theoretical basis: Transtheoretical Model-Stages of Change. Social Cognitive Theory.
Author/s: Muzaffar et al. [26] Publication year: 2014 Journal: Diabetes Technology and Therapeutics	Compare a passive online learning intervention with an active online learning intervention for school children about food intake and physical activity.	Sample size: <i>N</i> = 181. Ages: 11–14 years. Gender: Males and females. Setting: 3 middle schools. Country: USA	Study design: RCT. Intervention Group (IG): Received access to a website providing health information through interactive features including videos, narrated text, and knowledge/skill-based games. Control Group (CG): Received access to a website providing health information through passive/non-interactive texts.	Significant improvement in outcomes related to planning a meal in the IG compared to the CG post-intervention (<i>p</i> < 0.0001). Significant improvement in exercise outcome expectations in the IG post-intervention (<i>p</i> = 0.001). No significant differences in exercise self-efficacy, weight efficacy lifestyle, and rapid eating between the IG and CG post-intervention. Adverse effects of the intervention not reported.	Behaviour change techniques (BCTs): Shaping knowledge. Theoretical basis: Social Cognitive Theory.
Author/s: Baranowski et al. [27] Publication year: 2011 Journal: American Journal of Preventive Medicine	Evaluate the effectiveness of two video games in improving children's diet and physical activity.	Sample size: <i>N</i> = 133. Ages: 10–12 years. Gender: Males and females. Setting: Community. Country: USA	Study design: Randomised clinical trial. Intervention Group (IG): Received access to two video games that included health education, goal setting, action planning, and problem solving. Control Group (CG): Received access to knowledge-based games on popular websites.	Increased fruit and vegetable intake in the IG compared to the CG post-intervention (<i>p</i> = 0.018). No significant differences in water consumption and physical activity between the IG and CG post-intervention. Adverse effects of the intervention not reported.	Behaviour change techniques (BCTs): Shaping knowledge. Goals and planning. Theoretical basis: Not reported.

TABLE C1 | (Continued)

<p>Author/s: Rees et al. [28]</p> <p>Publication year: 2010</p> <p>Journal: Public Health Nutrition</p>	<p>Evaluate the effectiveness of a computer-generated tailored intervention leaflet in increasing dietary intake of targeted foods in adolescent girls.</p>	<p>Sample size: $N = 823$.</p> <p>Ages: 12–16 years.</p> <p>Gender: Females.</p> <p>Setting: 8 secondary schools.</p> <p>Country: UK</p>	<p>Study design: Cluster RCT.</p> <p>Intervention Group (IG): Received tailored health information and feedback on behaviour via a computer-generated intervention leaflet.</p> <p>Control Group (CG): Received health information via a generic leaflet.</p>	<p>Significant increase in brown bread intake in the IG compared to the CG (3-month follow-up) ($p < 0.05$).</p> <p>No significant differences in fruit, vegetables, and wholegrain cereal intake between the IG and CG (3-month follow-up).</p> <p>Adverse effects of the intervention not reported.</p>	<p>Behaviour change techniques (BCTs): Shaping knowledge. Feedback and monitoring. Theoretical basis: Theory of Planned Behaviour. Translational Model- Stages of Change.</p>
<p>Author/s: Scheerman et al. [29]</p> <p>Publication year: 2020</p> <p>Journal: Psychology and Health</p>	<p>Test the efficacy of a theory-based intervention delivered by an online social media platform to promote oral health among adolescents.</p>	<p>Sample size: $N = 791$.</p> <p>Ages: 12–17 years.</p> <p>Gender: Males and females.</p> <p>Setting: 30 high schools.</p> <p>Country: Iran</p>	<p>Study design: Cluster RCT.</p> <p>Intervention Group 1 (IG 1): Received access to a platform including health education and feedback on behaviour, in addition to action planning and self-monitoring.</p> <p>Intervention Group 2 (IG 2): Received access to a platform including health education and feedback on behaviour, in addition to action planning, self-monitoring, and social support.</p> <p>Control Group (CG): Did not receive any intervention during the experimental phase of the intervention.</p>	<p>Frequency of toothbrushing in IG 1 was significantly higher compared to the CG at follow-up ($p < 0.001$).</p> <p>Frequency of toothbrushing in IG 2 was significantly higher compared to the CG at follow-up ($p < 0.001$).</p> <p>Adverse effects of the interventions not reported.</p>	<p>Behaviour change techniques (BCTs): Shaping knowledge (IG 1 and IG 2). Goals and planning (IG 1 and IG 2). Feedback and monitoring (IG 1 and IG 2). Social support (IG 2). Theoretical basis: Health Action Process Approach.</p>
<p>Author/s: Inhulsen et al. [30]</p> <p>Publication year: 2022</p> <p>Journal: Journal of School Health</p>	<p>Evaluate the effect of a school-based intervention promoting sleep in adolescents.</p>	<p>Sample size: $N = 972$.</p> <p>Ages: 13–15 years.</p> <p>Gender: Males and females.</p> <p>Setting: 10 high schools.</p> <p>Country: Netherlands</p>	<p>Study design: Cluster RCT.</p> <p>Intervention Group (IG): Received interactive assignments, access to a serious game with a reward component, and access to an educational website with a health education component, in addition to feedback on behaviour and social support.</p> <p>Control Group (CG): No intervention received during the trial.</p>	<p>Significant increase in sleep knowledge in the IG compared to the CG post-intervention ($p < 0.05$).</p> <p>Significant improvement in attitude in the IG compared to the CG post-intervention ($p < 0.05$).</p> <p>Significant improvement in perceived behavioural control in the IG compared to the CG post-intervention ($p < 0.05$).</p> <p>No significant differences in subjective norms, behavioural intentions, sleep hygiene, sleep duration, and sleep quality between the IG and CG post-intervention.</p> <p>Adverse effects of the intervention not reported.</p>	<p>Behaviour change techniques (BCTs): Shaping knowledge. Feedback and monitoring. Social support. Reward and threat. Theoretical basis: Theory of Planned Behaviour.</p>

TABLE C1 | (Continued)

Possibly promising interventions				
Study citation	Study aim/s	Participants, setting/s, and country	Study overview	Health behaviour outcomes/adverse effects
Author/s: Williamson et al. [31] Publication year: 2006 Journal: Obesity	Test the efficacy of an Internet-based lifestyle behaviour modification program for African-American girls.	Sample size: $N = 57$. Ages: 11–15 years. Gender: Females. Setting: Community. Country: USA	Study design: RCT. Intervention Group (IG): Received access to a website with components that include health education, problem solving, goal setting, self-monitoring, and feedback on behaviour, in addition to social support. Control Group (CG): Received health education via face-to-face sessions and a website containing links to other health-related websites.	Increase in dieting and weight concerns in the IG at follow-up. Decrease in dieting and weight concerns in the CG (6-month follow-up). Within-group improvements in exercise and overeating in the IG and CG at follow-up ($p < 0.05$). Reduced consumption of fattening foods reported in the IG compared to the CG at follow-up ($p < 0.05$). Adverse effects of the intervention not reported.
				Behaviour change techniques (BCTs): Shaping knowledge. Goals and planning. Feedback and monitoring. Social support. Theoretical basis: Not reported.

TABLE C1 | (Continued)

<p>Author/s: Thompson et al. [32] Publication year: 2009 Journal: Preventive Medicine</p>	<p>Evaluate effects of a combined in-person and Internet-based program promoting fruit juice and low-fat vegetable consumption by boy scouts.</p>	<p>Sample size: N = 473. Ages: 10–14 years. Gender: Males. Setting: Community. Country: USA</p>	<p>Study design: RCT. Intervention Group (IG): Received health education and access to a website with components that include problem solving, goal setting, self-monitoring, and reward, in addition to in-person support. Control Group (CG): Received a separate intervention.</p>	<p>Significant increase in fruit juice consumption in the IG compared to the CG (9 weeks post-intervention) ($p = 0.003$). Significant increase in availability of fruit juice at home in the IG compared to the CG (9 weeks post-intervention) ($p = 0.009$). Significant increase in self-efficacy related to low-fat vegetable consumption in the IG compared to the CG (9 weeks post-intervention) ($p = 0.004$). Adverse effects of the intervention not reported.</p>	<p>Behaviour change techniques (BCTs): Shaping knowledge. Goals and planning. Feedback and monitoring. Social support. Reward and threat. Theoretical basis: Social Cognitive Theory.</p>
<p>Author/s: Slootmaker et al. [33] Publication year: 2010 Journal: Preventive Medicine</p>	<p>Evaluate the effectiveness and feasibility of an intervention that promotes physical activity among adolescents.</p>	<p>Sample size: N = 87. Ages: 13–17 years. Gender: Males and females. Setting: Secondary schools. Country: Netherlands</p>	<p>Study design: RCT. Intervention Group (IG): Received access to a website with tailored health behaviour advice and feedback, and components that include goal setting and self-monitoring. Control Group (CG): Received a single written information brochure with brief general health behaviour recommendations.</p>	<p>Increased moderate intensity physical activity of females in the IG compared to the CG (3-month follow-up) ($p = 0.04$). Reduced sedentary time of males in the IG compared to the CG (8-month follow-up) ($p = 0.04$). Beneficial intervention effect on self-efficacy to participate in sports in males ($p = 0.04$). Detrimental intervention effect on intention to participate in sports in females ($p = 0.01$).</p>	<p>Behaviour change techniques (BCTs): Shaping knowledge. Goals and planning. Feedback and monitoring. Theoretical basis: Not reported.</p>
<p>Author/s: Smith et al. [34] Publication year: 2014 Journal: Paediatrics</p>	<p>Evaluate the impact of an obesity prevention intervention using smartphone technology for adolescent boys.</p>	<p>Sample size: N = 361. Ages: 12–14 years. Gender: Males. Setting: 14 secondary schools. Country: Australia</p>	<p>Study design: Cluster RCT. Intervention Group (IG): Received health information and access to a website and smartphone application with components that include goal setting and self-monitoring, in addition to social support. Control Group (CG): Received regularly scheduled school sports and physical education lessons.</p>	<p>Reduced screen-time in the IG compared to the CG (8-month follow-up) ($p = 0.03$). Reduced sugar-sweetened beverage consumption in the IG compared to the CG (8-month follow-up) ($p = 0.01$). No significant difference in moderate to vigorous physical activity between the IG and CG (8-month follow-up). No adverse effects of the intervention reported.</p>	<p>Behaviour change techniques (BCTs): Shaping knowledge. Goals and planning. Feedback and monitoring. Social support. Theoretical basis: Self-Determination Theory. Social Cognitive Theory.</p>

TABLE C1 | (Continued)

Non-promising interventions					
Study citation	Study aim/s	Participants, setting/s, and country	Study overview	Health behaviour outcomes/adverse effects	Intervention characteristics
Author/s: Creemers et al. [35] Publication year: 2015 Journal: Journal of Medical Internet Research	Evaluate if computer-tailored feedback messages, with and without prompt messages, were effective in decreasing children's smoking intentions and smoking behaviour.	Sample size: N = 3213. Ages: 10–12 years. Gender: Males and females. Setting: Primary schools. Country: Netherlands	Study design: Cluster RCT. Intervention Group 1 (IG 1): Received 3 computer-tailored feedback messages via email and an intervention website. Intervention Group 2 (IG 2): Received 3 computer-tailored feedback messages and 6 prompt messages via email and SMS to use the intervention website. Control Group (CG): No feedback or prompt messages received during the intervention periods.	No significant difference in smoking intentions between IG 1 and CG at follow-up. No significant difference in smoking behaviour between IG 1 and CG at follow-up. No significant difference in smoking intentions between IG 2 and CG at follow-up. No significant difference in smoking behaviour between IG 2 and CG at follow-up. Adverse effects of the interventions not reported.	Behaviour change techniques (BCTs): Shaping knowledge (IG 1 and IG 2). Feedback and monitoring (IG 1 and IG 2). Theoretical basis: Not reported.
Author/s: Whittemore et al. [36] Publication year: 2013 Journal: Journal of Adolescent Health	Compare the effectiveness of two school-based obesity prevention programs for adolescents.	Sample size: N = 384. Ages: 14–17 years. Gender: Males and females. Setting: 3 high schools. Country: USA	Study design: Randomised clinical trial. Intervention Group (IG): Received access to a website with components that include health education, problem solving, goal setting, and self-monitoring, in addition to social support, feedback on behaviour, and coping skills training. Comparison Group (CG): Received access to a website with components that include health education, problem solving, goal setting, and self-monitoring, in addition to social support and feedback on behaviour.	No significant difference in health behaviour outcomes between the IG and CG at follow-up. No significant difference in self-efficacy between the IG and CG at follow-up. Adverse effects of the intervention not reported.	Behaviour change techniques (BCTs): Shaping knowledge. Goals and planning. Feedback and monitoring. Social support. Theoretical basis: Social Learning Theory.

TABLE C1 | (Continued)

<p>Author/s: Bech-Larsen et al. [37] Publication year: 2013 Journal: International Journal of Consumer Studies</p>	<p>Assess if a nutrition program, with and without a short message service (SMS)-based diary and feedback procedure, increases the fruit and vegetable intake of adolescents.</p>	<p>Sample size: $N = 256$. Age: 12 years. Gender: Males and females. Setting: 12 schools. Country: Denmark</p>	<p>Study design: RCT. Intervention Group (IG): Received health education from a health professional, activities promoting goal setting and self-monitoring, and feedback on behaviour via SMS. Control Group (CG): Received health education from a health professional.</p>	<p>No significant difference in fruit intake between the IG and CG post-intervention. No significant difference in vegetable intake between the IG and CG post-intervention. Adverse effects of the intervention not reported.</p>	<p>Behaviour change techniques (BCTs): Shaping knowledge. Goals and planning. Feedback and monitoring. Theoretical basis: Not reported.</p>
<p>Author/s: Babic et al. [38] Publication year: 2016 Journal: Preventive Medicine</p>	<p>Evaluate the efficacy of an intervention to reduce recreational screen-time in adolescents.</p>	<p>Sample size: $N = 322$. Age: 14 years. Gender: Males and females. Setting: 8 secondary schools. Country: Australia</p>	<p>Study design: Cluster RCT. Intervention Group (IG): Received health information and education to set goals and self-monitor screen-time, health messages from social media and messaging systems, and social support and rewards/consequences. Control Group (CG): Received usual school curriculum.</p>	<p>No significant difference in screen-time between the IG and CG (6 months post-intervention). No significant difference in physical activity between the IG and CG (6 months post-intervention). Adverse effects of the intervention not reported.</p>	<p>Behaviour change techniques (BCTs): Shaping knowledge Goals and planning Feedback and monitoring Social support Reward and threat Theoretical basis: Self-Determination Theory</p>