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Title: Implementation at-scale of school-based physical activity interventions: A systematic review utilizing the RE-AIM framework

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Conflict of Interest Statement

The authors declare that there are no competing conflicts of interest.

Abstract

School-based interventions can increase young people's physical activity levels, but few are implemented at-scale (i.e., the expanded delivery of efficacious interventions under real-world conditions into new/broader populations). The RE-AIM (Reach, Effectiveness, Adoption, Implementation, and Maintenance) framework can be used to describe the extent to which interventions have been implemented at-scale. The aim of our review was to determine the extent to which studies of school-based physical activity interventions implemented at-scale reported information across the RE-AIM dimensions.

We conducted a systematic search of seven electronic databases to identify studies published up to June 2019. A total of 26 articles (representing 14 individual studies) met the inclusion criteria and were analyzed. Eleven studies reported actual or estimated number of students exposed to the intervention, however the representativeness of these students was rarely reported. Nine studies reported the intervention effect on the primary outcome during scale-up. Ten studies reported the rate of participating schools/teachers, however none reported on the characteristics of adopters/non-adopters. Eight studies reported intervention fidelity. Eleven studies described the extent to which the intervention was sustained in schools. There was considerable variability in the reporting of RE-AIM outcomes across studies. There is a need for greater consistency in the evaluation, and reporting of, school-based physical activity interventions implemented at-scale.

Introduction

Physical inactivity has been described as a global pandemic, due to its prevalence, global reach, social, economic and health consequences.¹ Of concern, only 20% of children and adolescents globally² acquire the recommended level of aerobic physical activity (i.e., 60 minutes moderate-to-vigorous physical activity [MVPA] each day).³ International guidelines also recommend young people (5-17 years) engage in muscle-strengthening activities on at least three days per week,³ but available data suggest only 13-54% of adolescents meet this guideline.⁴⁻⁶ Evidence also suggests there have been global secular declines in young people's cardiorespiratory⁷ and muscular fitness (MF).⁸⁻¹⁰ Cardiorespiratory fitness is associated with a host of physical¹¹, psychological^{11,12} and cognitive health¹¹ benefits for children and adolescents. The health benefits associated with maintaining adequate MF are also compelling, with improvements in adiposity,^{13,14} bone health,^{11,13,14} and self-esteem.¹⁴ Evidently, both components of fitness are important predictors of health status, now and into the future.^{15,16} As such, youth interventions to increase participation in physical activity of sufficient volume and intensity to improve fitness, are needed. Schools are considered ideal settings to promote physical activity and fitness in adolescent populations, as most have the facilities, curriculum, staff and equipment to deliver health promotion interventions.¹⁷ As such, schools are well placed to help youth develop the skills, knowledge and confidence needed to sustain an active lifestyle beyond the schooling years.¹⁸

Findings from previous systematic reviews have demonstrated that multi-component school-based interventions can increase physical activity (predominantly measured using self-report) in child and adolescent populations.^{19,20} However, effect sizes are typically much smaller when physical activity is measured using accelerometers (e.g., less than 2 minutes of MVPA/day).²¹ In addition, effect sizes are larger in efficacy studies, compared to effectiveness trials, which are often characterised by poor intervention implementation

79 fidelity.²² These mixed findings highlight the challenges of school-based physical activity
80 research and the need to improve study design, conduct and reporting. Comprehensive school
81 physical activity programs (CSPAPs), also known as ‘whole-of-school’ programs, have been
82 identified as one of the eight investments that work for physical activity promotion in
83 youth.²³⁻²⁵ CSPAPs provide opportunities for students to be active during physical education
84 (PE), recess breaks, curricular time (i.e., through energizer breaks/cross-curricular physical
85 activity integration), and before- and after-school (i.e., through active
86 transportation/organized activities/programs). When comparing to single component
87 interventions (i.e., those delivered in PE only), CSPAPs have the advantage of offering a
88 suite of activity opportunities across the school day. The Physical Activity For Everyone
89 (PA4E1) program was one such effective CSPAP, which resulted in improved physical
90 activity behaviors of students.²⁶ However, despite their potential, implementing CSPAPs can
91 be challenging, and they require considerable support from educational authorities, teachers,
92 parents, and the community.²⁷ This challenge is evident within the literature, with few
93 CSPAPs,²⁴ or school-based interventions in general,²⁸ progressing beyond the pilot, efficacy,
94 or effectiveness stages. Successful school-based physical activity interventions need to be
95 implemented at-scale to have population health benefits.²⁹ However, the dynamic nature of
96 the education system presents a potential challenge for researchers when implementing
97 interventions at-scale, as there are many factors influencing decisions made by teachers,
98 executive staff, and policy makers.^{30,31} When scaling up, this challenge becomes even more
99 complex, with increases in the numbers of participating schools, staff and students, and as
100 intervention contexts become more varied (i.e., geographic locations, socio-demographic
101 characteristics etc.).³² The scarcity of translational research may be linked to the slow pace of
102 translating research into practice,³³ as well as the numerous barriers that exist. Within

schools, these barriers include lack of resources, time, priority of the intervention/policy, support, and teacher knowledge/skills.³⁴

The RE-AIM (Reach, Effectiveness, Adoption, Implementation and Maintenance) Framework^{35,36} was developed to evaluate the public health impact of interventions.³⁵ The dimensions of RE-AIM include: (1) **R**each into the target population, (2) **E**ffectiveness in changing health outcomes, (3) rate of **A**doption in delivery settings, (4) degree of **I**mplementation as intended and related costs, and (5) **M**aintenance of health outcome changes and implementation of the intervention over time.^{35,36} When considering the context of scaling up school-based physical activity interventions, RE-AIM provides outcomes that address student benefit (i.e., intervention reach into the student population, initial effectiveness in changing physical activity, and longer-term maintenance of improved physical activity levels) and setting factors that operationalize scale-up (i.e., rate of intervention adoption and representativeness among schools and teachers), quality and cost of delivery (i.e., degree to which school intervention strategies are implemented as intended, and related costs of implementation), and sustainability (i.e., school and teacher maintenance of implementation of intervention strategies).

Nearly two decades ago, Estabrooks and colleagues³⁷ applied the RE-AIM framework to the assessment of existing information on dissemination, implementation, effectiveness, and sustainability of school-based interventions that had targeted physical activity, nutrition, and tobacco use. Previous studies have reported well on aspects of internal validity, but did not on issues related to external validity, such as the representativeness of students and schools. It is important that information related to representativeness of the population, at the individual- (i.e., reach) and setting-level (i.e., adoption) are reported.^{38,39} At the individual-level this allows for the comparison of students who participated in the program, to those who were eligible but did not participate in program.^{38,39} Likewise, at the setting-level,

128 representativeness is determined by comparing characteristics of schools that adopted the
129 program, to those that could have, but did not.^{38,39} The collection of this data may help
130 maximise participation by utilizing strategies to better reach target populations.^{38,39}
131 Additionally, costs related to potential broad dissemination or scale-up were not well-
132 reported. Since then, a number of researchers have conducted scaled-up school-based
133 physical activity interventions.⁴⁰⁻⁴³ Previous reviews focused on physical activity
134 interventions implemented at-scale have looked at parent and school administrator data to
135 report implementation outcomes.^{44,45} Specifically, these reviews examined the extent to
136 which implementation and health outcomes were related⁴⁵ and the availability of survey
137 instruments to assess reach, adoption, implementation, and sustainability.⁴⁴ While both of
138 these reviews provided important conclusions for the scale up of physical activity
139 interventions in schools – better implementation results in better health outcomes⁴⁵ and there
140 is a paucity of survey measures for dissemination and implementation outcomes – neither
141 provided information on the degree to which the body of literature included information
142 across dissemination, implementation, and sustainability outcomes.^{44,45} A third review
143 reported on barriers/facilitators to adoption, implementation and sustainability of school-
144 based physical activity interventions,⁴⁶ as well as describing the implementation models
145 utilized. However, this review did not include an assessment of adoption, implementation,
146 and sustainability outcomes. Understanding how school-based physical activity scale-up
147 studies report across RE-AIM dimensions is needed to advance our understanding of the
148 representativeness of the findings, strategies to improve dissemination (reach and adoption),
149 implementation, and sustainability, and factors related to external validity that could provide
150 important information needed translate evidence-based physical activity interventions into a
151 broad and representative range of schools. Therefore, the aim of our review was to determine

the degree to which school-based physical activity interventions implemented at-scale reported on the five RE-AIM domains.

Methods

This review was prospectively registered with PROSPERO (CRD42017059836) and adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.⁴⁷

Information sources and selection of studies

Following consultation with an academic librarian, a structured electronic search of all publication years (through June 2019) using ProQuest (Education Database, ERIC, ProQuest Central), EBSCOHost (Academic Search Ultimate, CINAHL Complete, Education Research Complete, Psychology and Behavioral Sciences Collection, SPORTDiscus), Informit (A+ Education), OVID (EMBASE, MEDLINE, PsycInfo), PubMed, Web of Science and SCOPUS databases was conducted to review and assess RE-AIM components within disseminated/translated/scaled-up (hereafter referred to collectively as disseminated) school-based physical activity programs. See Appendix A for search terms. These strings were also limited to the title and/or abstract of publications written in English, with full-text available.

Study inclusion and exclusion criteria

Eligible studies were those that evaluated a disseminated school-based physical activity intervention. For the purposes of this review, we defined a disseminated school-based physical activity intervention as: ‘research that evaluated a scaled-up physical activity intervention or program that had been adopted by a state, district or county education board/department and made available to schools serviced by that board/department’. The full study eligibility criteria were as follows: 1) dissemination study (as defined above); 2) participants were school-aged children and/or adolescents (4-18 years) OR their

177 teachers/school staff members OR their parents; 3) a focus of the intervention/program was
178 the promotion of MVPA or health-related fitness components (i.e., strength, cardiorespiratory
179 fitness); 4) the intervention was primarily implemented within the school setting (not
180 externally from the school grounds, requiring students/teachers to travel); and 5) the article
181 reported on findings that fit within the scope of at least one of the RE-AIM components.
182 Studies were excluded if: 1) they were from conference abstracts, dissertations, or theses; 2)
183 they were a pilot/feasibility, efficacy, or effectiveness trial (i.e., not a dissemination study as
184 per the definition above, see ‘study design’ for excluded articles in Figure 1); 3) the
185 intervention/program was not delivered primarily in the school setting; 4) they were not
186 published in English; or 5) there was no full text available (following email to corresponding
187 author). Interventions delivered within a before- or after-school care programs and those
188 promoting active travel to/from school were excluded. Although such programs are important
189 components CSPAPs, they often differ qualitatively from interventions delivered during the
190 school day (i.e., during PE or curricular time). For example, interventions targeting the
191 before- and after-school periods are often delivered by external providers, and service
192 specific groups of students. By contrast, interventions delivered during school time are most
193 commonly delivered by school staff, and typically target a more representative group of the
194 student population. Similarly, active travel interventions do not necessarily take place on
195 school grounds, during school time. For the purposes of comparability and generalizability,
196 we decided to focus our review on a narrower category of intervention types. Interventions
197 delivered within early childhood centers or preschools were also excluded.

198 Following the electronic database search, duplicates of articles were deleted. Two
199 reviewers (SK and TS) independently assessed the title and abstracts of articles identified in
200 the search process for suitability. The full-text of articles identified as potentially eligible
201 were retrieved and independently assessed for eligibility by two reviewers (SK and TS) based

on the inclusion/exclusion criteria. All disagreements were discussed in depth, and resolved via consensus with a third reviewer (JS) when required. The reference lists of the retrieved full-text articles were searched, for any additional articles of interest (see Figure 1, study flow).

Data extraction strategy

Data extraction was performed by one reviewer (SK) and checked for accuracy by a second reviewer (TS). Key study characteristics were extracted, including: country of origin, size and setting of study population, study design, age of participants, intervention description, delivery method, physical activity/fitness outcomes, and length of intervention (Table 1). A description of each intervention is presented in Table 2. RE-AIM has been utilized as the basis for data extraction tools in systematic literature reviews.⁴⁸ The tool has been previously validated,⁴⁹⁻⁵³ with a number of authors conducting systematic reviews using the RE-AIM framework as a guide.^{28,35,37,49,50,52-60} RE-AIM framework components were extracted from individual papers, then grouped by intervention, to show reporting on each of the dimensions (Table 3).

RE-AIM assessment of dissemination reporting and quality

More recently, the RE-AIM criteria for conducting literature reviews,⁴⁸ which has been previously validated,⁴⁹⁻⁵³ was adapted for the school setting and utilized to extract data, across 20 factors representing RE-AIM reporting guidelines, from the included studies (Table 4). Two reviewers (SK and TS) independently assessed the included articles using the checklist. Each item on the scale was coded as ‘explicitly described and present’ (1), ‘absent’ (0) or ‘unclear or inadequately described’ (?). As has been done previously,⁵² using the 20 item checklist (Table 4), RE-AIM reporting quality was assessed based on tertile cut-points of reporting 15–20, 8–14, or 0–7 dimensions reflecting high, moderate, and low quality, respectively. For interventions where multiple publications were included, publications were

given an individual score, as well as an overall intervention score (for all included publications) to provide a complete assessment for the intervention. Initial inter-rater reliability was determined using Cohen's κ , showing high agreement 95.4% ($\kappa = 0.91$). RE-AIM assessment of dissemination reporting and quality are presented in Table 5.

Results

The final review included 26 articles representing 14 distinct interventions (see Figure 1).

Figure 1. Flow of studies through the systematic review process

Study Characteristics

Study characteristics are presented in Table 1. Briefly, studies were conducted in the United States (N=10), Australia (N=1), Canada (N=1), New Zealand (N=1), and the Netherlands (N=1). Sample sizes were presented as number of students (range: 210 to 1,000,000), teachers (range: 9 to 1,200), or schools (range: 2 to 1,060). All interventions, except one,^{61,62} were multi-component.

RE-AIM results

Outcome data from each of the RE-AIM domains is presented in Table 3, and described below.

Reach. All but one study⁶³ (93%) reported on at least one element of intervention reach into the student population. In general, reach was poorly described, with limited information provided on the number of students involved. Methods to identify the study population were reported by only seven articles⁶⁴⁻⁷⁰ (from five unique studies; 36%). However, methods were targeted more towards school-level recruitment (i.e., signifying adoption had occurred), rather than identification of included students. These methods included email invitations,⁶⁴ invitations to all schools (and subsequently, their enrolled students) within a certain area,^{65,67,68} certain regions being targeted due to poor physical education,⁶⁹ or a previously unexplored population.⁶⁶ Inclusion and/or exclusion criteria specific to students were not reported by any studies (0%). Student sample size (i.e., number of students exposed to the intervention) was reported in 11 interventions (79%). These data were reported as total number of students^{61,71-74} or students per school.^{64-66,69} Other studies estimated the number of students, either within a community,⁷⁵ or by approximating the number of students based on teacher workshop enrollments^{43,76} or number of schools involved.^{70,77-79} Studies reporting student reach had sample sizes ranging from 210⁶¹ to one million students.⁷⁶ Participation rate was reported by two interventions (14%), and was 51%⁷³ and 100%.⁷⁵ Seven interventions

261 reported on the characteristics of participants (50%), with students from city and rural
 262 schools^{64,65} and low-income areas.^{65,69,75,80} Students' ethnicity was reported within seven
 263 articles^{65,66,69,71,72,80,81}. Despite the reporting of characteristics of included students, studies
 264 did not mention whether they were representative of the entire eligible student population.
 265 *Effectiveness.* Twenty articles, from 12 studies reported on changes in the primary outcome
 266 from the current or a prior version of the study. Of these, 13 articles from nine studies (64%)
 267 reported on changes in the primary outcome during the current study.^{40,61,66,67,69-73,78,80-82}
 268 Whilst seven articles from six studies (43%) alluded to intervention efficacy/effectiveness
 269 being evaluated in past versions of the study (i.e., a randomized controlled trial that preceded
 270 dissemination/translation).^{41,43,64,68,74,79,83}. Two included studies (14%) did not refer to current
 271 or past changes in primary outcome/s.^{63,75} Primary outcomes included aerobic capacity,⁸²
 272 MVPA^{69,78,81} and the proportion of students achieving ≥ 60 minutes MVPA each day.^{73,80} Step
 273 counts and activity during the school day significantly increased,⁶¹ with a 10% increase
 274 during physical education shown in one study,⁶⁶ however no difference in class activity was
 275 reported.⁴⁰ Other measures included the number of days played outdoors and participation in
 276 organized physical activity,⁷¹ number of opportunities for, and total physical activity during
 277 the day,⁶⁷ fitness test scores,⁷² and knowledge regarding physical activity.⁷⁰ Intention-to-treat
 278 analysis and study retention, were not reported in any of the articles (0%).
 279 *Adoption.* Half of the studies (50%) reported a description of the program location.^{40,41,64-}
 280 ^{67,69,73,75,78,79,83} Staff delivering the program were described in six articles^{41,63,69,75,76,79} from
 281 four studies (29%), with only one study (7%) reporting the method to identify staff that were
 282 intended to implement the intervention strategies.⁷⁶ Only six articles^{41,64,69,76,82} from four
 283 studies (29%) reported the level of expertise of the implementation staff. Levels of expertise
 284 varied amongst studies, with generalist^{73,82} and PE^{69,76} teachers utilized, as well as the school
 285 Principal.⁶⁴ In two other studies, teachers with varied expertise contributed to intervention

delivery.^{41,64} Four studies reported the denominator of those trained (29%), to provide information on the number of intended staff that adopted the intervention.^{43,66,67,69,76,77,79} Rate of participating/non-participating schools was reported by the majority of studies, with 10 (71%) reporting this information at the school/teacher level in at least one associated publication.^{40,41,43,64-67,69-71,73,74,77-83} No studies compared the characteristics of schools/staff that adopted the intervention and those that did not.

Implementation. All but one⁷² of the included studies reported information related to program implementation (93%). The number/duration of intervention contacts/sessions was reported by six of the included studies.^{61,70,73,75,79,80} This was reported as total number of sessions per day⁶¹ or year,^{70,75,80} as well as the percentage of teachers delivering some^{70,79} or all of the intended sessions.⁷³ Intervention fidelity was reported by eight studies (57%).^{40,41,63,64,68,70,73,75,78-81,83} This was reported in a number of ways, including the percentage/number of included teachers/schools that had implemented major intervention components,^{63,64,68,73,74,78-80} the percentage/number of lessons which included program components/materials,^{40,41,61,70,79-81} and the degree of implementation.^{70,73,83} Degree of implementation was collected through audit of lesson⁷³ and self-reported scoring based on a checklist.^{70,83} One study stated that only activities that could be easily integrated without much time or effort were implemented.⁶³ Cost of the intervention and its delivery was reported by only one article (7%),⁶⁹ and was an approximation.

Maintenance. Reporting of outcomes being sustained ≥ 6 -months post-intervention was limited, with only four studies including this data (29%). Outcomes included improved aerobic capacity,⁸² increased levels of MVPA,^{69,83} and continuation of fitness data collection.⁷² Whether or not the intervention was still in place at time of publication (i.e., the intervention was still being delivered, or there were plans to continue delivering it) was reported by 11 of the 14 studies (79%). This was reported as a percentage of schools/teachers

delivering the intervention after the initial implementation period (i.e., a second time around, number of years later),^{40,41,43,62,64,72,74,81} teacher reports of intention to continue delivery,^{62,70,75} and reordering of program materials.⁷³ Reporting on the institutionalization of the intervention was limited, with eight articles^{40,41,64,66,70,75,78,79,81} from six studies reporting this data (49%). The acceptance of the intervention and its components as regular school practice^{64,70,79} and teacher evaluation,⁷⁵ follow-up support from the research/intervention team,⁶⁶ continued funding,^{78,81} and being a former intervention school⁴⁰ were noted as reasons promoting institutionalization.

Study Quality

Study quality was assessed utilising the checklist presented in Table 4, with findings offered in Table 5. Only one study,^{41,66,69,76} scored high on the RE-AIM reporting checklist, with seven moderate, and six scoring in the low quality category.

Discussion

The aim of this systematic review was to determine the degree to which school-based physical activity interventions implemented at-scale, reported on the five dimensions of RE-AIM. We identified 14 school-based physical activity interventions that have been implemented at-scale, described via 26 included articles. Of these studies, the majority contained multiple components, which included components such as: teacher training, playground markings, and equipment packs to schools. Included programs were delivered in a variety of ways, such as through enhanced physical education, activity breaks, or lesson time. We observed considerable variability in the methods used to report RE-AIM outcomes in the included studies. There is a need to improve the consistency of reporting for interventions delivered at-scale, to allow for future success of programs. We offer key suggestions and examples on how researchers may accomplish this, in Supplemental Table 1.

Reach is an essential inclusion and an important indicator of impact, as the goal of this type of study is to bridge the research/practice gap and to provide maximum access to efficacious programs at-scale. The inclusion of reach data within this review, reported to some extent in all but one study⁶³ is promising, however, some improvements are necessary. It is important that studies have measures in place to ensure there is capacity to calculate potential and/or actual reach into the population. One way to do so is to determine the participation rate of eligible individuals, which was lacking from studies in this review, as only two studies reported participation rate of students, ranging from 51%⁷³ to 100%.⁷⁵ Lack of reporting of participation rate may also be due to the nature of most scale-up interventions; the implicit intent is that all students in the schools will be exposed to the intervention. This may be true for some interventions (e.g., CSPAPs) but not for others (e.g., interventions that rely on teacher training, adoption, and implementation). Also, the determination of a valid denominator is difficult when assessing participation/non-participation.

Our review aligns with others examining interventions on health behaviors—there is a tendency of researchers to focus on internal validity at the exclusion of understanding generalizability—this includes understanding the representativeness of students in participating schools.^{28,37,53,55,84} Improvements are needed in the reporting of the participation rate, along with explanations for non-participation, as well as if the characteristics of students (i.e., location, socio-economic status [SES]) may have impacted their participation. A potential method to better assess representativeness of students is to examine differences in student population characteristics based on a comparison of students from schools that adopt to those attending schools that do not adopt an intervention. Ideally, questionnaires would be distributed to participating students and would include demographic characteristics. However, if this is not possible (often the case when delivering at-scale), the utilisation of school demographic and enrollment data, such as is available in Australia⁸⁵ may be one

useful way to determine reach. This data allows for researchers to compare student demographics from schools that did, and did not adopt the program (i.e., may the varying student populations across schools have impacted their adoption and delivery of the program). This data may then be compared with state and/or national level demographic census data, to further assess the representativeness of students attending adopting/non-adopting schools.

For the current review, both efficacy and effectiveness data were included under the ‘effectiveness’ dimension. A recent review⁸⁶ introduced four stages of scaling up: (i) development, (ii) efficacy testing, (iii) real-world trial, and (iv) dissemination.⁸⁶ Combinations of these four stages represent four pathways to scale-up, referred to as: (i) comprehensive, (ii) efficacy omitter, (iii) trial omitter, and (iv) at-scale dissemination. ‘Comprehensive’ trials go through all four stages,⁸⁶ whereas the ‘efficacy omitters’ progress to a large real-world (effectiveness) trial without prior efficacy testing.⁸⁶ In the ‘trial omitter’ pathway, dissemination of an intervention immediately follows an efficacy study (no effectiveness trial).⁸⁶ Finally, ‘at-scale dissemination’ trials progress directly from development to widespread rollout.⁸⁶ As such, for trials following the ‘trial omitter’ pathway, effectiveness data is not available as only efficacy testing occurred prior to at-scale dissemination. Conversely, ‘efficacy omitters’ collect only effectiveness data prior to at-scale delivery, without completing prior efficacy testing. If either of these trial types were to refer to past efficacy/effectiveness, the presented data will depend on what pathway was taken, and what type of trial precluded at-scale dissemination. However, for the purpose of this review, data from both trial types (i.e., efficacy and effectiveness) were reported under the RE-AIM umbrella dimension of ‘*Effectiveness*’.

Reporting of ‘effectiveness’ varied across studies. While a number of studies collected outcome data as part of the implementation at-scale study (i.e., hybrid

effectiveness-implementation trials),⁸⁷ others reported the efficacy findings from an earlier trial. As the goal of these school-based interventions was to increase students' physical activity levels and fitness, reporting of effectiveness is important, across all research phases (i.e., efficacy, effectiveness and implementation at-scale). Those that infer efficacy/effectiveness from previous studies, should ensure that the decision to scale-up and disseminate an intervention be based on robust evidence of its effectiveness. This is in part due to the common phenomenon of a 'voltage drop' when an intervention progresses from piloting through to efficacy, effectiveness, to dissemination.^{88,89} 'Voltage drop' refers to a reduction in intervention effectiveness as it moves into real-world settings with little or no support from the research team. Relying on past effectiveness data may not take into account a possible 'scale-up penalty', due to adaptations to the intervention in the new delivery setting.⁸⁸ However, there are a number of challenges in the measurement of effectiveness data in interventions evaluated at-scale. Researchers will generally require more feasible, yet potentially less valid measures. For example, within efficacy and effectiveness studies, researchers may use accelerometry to objectively assess student MVPA and also include a brief self-report measure of MVPA. In the next phase of research (i.e., implementation at-scale), it is unlikely to be feasible to assess physical activity using accelerometers. Researchers may decide to only use the brief self-report measure, or alternatively, may use accelerometers in a sub-sample of students. Additionally, we encourage researchers to report standardized effect sizes⁸⁸ across all phases of research. The reporting of these effect sizes would allow not only for the calculation of the magnitude of effect,⁹⁰ but also provide a standardized score that can be compared to past studies.

Testing for effectiveness may not be a priority when scaling-up physical activity interventions, when the assumption is that the school system has adopted an effective program based on earlier research. During this research phase other implementation outcomes

such as feasibility, acceptability, and appropriateness are more relevant.⁹¹ It is particularly important to assess the effectiveness of interventions that have progressed directly from development to delivery at-scale (e.g., Exercise Your Options program).⁷³ In these instances, we recommend that the intervention be evaluated during dissemination, using feasible methods, such as online surveys and apps, to ensure the program is indeed effective at improving outcomes. This approach aligns with a hybrid type 3 effectiveness implementation trial⁸⁷ where the primary outcome is implementation quality with a secondary outcome of intervention effectiveness. Important in this methodology is that the indicator of effectiveness, which may not be of research grade, be practical and hold face validity for the school systems conducting the evaluation.

Adoption includes criteria such as the number and representativeness of organizations (schools) adopting the intervention, and the percentage of schools delivering the program within a district, state, or country where the intervention is available. In a previous review, adoption was reported poorly, with only seven of 27 articles reporting this data.⁴⁶ Within the current review, data pertaining to adoption and school participation rates were reported effectively. This finding may indicate that the methods employed by the respective research teams was effective and would be a useful guide for prospective studies. It is important for researchers to present this information to provide future studies with an insight into recruitment and training methods to maximize potential uptake of the program. However, information related to non-adopters was limited. As was discussed for *Reach*, there is a need to collect, assess and analyze any available data from non-participants (such as school and teacher characteristics) to determine if these may have bearing on access to, and adoption of the intervention.³⁹ Future studies may benefit from assessing available school-level data to determine differences between schools who do, and do not adopt the program.⁸⁵ Additionally, the incorporation of qualitative assessment, such as interviews with teachers classified as

adopters and non-adopters are warranted. The provision of information on program location is also necessary, as this provides an insight into the potential adaptability of a program for other areas (as they may have a similar/differing SES, population density, cultural makeup).

Within this review, the reporting of staff delivering the program, as well as information regarding the delivery agent was limited. This may in part be due to the nature of the studies, and the delivery within the school setting, as the literature shows that teachers assume the role of the delivery agent in the majority of school-based physical activity interventions.²⁰ A recent review showed that teacher training is included in the majority of school-based physical activity interventions.⁹² The importance of teacher training (i.e., attending a professional learning workshop) was highlighted in two articles from the Action Schools! BC study.^{43,79} Teachers who had attended at least one training session were almost twice as likely to deliver the program, compared to those that had not.⁷⁹ As such, it is likely that receiving teacher training is an important predictor of adoption. Reporting this number, along with the number that have begun delivering the program, will provide information on the acceptability of the program for schools, and give researchers an insight into what types of factors within training may be promoting program adoption.

Implementation was reported poorly for the number/duration of intervention sessions and the cost of delivery and cost criteria, and moderately for delivery as intended. However, it was interesting to find that some studies^{63,64,68,73,74,78-80} reported implementation with a slight adoption focus. These articles reported on a percentage of teachers/schools (which would imply adoption) that had implemented some/all of the intervention components. This would suggest that the level of adoption and implementation varied across schools, between teachers and their respective classes. In some instances, this may highlight that adaptations have been made to the intervention or implementation processes, which may or may not compromise session quality. This compromise may lead to a decrease in effectiveness

(‘voltage drop’)^{88,89} or negative outcomes for students. However, there is also the potential for adaptations to improve student outcomes if the changes are more acceptable for teachers and schools.⁹³ Scaling-up in the school setting must allow for a ‘thoughtful balance’ between planning for desired outcomes while adapting to contextual and environmental constraints.^{94,95} Past research in school settings has shown considerable variability in implementation quality.⁹⁶ Future research would benefit from improved reporting of the true pool of potential participants/schools, dosage, adherence, quality of process, and adaptation.⁹⁷

In the review conducted by Cassar and colleagues⁴⁶ a similar lack of implementation reporting was noted, with just over half of included studies reporting implementation (note the outcomes reported here were different). Without knowledge on implementation being gathered, it is difficult to ascertain if what teachers are delivering is meeting the minimum threshold to improve physical activity and/or fitness outcomes. As noted in previous research^{45,98} outcomes are linked with the level of implementation. An important implementation measure evident in a few studies was the utilisation of lesson observations to evaluate implementation fidelity,^{67,69,73} an inclusion that may be useful for future studies aiming to improve implementation reporting. The lack of reporting of costs (estimated in only one article)⁶⁹ associated with intervention delivery is something that must be highlighted, and addressed in future studies. Cost is one of eight implementation outcomes suggested by Proctor and colleagues⁹⁹ as well as one of 10 implementation determinants included within the evaluation roadmap penned by McKay et al.¹⁰⁰ Both articles^{99,100} describe cost as encompassing both the intervention and the associated implementation strategies, with cost noted as the second most important indicator within the Delphi rounds conducted for McKay’s roadmap.¹⁰⁰ Cost has bearing on the potential of an intervention to be adopted in the first instance, successful and continue on into the future, at the school and institutional level, so should not be an oversight in future studies.

Maintenance combines parameters of the four preceding elements long-term, looking at lasting change at the individual (reach, effectiveness) and setting (adoption, implementation), as well as whether the intervention has continued to be delivered as intended over the years (maintenance). This element of RE-AIM is synonymous with ‘sustainability’.^{99,100} In a previous review,⁴⁶ maintenance/sustainability aspects were reported by only seven studies, which aligns with the poor reporting in the current review. Few studies reported on the assessment of outcomes $\geq$ 6-months after the intervention, and the continuation of the intervention and institutionalisation were reported in under half of studies. Without improved reporting of these outcomes, it is difficult to determine the true long-term impact of interventions. The long-term success of an intervention hinges on a number of factors, such as multi-sectoral partnerships and embedded knowledge exchange;⁴³ however, there is still more to learn. Future studies should look to ensure they have the capacity to collect maintenance data, to enable for the progression of the field from the lessons they have learnt along the way.

Strengths and limitations

To our knowledge this is the first review focused on the implementation at-scale of school-based physical activity interventions using the RE-AIM framework. Previous reviews targeting scale-up of school based studies have concentrated on CSPAPs²⁴ and on barriers/facilitators to adoption, implementation and maintenance.⁴⁶ This is the first review to focus solely on disseminated (scaled-up) trials, to look at real world impact of the intervention. This review highlights necessary design and reporting improvements needed in future studies, as aligned with RE-AIM, to help progress the field. Despite these strengths, this review is not without limitations. Although the use of RE-AIM was a strength, this did limit our ability to capture additional information for outcomes outside of the RE-AIM dimensions, such as acceptability and adaptability.⁹⁹ Future research would benefit from the

development of a tool to compare and contrasting the outcomes presented within these two frameworks. Another limitation of the present review was our narrow inclusion criteria, which excluded other types of school-based physical interventions (i.e., before/after school programs, active travel initiatives). Such programs form an important part of school-based physical activity promotion, but were beyond the scope of this review.

Conclusions

Only a handful of successful school-based physical activity interventions have been delivered at-scale,^{24,46} and they have reporting varied impact and success. Future school-based physical activity interventions should be designed with dissemination in mind, and be guided by an appropriate framework.⁹⁵ Design and reporting should take into account potential adaptations, as well as identified facilitators and barriers to adoption, implementation and maintenance. Using this thought process during conceptualization and design will increase the likelihood of delivery and success at-scale. Utilising the RE-AIM framework as an evaluation tool may assist researchers and end users to assess factors that may increase ease of delivery and success during program implementation. Scaling up and disseminating interventions that improve physical activity levels is a challenging task, but given the right tools, preparation and delivery, it is feasible and can be done to fight against the pandemic of physical inactivity. We should “*embrace the challenge of taking action to a larger and more sustainable level.*”²⁴ (p. 1345) This review, along with other quality resources,¹⁰¹ may serve as tools for future researchers to identify areas within their design, data collection procedures and reporting practices. This will help ensure that the impact of the intervention can be measured and communicated, to improve future practice.

Appendix A. Search terms

535 The following search strings were used: (“physical activit*” OR fitness OR activ* OR
536 exercis* OR sport OR move*) AND (child* OR adolescen* OR youth OR “young people”
537 OR teen*) AND (school* OR school-based OR education OR “physical education” OR
538 curricul*) AND (interven* OR program* OR trial) AND (disseminat* OR diffus* OR
539 translat* OR scale-up OR scal* OR sustain* OR institution* OR integrat* OR implement*).

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Table 1. Characteristics of included studies

Authors, Year	Name of program	Year/s delivered	Country of origin	N	Setting	Methods	Age of participants	Delivery method	PA/fitness outcome	Length of intervention
Play ZONE	Austin et al, 2011	Began in Term 4, 2006	Australia	8 schools (students ranging from 13-719)	Public primary schools	Mixed methods	Whole of school	Playground line marking and playground game instruction. Delivered via a working group	MVPA via accelerometry, combined with heart rate telemetry (in previous efficacy study)	NR
				50000-100000 students from 497 (95 were programming schools) schools completed FitnessGram measures; there were 184 elementary, 239 middle, and 74 high schools in the final sample.	Elementary, middle and high schools	Quantitative	All years	Online classes and webinars, plus newsletters	Fitnessgram aerobic capacity (PACER or one mile run)	4-week PA challenge; ongoing
				1060 schools (approximately 35 in each of the 32 NFL franchises)	Elementary, middle and high schools	Mixed methods (Focus groups, surveys, Fitnessgram measures)	All ages (i.e., 5-18)	NR	Fitnessgram	NR
NFL Play 60	Bai et al., 2016	2011-2015	USA	1060 schools (approximately 35 in each of the 32 NFL franchises)	Elementary, middle and high schools	Quantitative - pre-post within teacher design was used to address the	Elementary school age	PE	MVPA	2 years
SPARK & FIT	Belansky et al., 2016	2011-2013	USA	17 schools participated with approximately 3803	Elementary schools (rural, low income)	Quantitative - pre-post within teacher design was used to address the	Elementary school age	PE	MVPA	2 years

					students (224 students per school on average; data from 22 teachers)		research questions posed in this study				
	Dowda et al., 2005	SPARK PE	Began in summer 1994	USA	277 schools that had adopted SPARK; surveys sent to 233. Evaluation occurred in 111 schools from 7 states	Elementary schools	Teacher surveys	Originally grades 3-6, but extended to include K-2 during the diffusion stage	PE	PA and components of physical fitness	1 year
	McKenzie et al., 2009	SPARK	Dissemination from 1994 to 2009	USA	Potentially 1 million students	Upper elementary and middle schools	Workshop attendance numbers	Upper elementary and middle school students	PE	PA during PE, physical fitness	Generally a 4-week program
	Nigg et al., 2017	SPARK Northern Mariana Islander adaptation	2007-2008	USA	Fourteen elementary, four junior high, and five senior high schools	Schools (elementary to senior high)	Workshop evaluations (rating and qual comments), program evaluations, class observations	All grades (K-12)	PE	Walking and vigorous activity during lesson time (pedometers, SOFIT)	One year
	Bice et al., 2014	CATCH - Factors influencing implementation	Past 6 years (i.e., 2008-2013)	USA	284 employees from 36 schools	Elementary schools from 16 counties in rural southern Illinois	Quantitative - teacher level data	Elementary school employees (i.e., teachers and administrators)	Throughout the school day (i.e, PEand other classes)	PA	NR
CATCH & adaptations	Heath et al., 2002	CATCH - El Paso	1998-2000	USA	24 schools (20 CATCH)	Elementary schools	Mixed methods (Observation,	Students in grades 3-5	Within PE	MVPA during PE using the System for	3-year outcome and process

				schools, 4 controls)		interviews, process evaluation)	and their teachers		Observing Fitness Instruction Time (SOFIT) was used in all schools to objectively assess the quantity and quality of PE.	evaluation of 4 cohorts, varied intervention lengths
Heath et al., 2003	CATCH - El Paso	1997-2002	USA	108 elementary schools	Elementary schools	Mixed methods (Observation, interviews, process evaluation)	Students in grades 3-5 and their teachers	Within PE	MVPA in PE and self-report PA	NR
Hoelscher et al., 2004	CATCH Institutionalisation	1998-1999 - 5 years post CATCH main trial	USA	88 schools (56 former intervention, 20 former comparison, 12 unexposed control)	Elementary schools	Questionnaires assessing implementation, staff questionnaires, SOFIT (645 lessons observed)	Students in grades 3-5 and their teachers	Within PE	MVPA in PE	NR
Hoelscher et al., 2001	CATCH dissemination	1998 onwards	USA	728 schools	Elementary schools	Program purchase data, training attendance data	Students in grades 3-5 and their teachers	Within PE	MVPA in PE	NR
Hoelscher et al., 2010	CATCH Travis County	2007-2008	USA	15 schools	Elementary schools	Student questionnaires, SOFIT observations	4th grade students	Within PE	MVPA in PE, self-report PA behaviours	3-years, this paper present 2-year interim results

MA-CORD	Blaine et al., 2017	MA-CORD project - Adaptation of 'Eat Well and Keep Moving' and 'Planet Health'	2012-2014	USA	5144 students	Elementary and middle schools in 2 low income school districts	Mixed methods	4 th through 7 th grade	Within lesson time	PA	3 years
HLCK	Chomitz et al., 2010	Healthy Living Cambridge Kids	2004-2007	USA	1,858 K-5th grade children participated from 12 schools	Elementary schools	Quantitative	Kindergarten – 5 th grade	Enhanced PE	Fitness: endurance cardiovascular test; abdominal strength test; flexibility test; upper body strength test; and an agility test.	3 years
MTI	Dunn et al., 2012	Move-To-Improve	Began in 2010	USA	1200 teachers from 160 schools trained to deliver MTI; 39 included within this evaluation	Elementary schools	Lesson observations	K-3 grade teachers and their students	Fitness breaks	Observed classroom PA	NR
EYO	Dunton et al., 2009	Exercise Your Options	2006-2007 school year	USA	Sixteen classes (N = 683 students and 16 teachers) sampled from the statewide pool who used the program	Middle schools	Program records, classroom observations, teacher and student surveys	Grade 6-9 (mean age of those included in the evaluation was 12.47 years)	Additional curriculum	Self-reported days per week of 60 minutes of PA	8 lessons

Take 10!												
Goh et al., 2014	Take 10!	2012	USA	210 students and 9 teachers from three 3rd grade, three 4th grade, and three 5th grade classes	Elementary schools	Quantitative	Students in grades 3-5 and their teachers	Within lesson time	Students' daily PA levels was measured by pedometers. Accelerometers were used in a subsample of students	12-weeks (8-weeks of intervention)		
Goh et al., 2017	Take 10!	NR	USA	Fifteen classroom teachers from two schools (including the 9 from the Goh et al., 2014 study)	Elementary schools	Qualitative	Teachers of students in grades 3-5	Within lesson time	Students' daily PA levels was measured by pedometers. Accelerometers were used in a subsample of students	12-weeks (8-weeks of intervention)		
Masse et al., 2012	Action Schools! BC	Dissemination occurred in 2004-2005, data collected 4 years later	Canada	133 schools (122 principals (92% response rate) and 599 of 850 Grade 4-7 teachers (71% response rate) completed an online survey.	Elementary and middle schools (grades 4-7)	Cross-sectional multistage survey for principals and teachers (of grades 4-7)	Principals and teachers of students in grades 4-7	Activity breaks	PA and fitness (in efficacy & effectiveness trials)	Ongoing		
Action Schools! BC												
McKay et al., 2015	Action Schools! BC	Implementation after scaling up (2008-2009)	Canada	Approximately 500000 students	Elementary and middle schools (grades K-7)	Varied methods from the efficacy, effectiveness and implementation trials	Student and teacher data from the 3 program phases	Activity breaks	PA and fitness (in efficacy & effectiveness trials)	Ongoing		

Pathways	Page-Reeves et al., 2013	Pathways - Participatory Action for Healthy Lifestyle	2002	USA	5 schools	Elementary schools	Qualitative - interviews and surveys	Elementary school students	Exercise breaks	Increased PA	NR
Healthy Choices	Peterson et al., 2015	Healthy Choices	2004-2007, but evaluation only for the 2005-2006 school year	USA	45 schools	Middle schools (7 th grade)	Student surveys	7 th grade students	The interdisciplinary curriculum incorporated intervention messages into core school subjects such as language arts, math, social sciences as well as into PE classes	School-level percent of students achieving PA target.	3 years
Project .	Rush et al., 2016	Project Energise	2004-2006 RCT	New Zealand	302 schools, including 53375 students	Primary school	Mixed methods	Primary school students	Throughout the school day	550m run time	2 years
DOiT	Van Nassau et al., 2014	DOiT	2011 onwards	The Netherlands	1486 students from 29 schools	Prevention al schools	Self-report questionnaire	12-14 year olds	NR	Self-report PA behaviour (sport participation, active transport to school)	20 months
	Van Nassau et al., 2016	DOiT	2011 onwards	The Netherlands	20 schools (110 teachers and 938 students)	Prevention al schools	Student and teacher questionnaires	12-14 years old students and their teachers	NR	Self-report PA behaviour (sport participation, active transport to school)	20 months

847 Abbreviations: BC, British Columbia; CATCH, formerly Child and Adolescent Trial for Cardiovascular Health now Coordinated Approach to Child Health; K,
848 kindergarten; DOiT, Dutch Obesity Intervention in Teenagers; MA-CORD, Massachusetts Childhood Obesity; Research Demonstration; MTI, Move-To-
849 Improve; MVPA, moderate-to-vigorous physical activity; NFL, National Football League; NR, not reported; PA, physical activity; PACER, Progressive

850 Aerobic Cardiovascular Endurance Run; PE, physical education; SOFIT, System for Observing Fitness Instruction Time; SPARK, Sports, Play, and Active
851 Recreation for Kids; USA, United States of America.

Table 2. Description of included interventions

	Intervention description	Intervention type
Play Zone	Main intervention components included painted playground line-markings, a playground games manual, supportive playground play equipment (e.g., balls and skipping ropes), and an active peer leader training manual. In addition, as part of the adoption process, schools and students were given the task of renaming and rebranding the intervention, giving them a sense of ownership and buy-in for the project.	Multi-component
NFL Play 60	Provides a Teacher Guide that includes ideas, tips, and directions about how to implement a 4-week PA Challenge in school and how to engage students. Supplemental materials are also available, including Student Game Planner for students to track their PA minutes; online Trackers for teachers to track their students' PA minutes; online platform where the enrolled school can compete with other schools across the country; fun and creative ways to promote the 4-week PA Challenge; more than 60 subject-based lesson plans; over 100 PA breaks and homework assignments; take home resources for parents; and ideas on how to incorporate PA in the classroom. Teachers in the network received training on the effective use of the FitnessGram program through online classes and webinars, as well as through content provided in monthly eNewsletters. Teachers also got access to FitnessGram manuals, DVDs, and onsite training, which makes it challenging to specifically document the overall dose of training that was provided and received. Teachers were encouraged to implement various NFL PLAY 60 programs to promote PA in youth and to enhance their school wellness programming. As part of their involvement in the network, schools were asked to assess their student's fitness each year and to enter the data through the web-based FitnessGram software.	Multi-component
	The NFL PLAY 60 programs include a variety of resources for schools, including the PLAY 60 Challenge and Fuel Up to Play 60. The PLAY 60 Challenge is funded by the NFL Foundation, facilitated by American Heart Association. The challenge is a 4-week physical activity tracking log that includes teacher guidelines and resources with physical activity challenges and suggestions. Fuel Up to Play 60 (FUTP60) is funded by the National Dairy Council and the NFL and is facilitated by GenYouth. FUTP60 is a capacity-building program that focuses on healthy eating and physical activity. Numerous resources are available for teachers, and participating schools have the opportunity to apply for grant funding up to \$4,000 per year.	
SPARK and adaptations	Healthy Eaters, Lifelong Movers had 2 components: PE Academy and Assess, Identify, Make it Happen ("AIM"). AIM component - a strategic planning process used in schools to increase student opportunities for physical activity and healthy eating by implementing evidence-based environment and policy practices. PE Academy component - SPARK curriculum and equipment, workshops, and site coordinator support. SPARK PE was designed to encourage health-related PE by maximizing physical activity participation during class to improve students' fitness, skills, and enjoyment. Main program components were an active PE curriculum, staff development, and on-site support. The PE curriculum was designed as a practical resource for both classroom teachers and	Multi-component

	<p>PE specialists, and it provided developmentally appropriate yearly unit and lesson plans. Each lesson included two types of class activities: (a) health-related fitness activities targeted the development of muscular strength and endurance, cardiovascular endurance, flexibility, and locomotor and non-locomotor skills; and (b) skill-related fitness activities targeted the development of generalizable manipulative and sport-related skills.</p> <p>The SPARK program was developed for PE and classroom teachers and is designed to provide substantial opportunities for all children to actively engage in movement. It aims to develop a variety of basic motor and manipulative skills, such as throwing, catching, and kicking, and then progresses in skill and integration of both fine and gross motor activities. It also develops positive social skills and the ability to get along with others by reinforcing ideas such as sharing equipment and demonstrating cooperative behavior. Finally, SPARK focuses on developing and maintaining acceptable levels of physical fitness through increased moderate to vigorous PA. The goal of SPARK is to increase participation in activities and personal physical skill levels, while increasing PA confidence and promoting positive PA and health attitudes.</p>	
CATCH and adaptations	<p>CATCH is a multifaceted program that addresses the increasing trend of childhood obesity, focusing physical activity and nutrition. CATCH has evolved into a program widely used and recognized primarily on as a school health standard in many parts of the United States. CATCH is a voluntary school health program and requires additional effort from school employees to implement.</p> <p>The original CATCH program began in 1986 with Phase I, which was a 3.5-year feasibility study implemented at four study centers: San Diego, California; New Orleans, Louisiana; Minneapolis, Minnesota; and Austin, Texas. Phase II (1991 to 1994) included 5,106 3rd graders at 96 schools in the four study centers. A total of 24 schools at each study center were randomly assigned to one of the following conditions: (a) 10 control schools, (b) 7 intervention schools that received only the school-based interventions, and (c) 7 intervention schools that received both the school-based interventions and the family programs. The CATCH Institutionalization Study was conducted to determine the level of institutionalization of the CATCH program in former intervention and comparison schools by measuring the extent to which the CATCH school-level goals for levels of moderate to vigorous activity in PE classes, as well as the extent to which CATCH classroom lessons were implemented in the former CATCH intervention and comparison schools. This report describes the institutionalization of the CATCH program 5 years after the end of the main research trial. Institutionalization was measured by the routine use of the CATCH program components and achievement of CATCH main trial school-level goals 5 years after the completion of the main trial. The Travis County CATCH team updated the original CATCH curriculum to reflect the 2005 US Dietary Guidelines, as well as targeting sedentary activity (e.g., television viewing), which has been linked to obesity prevention. Specific behavioral objectives were included: (i) to increase moderate-to-vigorous PA in students, in school PE and activity breaks as well as at home; (ii) to decrease sedentary activity, specifically television viewing; (iii) to increase fruit and vegetable consumption; (iv) to decrease sugar-sweetened beverage consumption; (v) to increase consumption of CATCH GO foods; and (vi) to encourage healthy meal patterns, such as breakfast consumption.</p>	Multi-component
MA-CORD	<p>MA-CORD was a multilevel, multisector intervention to prevent or control obesity among children in 2 low-income communities in Massachusetts with greater-than-average prevalence of childhood obesity relative to national estimates. The</p>	Multi-component

	MA-CORD school intervention consisted of evidence-based components: teacher training, curriculum delivery, use of wellness champions (e.g., school nurses, teachers), provision of physical activity supplies (e.g., balls, jump ropes), and educational materials (e.g., flyers, banners).	
Healthy Living Cambridge Kids	At the school level, PE policies, systems, and programs were implemented at all schools similarly to improve access to appealing, appropriate physical activity opportunities for all children; school stakeholders were trained to implement new guidelines and policies; and PE programs such as Project Adventure and ballroom dancing. PE enhancement grants offered professional development for PE teachers and new gymnasium equipment in all schools. At the individual- and family level, strategies and policies were designed to increase the awareness of children and their families of each student's health risk due to their fitness test scores, and to provide skills and resources for addressing individual and family health risks and lifestyle choices through school-based family nights.	Multi-component
MTI	Teachers attended a 3-hour MTI workshop held after school or on weekends. At the workshop, an MTI trainer discussed childhood obesity and the importance of physical activity, reviewed the MTI manual, led them through 17 of the 30 MTI fitness breaks, and asked teachers to discuss how they could adapt lessons to their classrooms. Teachers received 1) a manual detailing 30 fitness breaks; 2) equipment kits including polyvinyl spot markers used to help children identify personal space, bean bags, scarves, and 2 CDs; and 3) a professional development stipend.	Multi-component
Exercise Your Options	The program consisted of an eight-lesson student activity booklet and supportive video clips, provided on DVD/CD-ROMs and through a Web site. A teacher's guide that contains lesson plans and instructions was provided. The physical activity lesson asked students to complete activity charts and identify how they can substitute sedentary activities (e.g., watching TV, playing video games) with activities of greater intensity.	Multi-component
Take 10!	The TAKE 10! classroom-based, PA promotion curriculum developed by the International Life Sciences Institute Center for Health Promotion was added as an intervention program to increase students' PA during the school day. TAKE 10! is a movement-integrated activity program that teaches children the importance of PA and energy balance while integrating PA into classroom lessons. Academic areas within TAKE 10! that integrate movement and learning include language arts, math, science, social studies, and general health. Specifically, this program consists of a variety of 10-minute activities that include an exercise, cool down period, and a series of questions related to health and nutrition. The TAKE 10! program consists of a variety of 10-min physical activities that are integrated into academic lessons, specifically language arts, math, science, social studies, and general health.	Single component
Action Schools! BC	Unlike most other interventions, ASI/BC is not curriculum-based, nor is it delivered exclusively in PE. Rather, the model emphasizes that teachers take small physical activity breaks throughout the school day, in addition to providing scheduled PE. This provided generalist teachers the opportunity to deliver active classroom breaks whether or not they had support from a PE specialist at their schools. ASI/BC is a comprehensive school health-based model providing teachers and schools with training and resources to integrate physical activity (PA) into the school environment. To achieve student-level health outcomes, we targeted the school environment using a comprehensive whole school model. There are six Action Zones within the ASI/BC model and	Multi-component

	the features of the delivery model were: a local school action team, tools to foster creation of individualised school action plans (planning and resource guides), an ASI BC central support team, a local ASI BC school facilitator and classroom action bins containing equipment and resources for providing in-class PA and promoting healthy living.	
Pathways	Physical activity enhancements - not described in detail.	Multi-component
Healthy Choices	Schools developed a multi-disciplinary team and implemented an obesity prevention curriculum, before and after school activities, environmental and policy changes and health promotions targeting participation in > 1 hours/day of physical activity (PA) on most days. Program components were: 1) Planet Health interdisciplinary curriculum, 2) before- and after-school activities, 3) environmental and policy assessment and changes, 4) school-wide health promotion campaign, and 5) development of a multidisciplinary implementation team, including a school HC coordinator.	Multi-component
Project Energise	Underlying the programme are nine healthy eating goals and seven PA goals that have remained in place since the inception of the programme. Wording has changed slightly to incorporate the adaptations made to various national initiatives, such as the National Heart Foundation School Food Programme and Active Schools campaign. The programme is aligned with government food, nutrition and PA guidelines and therefore works alongside and with other agencies such as the Heart Foundation. All messages and activities delivered by oral, written and demonstration modes through the programme are composed in ways to be clear, concise and consistent across all intervention components and can be mapped to the programme goals.	Multi-component
DOiT	The DOiT-implementation programme consisted of 12 fixed theory lessons and four physical education lessons (i.e., 16 lessons equally divided over two school years) and three optional lessons. The lessons in the first year aimed at increasing awareness and knowledge of EBRBs. The lessons in the second year focused on increasing awareness and acting upon the influence of the (obesogenic) environment. The parental component focused on increasing social support of the parents and on raising awareness of the availability and accessibility of healthy products and activities in the home environment. We developed materials and a few programme activities to improve parental engagement: an information booklet, homework assignments that adolescents needed to conduct with their parents, information for parents on the DOiT website and an optional parents' meeting. The DOiT class room materials included a 'schoolbook' accompanied by worksheets and a student toolkit (pedometer, food/exercise diary and an online computer-tailored advice).	Multi-component
	DOiT is a school-based obesity prevention program for 12- to 14-year-olds. The program targets both sides of the energy balance equation (energy intake and energy expenditure) in order to prevent overweight and obesity in adolescents. The initial program was developed and evaluated in 2002–2006. In 2009, the program was adapted, consisting of 12 fixed theory lessons and four physical education (PE) lessons (i.e. 16 lessons equally divided over 2 school years), three optional lessons and a parental component. The lessons in the first year aimed at increasing awareness and knowledge of EBRBs and to induce behavioral changes concerning EBRBs in order to prevent obesity in adolescents. The lessons in the second year focused on increasing awareness and coping mechanisms for the influence of the obesogenic environment. The parental	

	component focused on increasing social support of the parents and on raising awareness of the availability and accessibility of healthy products and activities in the home environment. The DOI _T materials included a ‘schoolbook’ accompanied by worksheets, a student toolkit (pedometer, food/exercise diary and online computer-tailored advice) and a parental information booklet.	
853	Abbreviations: AS ₁ BC, Action Schools ₁ ; BC, BC, British Columbia; CATCH, formerly Child and Adolescent Trial for Cardiovascular Health now Coordinated	
854	Approach to Child Health; DOI _T , Dutch Obesity Intervention in Teenagers; MA-CORD, Massachusetts Childhood Obesity; Research Demonstration; MTL,	
855	Move-To-Improve; MVP _A , moderate-to-vigorous physical activity; NFL, National Football League; P _A , physical activity; PE, physical education; SPARK,	
856	Sports, Play, and Active Recreation for Kids.	

Table 3. Study results by RE-AIM domain

Study (Authors, Year)	Reach	Effectiveness	Adoption	Implementation	Maintenance
Play ZONE (Austin et al., 2011)	<i>Method to ID population</i> Students from schools recruited via an expression of interest emailed to all primary school principals in the Central Queensland Education Region.	<i>Changes in primary outcome</i> Alluded to efficacy being determined in previous versions of the study.	<i>Description of program location</i> City and rural schools in the Rockhampton region of Queensland, Australia.	<i>Number/duration of intervention sessions</i> NR	<i>Outcomes ≥ 6-months post-intervention</i> NR
	<i>Inclusion/Exclusion</i> NR		<i>Description of staff</i> NR		
	<i>Sample size</i> 13-719 students from each school.		<i>Identification of delivery agent</i> NR		
	<i>Participation Rate</i> NR		<i>Delivery agent expertise</i> School champions were either general teachers, PDHPE teachers, principals or 'other'.		
	<i>Characteristics of participants/non-participants</i> Participants were from city and rural schools. Non-participating students perceived as active enough.		<i>Denominator for those trained</i> NR		
NFL Play 60 (Bai et al., 2017; Welk et al., 2016)	<i>Method to ID population</i> Welk et al., 2016: Schools (and their students) within the area of the 32 NFL franchises. <i>Inclusion/Exclusion</i> NR	<i>Reported retention</i> NR	<i>Rate of participating/non-participating schools</i> 8/49 schools contacted agreed to participate (16%). Interviews with 16 non-participating schools, 11/16 expressed interest to participate in the future.	<i>Cost of intervention</i> NR	<i>Institutionalisation of intervention</i> All schools that had implemented PZ for 12 months (7/8) reported that it was now accepted practice and part of school routine
			<i>Description of program location</i> Welk: Schools within the area of the 32 NFL franchises.		
			<i>Description of staff</i> NR	<i>Number/duration of intervention sessions</i> NR	
		<i>Changes in primary outcome</i> Bai et al: Annual improvements in aerobic capacity were significantly greater in schools that participated in the programs for both girls (3.0%, $p<0.01$) and boys (2.9%, $p<0.01$) compared with non-programming schools.			<i>Outcomes ≥ 6-months post-intervention</i> Bai et al: Effectiveness was maintained over the 4-year period in which data was collected, with better improvements in aerobic capacity for schools involved for 4 years (compared with 2 or 3 years).

SPARK & adaptations (Belansky et al., 2016; Dowda et al., 2005;	<i>Sample size</i> Bai et al 2016: A range of 50,000–100,000 students. The total number of students included in the final sample varied from 2012 to 2015, with 41,769, 77,156, 101,029, and 80,579 qualified for valid AC and 49,633, 87,336, 107,898, and 82,623 for valid BMI over the 4-year span. Welk: Elementary schools had an average of 472 students enrolled, while high schools had an average of 1,194 student.	<i>ITT rather than completers analysis</i> NR	<i>Identification of delivery agent</i> NR	<i>Extent of intervention delivery as intended</i> NR	<i>Is the intervention still in place?</i> NR
	<i>Participation Rate</i> NR		<i>Delivery agent expertise</i> Bai: Teachers, whom received training related to FitnessGram.		
	<i>Characteristics of participants/non-participants</i> Welk: More than half of the students (54%) were eligible for free and reduced lunch, and half of them (50%) were considered non-White. More than 40% of schools are located in cities, and nearly 20% are in suburban or rural areas, respectively.		<i>Denominator for those trained</i> NR		
	<i>Reported retention</i> NR		<i>Rate of participating/non-participating schools</i> Bai et al: About 19% (95/497) of schools adopted the program and were classified as programming schools. Of these 497 schools, 184 were elementary, 239 middle, and 74 high. Welk et al: A total of 1,304 schools have voluntarily enrolled since the beginning of the project. A total of 244 sites dropped out of the study leaving a final sample of 1,060 enrolled sites.		
	<i>Method to ID population</i> Belansky: Program initiated as PE has not increased in rural Colorado, despite state/national programs and initiatives.	<i>Changes in primary outcome</i> Belansky et al: MVPA increased from 51.1% to 67.3% over the 2-year intervention resulting in approximately 14.6 additional	<i>Description of program location</i> Belansky: San Luis Valley is an 8188 square mile rural intermountain valley in south-central Colorado. There are 17	<i>Number/duration of intervention sessions</i> NR	<i>Outcomes ≥ 6-months post-intervention</i> Belansky et al: Maintenance of a number of findings 2 years post baseline, schools demonstrate

McKenzie et al., 2009; Nigg et al., 2017)	Nigg: SPARK proven as an effective program, yet has had limited application in Pacific Islanders.	hours of physical activity over a school year. Dowda et al: As previously published, SPARK PE had positive effects on physical activity in class and components of physical fitness. SPARK PE classes were well received by students. Nigg et al: Students increased their walking and vigorous activity during PE classes by 10% over the school year.	elementary schools across 14 school districts with approximately 3803 students (224 students per school on average). Dowda et al: The 277 SPARK schools were located in California, Hawaii, Maryland, Tennessee, Utah, Washington, Arizona, and Saipan, Northern Mariana Islands. Nigg et al: The islands of Saipan, Rota and Tinian.		additional gains from a second year of intervention. After 1 and then 2 years of intervening with physical education teachers, MVPA levels increased to 58% and then 67%.
	<i>Inclusion/Exclusion</i> NR		<i>Description of staff</i> Belansky et al: Elementary school physical education teachers from 17 schools participated in the intervention + site coordinators. Dowda et al: PE specialist and generalist classroom teachers from participating schools. In schools without PE specialists, on-site facilitators were trained to assist teachers with implementation. 70% were women, 55% had been teaching for more than 10 years. McKenzie et al: Experienced instructors (most with master's degrees), who previously implemented the SPARK program in their own school and then participated in extensive training on how to teach others to implement the program – which included both PE specialist and generalist teachers.		
	<i>Sample size</i> Belansky et al: Approximately 3803 students (224 students per school on average). McKenzie et al: Potentially 1 million students. Nigg et al: There were 5706 elementary and 5036 secondary	<i>ITT rather than completers analysis</i> NR	<i>Identification of delivery agent</i> McKenzie et al: External company licensed program resources and training. Teachers of involved students, who were already in schools then received training and delivered the program to students.		
			<i>Extent of intervention delivery as intended</i> Dowda et al: 90% reported using SPARK concepts and methods for > 50% of PE lessons; 83% reported using SPARK lesson plans for > 50% of PE lessons.		<i>Is the intervention still in place?</i> Dowda et al: About 80–90% of SPARK users had been implementing SPARK for more than 2 years, and most of the time they continued to rely on both actual lesson plans and the program's concepts and methods. 53%

school students at the invited schools.			<i>Delivery agent expertise</i>		reported that > 50% of teachers in school were using SPARK. Up to 80% of schools that adopted SPARK PE reported sustained use up to 4 years later.
<i>Participation Rate</i> NR			<p><i>Delivery agent expertise</i></p> <p>Belansky: Elementary school PE teachers</p> <p>Dowda et al: PE specialist and generalist classroom teachers.</p> <p>McKenzie et al: An experienced physical educator, who gained extensive experience writing and conducting the staff development programs during the initial interventions, has been directing the SPARK dissemination effort since its inception.</p>		
<i>Characteristics of participants/non-participants</i> Belansky et al: Rural, low-income students', participated in the intervention. 50.6% of participants were Hispanic, with 70.5% qualifying for free/reduced lunch.			<p><i>Denominator for those trained</i></p> <p>Belansky: 21/22 teachers in the 17 schools completed the intervention.</p> <p>McKenzie et al: 810 workshops with an average of 30 teachers in attendance.</p> <p>Nigg et al: A total of 278 elementary school teachers and 236 secondary school teachers were invited to participate. These teachers were invited from all schools (12 elementary, 2 junior high, and 3 senior high) from the island of Saipan in addition to one elementary, one junior high, and one high school from each of the islands of Rota and Tinian.</p>	<p><i>Cost of intervention</i></p> <p>Belansky et al: Approximately \$1.2M for the PE Academy.</p>	<p><i>Institutionalisation of intervention</i></p> <p>Nigg et al: SPARK provides free lifetime follow-up support and consultation for each training attendee via a toll-free number and email. SPARK also produces and distributes a quarterly newsletter – free to training attendees.</p> <p>Additionally, each site principal receives two mailings a year with helpful tips to 'keep the SPARK alive.</p>
Nigg et al: Chamorro, Filipino, and Carolinian students are the most prevalent.	<i>Reported retention</i> NR		<p><i>Rate of participating/non-participating schools</i></p> <p>Belansky et al: All 17 elementary schools agreed to participate in the PE Academy and all 12 schools eligible for AIM agreed to participate in that component as well</p>		

			Dowda et al: 81% of the 111 schools that returned surveys were currently using SPARK in their school. Nigg et al: 100% - all schools invited agreed to attend the premium training. Random subsample of these schools included in the evaluation.		
	<i>Method to ID population</i> NR	<i>Changes in primary outcome</i> Bice et al: Reports that previous studies showed students' who participated in CATCH were significantly more physically active than those who did not. Heath et al 2002: Most of the intervention schools assessed in the El Paso CATCH program substantially increased their MVPA and VPA at the end of the 1st year in the program. MVPA in El Paso CATCH schools was higher and changed more than that reported by the national CATCH trial, which showed a 30% increase in MVPA from baseline to the end of the 1st year. The El Paso CATCH VPA values also demonstrated a much larger increase than the 16% increase evident in the national CATCH. Heath et al 2003: The El Paso CATCH program was well received and resulted in significant increases in MVPA during PE (ranging from 52% to 59%). Hoelscher et al 2004: There were no differences between percent of class time spent in moderate to vigorous physical activity (MVPA) or vigorous physical activity (VPA) between former	<i>Description of program location</i> Bice et al: Rural southern Illinois Heath et al 2003: Area from New Mexico to West Central Texas. Hoelscher et al 2004: Texas schools.		
CATCH & adaptations (Bice et al., 2014; Heath et al., 2002; Heath et al., 2003; Hoelscher et al., 2001; Hoelscher et al., 2004; Hoelscher et al., 2010)	<i>Inclusion/Exclusion</i> NR		<i>Description of staff</i> NR	<i>Number/duration of intervention sessions</i> NR	<i>Outcomes ≥ 6-months post-intervention</i> Bice et al: Years after, the CATCH intervention students still exhibited significantly higher physical activity levels.

		intervention, former comparison, and unexposed control schools. Hoelscher et al 2010: Significant improvements in no. of days played outdoors and no. of days participated in organized PA after one year.		<i>Extent of intervention delivery as intended</i> Bice et al: Physical education teachers reported a degree of implementation of 84.8% and classroom teachers reported degree of implementation to be 52.97%, on a continuous scale. Heath et al 2002: There was a large range in use of CATCH activities by PE teachers, from 10% to 100% of classes taught with CATCH materials (average of 50% of classes taught having CATCH activities). Heath et al 2003: All El Paso CATCH schools implement all components of CATCH. Hoelscher et al 2004: Intervention schools reported that approximately a third of class time was based on CATCH activities compared to 30% of class time based on CATCH activities in former comparison schools and almost 10% of class time based on CATCH activities in unexposed control school. The teachers from former intervention schools reported teaching only about two CATCH lessons during the previous school year. In the original CATCH curriculum, there were 15 lessons for grade 3, 12 lessons (with parts A and B) for grade 4, and 8 lessons (with parts A and B) for grade 5. The total time spent teaching CATCH was also low, with	
	<i>Sample size</i> Heath et al 2003: By fall 2002, more than 50,000 children and their families were involved in the program. Hoelscher et al 2001: CATCH has potentially reached 435000 Texas school children. Hoelscher et al 2010: 1107 students	ITT rather than completers analysis NR	<i>Identification of delivery agent</i> NR		Is the intervention still in place? Heath et al 2002: Yes. Hoelscher et al 2004: Yes
	<i>Participation Rate</i> NR		<i>Delivery agent expertise</i> NR		

			values of approximately 1–5 h reported in both former intervention and former comparison schools. The amount of time required to teach CATCH ranges from 10 h in 3rd grade to 16 h in 4th grade, so the reported time was much lower than actually suggested in the curriculum.		
	<p><i>Characteristics of participants/non-participants</i></p> <p>Heath et al 2002: Schools had children of predominantly Mexican heritage (75% to 98% Hispanic).</p> <p>Hoelscher et al 2010: 54% female, 61% Hispanic, 23% White/other, and 15% African American. 6.7% of students were economically disadvantaged.</p>	<p><i>Reported retention</i></p> <p>NR</p>	<p><i>Denominator for those trained</i></p> <p>Hoelscher et al 2001: More than 900 school personnel trained from 578 schools trained to deliver CATCH.</p> <p><i>Rate of participating/non-participating schools</i></p> <p>Bice et al: 36 elementary schools from 16 counties</p> <p>Heath et al 2002: Of the 83 schools which had adopted and implemented CATCH in the El Paso region, this article presents 3-year outcome and process evaluation from 20 schools (24 in total, 4 served as controls).</p> <p>Heath et al 2003: CATCH was implemented in 18 Title I pilot schools. Known as the Coordinated Approach to Child Health 5 years later, the El Paso CATCH program has been embraced by the border community and reaches 108 elementary schools.</p> <p>Hoelscher et al 2004: 76 schools involved in the CATCH-ON study, as well as 12 unexposed control schools. Approximately 19% of Texas schools have purchased CATCH materials.</p> <p>Hoelscher et al 2001: 578 schools with a teacher trained to deliver CATCH, and more than 728 that have purchased CATCH materials.</p> <p>Hoelscher et al 2010: The 15 schools that knowingly adopted this program</p>	<p><i>Cost of intervention</i></p> <p>NR</p>	<p><i>Institutionalisation of intervention</i></p> <p>Heath et al 2002: The El Paso CATCH program was successful because of the continued funding from its sponsor, the Paso del Norte Health Foundation. Money was awarded each year for new schools to join the program, and the continuing schools were also provided with monetary support for program maintenance activities.</p> <p>Heath et al 2003: Passing over implementation responsibilities to the school districts (institutionalisation) and continued funding ensured the program would continue into the future.</p> <p>Hoelscher et al 2004: Higher levels of institutionalization in the former intervention compared to former comparison schools.</p>

			and participated in the evaluation contributed to the overall number of schools involved in CATCH across the US.		
MA-CORD (Blaine et al., 2017) – Planet Health	<i>Method to ID population</i> NR	<i>Changes in primary outcome</i> NR	<i>Description of program location</i> Two low income school districts with greater-than-average prevalence of childhood obesity	<i>Number/duration of intervention sessions</i> In year 1, teachers in Community 1 nearly met the teaching goal of 6 MA-CORD lessons per year; Community 2 reported fewer lessons. In year 2, mean lessons taught dropped slightly for Community 1 and increased for Community 2.	<i>Outcomes ≥ 6-months post-intervention</i> NR
	<i>Inclusion/Exclusion</i> NR		<i>Description of staff</i> Classroom and health education teachers.		
	<i>Sample size</i> An estimated 1,486 students in Community 1 and 2,626 students in Community 2 reached by the intervention.		<i>Identification of delivery agent</i> NR		
	<i>Participation Rate</i> 100% from Community 1 and 72% from Community 2.		<i>Delivery agent expertise</i> NR		
	<i>Characteristics of participants/non-participants</i> Low-income students.	<i>Reported retention</i> NR	<i>Denominator for those trained</i> NR	<i>Extent of intervention delivery as intended</i> In interviews, staff members described health teachers as strong implementers of the curriculum.	<i>Institutionalisation of intervention</i> MA-CORD activities were made part of teachers' professional evaluation in one school, ensuring MA-CORD lessons would be sustained through supervisory accountability.
			<i>Rate of participating/non-participating schools</i> NR		
	<i>Method to ID population</i> NR		<i>Description of program location</i> NR		
HLCK (Chomitz et al., 2010)	<i>Inclusion/Exclusion</i> NR	<i>Changes in primary outcome</i> Fitness test scores improved significantly for all children from baseline to follow-up, irrespective of race/ethnicity or income status, and on all measures – mean number of fitness tests passed; percent passing all five fitness tests from 29.9 to 44.5%; and percent passing the endurance	<i>Description of staff</i> NR	<i>Number/duration of intervention sessions</i> NR	<i>Outcomes ≥ 6-months post-intervention</i> Fitness data collected annually, and continues to be collected to monitor progress post-HLCK.

		cardiovascular test from 52.6 to 66.6%				
	<i>Sample size</i> 1858 K-5th grade children	<i>ITT rather than completers analysis</i> NR	<i>Identification of delivery agent</i> NR	<i>Extent of intervention delivery as intended</i> NR	<i>Is the intervention still in place?</i> Community-wide momentum facilitated the post-intervention sustainability of program elements (i.e., "New PE").	
	<i>Participation Rate</i> NR		<i>Delivery agent expertise</i> NR			
	<i>Characteristics of participants/non-participants</i> Mean age was 7.7 years, and 48.2% were female. 37.3% were black, 14.0% Hispanic, 37.1% white, 10.2% Asian, 1.7% other race; 43.3% were lower income	<i>Reported retention</i> NR	<i>Denominator for those trained</i> NR	<i>Cost of intervention</i> NR	<i>Institutionalisation of intervention</i> NR	
			<i>Rate of participating/non-participating schools</i> NR			
	<i>Method to ID population</i> All New York City public elementary schools, and their students, invited.	<i>Changes in primary outcome</i> Students with teachers trained in MTI had significantly more physical activity than students in classrooms without a trained teacher. These students also experienced more instances of physical activity during the day.	<i>Description of program location</i> New York City.	<i>Number/duration of intervention sessions</i> NR	<i>Outcomes ≥ 6-months post-intervention</i> NR	
	<i>Inclusion/Exclusion</i> NR		<i>Description of staff</i> NR			
MTI (Dunn et al., 2012)	<i>Sample size</i> NR	<i>ITT rather than completers analysis</i> NR	<i>Identification of delivery agent</i> NR	<i>Extent of intervention delivery as intended</i> NR	<i>Is the intervention still in place?</i> NR	
	<i>Participation Rate</i> NR		<i>Delivery agent expertise</i> NR			
	<i>Characteristics of participants/non-participants</i> NR	<i>Reported retention</i> NR	<i>Denominator for those trained</i> 1200 teachers from 160 schools trained. <i>Rate of participating/non-participating schools</i> All public elementary schools invited, with 160 receiving program training. 39 schools involved in this evaluation.	<i>Cost of intervention</i> NR	<i>Institutionalisation of intervention</i> NR	
EYO (Dunton et al., 2009)	<i>Method to ID population</i> NR	<i>Changes in primary outcome</i>	<i>Description of program location</i> California	<i>Number/duration of intervention sessions</i>	<i>Outcomes ≥ 6-months post-intervention</i>	

	<i>Inclusion/Exclusion</i> NR	After the program, days per week of at least 60 minutes of physical activity increased, as reported by students.	<i>Description of staff</i> NR	86% of the teachers reported implementing all eight of the EYO lessons.	NR
	<i>Sample size</i> 234,442 middle-school students. Across the 5-year time span, an average of 249,578 students used the program each year.	<i>ITT rather than completers analysis</i> NR	<i>Identification of delivery agent</i> NR	<i>Extent of intervention delivery as intended</i> Classroom observation data showed that 75% of the lessons observed were implemented in the recommended order. Observers reported that all of the teachers conveyed 81% to 100% of the lesson content.	<i>Is the intervention still in place?</i> On average, 52% of teachers reconsidered the program after their initial year.
	<i>Participation Rate</i> Over the past 5 years, 51% of all middle-school students in California were exposed to the program, through 1,247,889 student workbook requests.		<i>Delivery agent expertise</i> Middle school teachers.		
	<i>Characteristics of participants/non-participants</i> Ninety-four percent of students were in the seventh grade, 5% were in the eighth grade, and 1% in the ninth grade. The mean age of the participants (included in the evaluation) was 12.47 years		<i>Denominator for those trained</i> NR		
Take 10! (Goh et al., 2014; Goh et al., 2017)	<i>Method to ID population</i> NR	<i>Reported retention</i> NR	<i>Rate of participating/non-participating schools</i> Of the 3803 middle-school teachers (grades 6, 7, and 8) in California for whom data were available (i.e., approximately 95% of all middle-school teachers in California), 1606 teachers (42%) ordered the program materials for the 2006 to 2007 school year. Program usage reports for the prior 5 school years (2002–2003 through 2006–2007) showed that 9340 teachers ordered EYO during this period. Across the 5-year time span, an average of 1868 teachers used the program each year.	<i>Cost of intervention</i> NR	<i>Institutionalisation of intervention</i> NR
			<i>Description of program location</i> NR		
			<i>Description of staff</i> NR		
	<i>Inclusion/Exclusion</i> NR	<i>Changes in primary outcome</i> Goh et al 2014: Students accumulated approximately 672 more daily in-school steps during mid-intervention (week 8) compared with baseline (week 1), and the difference was		<i>Number/duration of intervention sessions</i> Goh et al 2014: Teachers conducted on average one TAKE 10! activity per school day during the 8-week intervention period. The number of times teachers implemented the	<i>Outcomes ≥ 6-months post-intervention</i> NR

		statistically significant (P<.001). Results also indicated that students accumulated approximately 12894 more daily in-school activity counts during end-intervention (week 12) compared with baseline (week 1). The difference of in-school activity counts accumulated between baseline and end-intervention was statistically significant (P=.012). Furthermore, results revealed that students accumulated approximately 17328 more daily in-school activity counts during end-intervention (week 12) compared with mid-intervention (week 8). The difference of in-school activity counts accumulated between mid-intervention and end-intervention was statistically significant (P=.001).		TAKE 101 activities ranged from one to three times per day.			
	Sample size	Goh et al 2014: These 210 students contribute to the overall reach of Take 101	ITT rather than completers analysis	Identification of delivery agent	Extent of intervention delivery as intended	Is the intervention still in place?	
	Participation Rate						Delivery agent expertise
	NR						NR
Characteristics of participants/non-participants	NR	Reported retention	Denominator for those trained	Cost of intervention	Institutionalisation of intervention		
			NR				
			Rate of participating/non-participating schools				
Method to ID population	Changes in primary outcome	Description of program location					

Action Schools! BC (Masse et al., 2012; McKay et al., 2015)	NR	Masse et al 2012: Effectiveness previously shown - Evaluation of ASIBC in ten schools (514 children) demonstrated that the model was efficacious; it increased physical activity, fitness, and other health outcomes in children randomized to intervention schools. McKay et al 2015: Reported previously.	Masse et al 2012: Schools were predominantly from census metropolitan areas (60%) and 30% (M) of the population around these schools had a postsecondary education.	<i>Number/duration of intervention sessions</i> Masse et al 2012: Of the teachers implementing ASIBC, 40% provided classroom action breaks on a weekly basis.	<i>Outcomes ≥ 6-months post-intervention</i> NR
	<i>Inclusion/Exclusion</i> NR		<i>Description of staff</i> Masse et al 2012: School principals and teachers who completed the surveys were predominantly female (61% and 71%, respectively) and Caucasian (91% and 85%, respectively) with varied levels of teaching experience.		
	<i>Sample size</i> Masse et al 2012: On average, study schools (n=133) enrolled 291 students. McKay et al 2015: Student reach is approximately 500000, considering the number of workshops delivered and teachers in attendance.		<i>Identification of delivery agent</i> NR	<i>Extent of intervention delivery as intended</i> Masse et al 2012: About 50% of schools had established between five and six guidelines or policies that supported the implementation of ASIBC. Trend toward implementation of the initiative ($p=0.071$) among those teachers who perceived ASIBC as having positive attributes.	<i>Is the intervention still in place?</i> McKay et al 2015: Four years after scale-up, trained ASi BC teachers provided more PA opportunities for students even in the context of supportive provincial policies.
	<i>Participation Rate</i> NR	<i>ITT rather than completers analysis</i> NR	<i>Delivery agent expertise</i> NR		
	<i>Characteristics of participants/non-participants</i> NR	<i>Reported retention</i> NR	<i>Denominator for those trained</i> Masse et al 2012: Approximately 75% of teachers attended at least one ASIBC workshop; about one third of those attended more than one workshop. Teachers who attended at least one workshop were 1.88 times more likely to implement ASIBC than teachers who received no training. McKay et al 2015: To date, 4677 workshops have been delivered to more than 80000 teachers. Over 10 years of scale-up (2004–2014), more than 225 ASi BC Trainers have been	<i>Cost of intervention</i> NR	<i>Institutionalisation of intervention</i> Masse et al 2012: Schools at the 75th percentile for institutionalizing ASIBC (making changes to support implementation) were 2.09 times more likely to implement the model compared with schools at the 25th percentile.

			trained; 75 actively deliver training workshops to teachers each year. The Support Team and Trainers deliver 400–500 workshops per year. <i>Rate of participating/non-participating schools</i> Masse et al 2012: On average, 73% of teachers reported delivering ASIBC. McKay et al 2015: ASI BC is now active in 100% of BC school districts (n=60+) with 94% of schools registered (1474/1571 schools); of those, 89% received teacher training through a workshop.		
	<i>Method to ID population</i>	<i>Changes in primary outcome</i>	<i>Description of program location</i>	<i>Number/duration of intervention sessions</i>	<i>Outcomes ≥ 6-months post-intervention</i>
	<i>Inclusion/Exclusion</i>		<i>Description of staff</i>		
	<i>Sample size</i>		<i>Identification of delivery agent</i>		
	<i>Participation Rate</i>		<i>Delivery agent expertise</i>		
Pathways (Page-Reeves et al., 2013)	<i>Participation Rate</i>	<i>ITT rather than completers analysis</i>	<i>Delivery agent expertise</i>	<i>Extent of intervention delivery as intended</i>	<i>Is the intervention still in place?</i>
	<i>NR</i>		<i>NR</i>		
	<i>Characteristics of participants/non-participants</i>	<i>Reported retention</i>	<i>Denominator for those trained</i>	<i>Cost of intervention</i>	<i>Institutionalisation of intervention</i>
			<i>NR</i>		
	<i>Rate of participating/non-participating schools</i>		<i>NR</i>		
	<i>NR</i>		<i>NR</i>		
	<i>Method to ID population</i>	<i>Changes in primary outcome</i>	<i>Description of program location</i>	<i>Number/duration of intervention sessions</i>	<i>Outcomes ≥ 6-months post-intervention</i>
	<i>NR</i>		<i>NR</i>		
Health Choices (Peterson et al., 2015)	<i>Inclusion/Exclusion</i>	The percent achieving behavioral goals over three years increased significantly for PA: 37.1 to 39.9 (p = 0.02).	<i>Description of staff</i>	On average, schools implemented 1.75 health promotions of the 5-2-1 message, 2 before- and after-school programs and 3.2 environmental and policy changes in Year 2.	<i>NR</i>
	<i>NR</i>		<i>NR</i>		

Project Energise (Rush et al., 2016)	<i>Sample size</i> NR	<i>ITT rather than completers analysis</i> NR	<i>Identification of delivery agent</i> NR	<i>Extent of intervention delivery as intended</i> The mean dose of HC intervention components met or exceeded minimum program requirements, but intensity ranged widely across schools. Sixty one percent of schools met the definition for the HC team. Notably, HC schools on average taught 6 of 15 PE micro- units across 6th, 7th and 8 th grades in Year 2.	<i>Is the intervention still in place?</i> NR
	<i>Participation Rate</i> NR		<i>Delivery agent expertise</i> NR		
	<i>Characteristics of participants/non-participants</i> NR		<i>Denominator for those trained</i> NR		
	<i>Characteristics of participants/non-participants</i> Student characteristics were similar to that of other Massachusetts middle schools, with 27.6% of students eligible for free/reduced lunch, 70.3% self-identified as non-Hispanic white vs. 25.2% and 66.9% in the broader population of MA middle schools.	<i>Reported retention</i> NR	<i>Rate of participating/non- participating schools</i> 128 middle schools from 2004–2009, with 69 schools initiating their participation in academic year 2004– 2005, 51 schools in 2005–2006 and eight in 2006–7.	<i>Cost of intervention</i> NR	<i>Institutionalisation of intervention</i> NR
	<i>Method to ID population</i> NR	<i>Changes in primary outcome</i> A follow-up evaluation of the RCT showed improved run speed outcomes for Energized children compared to historical controls	<i>Description of program location</i> NR	<i>Number/duration of intervention sessions</i> NR	<i>Outcomes ≥ 6-months post- intervention</i> NR
	<i>Inclusion/Exclusion</i> NR		<i>Description of staff</i> NR		
	<i>Sample size</i> 53,375 children.		<i>Identification of delivery agent</i> NR		
	<i>Participation Rate</i> NR	<i>ITT rather than completers analysis</i> NR	<i>Delivery agent expertise</i> NR	<i>Extent of intervention delivery as intended</i> NR	<i>Is the intervention still in place?</i> The program celebrated its 10-year anniversary in 2015.
			<i>Denominator for those trained</i> NR		
		<i>Reported retention</i> NR	<i>Rate of participating/non- participating schools</i> Project Energize is being delivered in 302 schools (15% of all schools in NZ).	<i>Cost of intervention</i> NR	<i>Institutionalisation of intervention</i> NR

DOI <i>T</i> (Van Nassau et al., 2014; Van Nassau et al., 2016)	<i>Method to ID population</i> Van Nassau et al 2014: All schools eligible. Van Nassau et al 2016: Available to all schools in the Netherlands.	<i>Changes in primary outcome</i> Van Nassau et al 2014: Reported previously. Van Nassau et al 2016: Teachers reported that they thought adolescents had gained new knowledge on physical activity as a result of DOI <i>T</i> (77%), had become self-aware of their behaviors (71%), had changed their behaviors (37%), and had maintained their healthy behavior (14%).	<i>Description of program location</i> NR	<i>Number/duration of intervention sessions</i> Van Nassau et al 2016: On average teachers delivered 3.5 of six (58%) lessons in the first year and 2.2 of the second six (37%) lessons in the second year. PE teachers delivered on average 2.8 of the four (70%) planned lessons, spread over the 2 years. On average, 56% of the lessons were delivered according to the teacher manual.	<i>Outcomes ≥ 6-months post-intervention</i> NR
	<i>Inclusion/Exclusion</i> NR		<i>Description of staff</i> NR		
	<i>Sample size</i> Van Nassau et al 2016: More than 5000 adolescents received DOI <i>T</i> . This paper reports on 1459 adolescents reached.		<i>Identification of delivery agent</i> NR	<i>Extent of intervention delivery as intended</i> Van Nassau et al 2014: Only a few teachers had implemented all lessons and all components of the program, based off the self-reported implementation index.	
	<i>Participation Rate</i> NR	<i>ITT rather than completers analysis</i> NR	<i>Delivery agent expertise</i> NR	<i>Van Nassau et al 2016: Despite teachers' satisfaction with the DOI<i>T</i> lessons and teaching materials, degree of program implementation was lower than expected, especially towards the end of the program. The percentage of lessons delivered decreased from 74% to 18% towards the end of the program. Fidelity to the teacher manual ranged from 85 to 26%.</i>	<i>Is the intervention still in place?</i> Van Nassau et al 2016: Forty-seven percent of the teachers reported that they wanted to continue DOI <i>T</i> after year 1; 33% after year 2.
<i>Characteristics of participants/non-participants</i> NR	<i>Reported retention</i> NR	<i>Denominator for those trained</i> NR	<i>Rate of participating/non-participating schools</i> Van Nassau et al 2016: 66 schools ordered the DOI <i>T</i> materials within the first year.	<i>Cost of intervention</i> NR	<i>Institutionalisation of intervention</i> Van Nassau et al 2016: Twenty-seven percent of the teachers reported that DOI <i>T</i> was embedded in their school curriculum and 19% reported that DOI <i>T</i> had become part of their school health policy.

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Abbreviations: BC, British Columbia; CATCH, formerly Child and Adolescent Trial for Cardiovascular Health now Coordinated Approach to Child Health;

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ID, identify; ITT, intention-to-treat; DOI.T, Dutch Obesity Intervention in Teenagers; MA-CORD, Massachusetts Childhood Obesity; Research Demonstration;

860 MTI, Move-To-Improve; MVP A, moderate-to-vigorous physical activity; NFL, National Football League; NR, not reported; PA, physical activity; PACER,
861 Progressive Aerobic Cardiovascular Endurance Run; PE, physical education; PZ, Play Zone; RCT, randomized controlled trial; SPARK, Sports, Play, and
862 Active Recreation for Kids

863 **Table 4:** RE-AIM checklist of study reporting and quality

Item	Description of reporting and quality criteria
REACH	1. Reporting of the method to identify the target population
	2. Reporting of inclusion/exclusion criteria
	3. Reporting of sample size
	4. Reporting of participation rate
	5. Reporting of the characteristics of participants/non-participants
EFFECTIVENESS	6. Reporting of changes in the primary outcome measure (current or prior study)
	7. Usage of intention-to-treat rather than completers data analysis
	8. Reporting of retention following program completion
ADOPTION	9. Reporting a description of the program location
	10. Reporting a description of staff who delivered the program
	11. Reporting the method to identify the delivery agent
	12. Reporting of the level of expertise of the delivery agent
	13. Reporting the denominator for those trained (all/some in a region)
	14. Reporting of the rate comparing participating/non-participating schools/teachers
IMPLEMENTATION	15. Reporting of the number and duration of intervention contacts/sessions
	16. Reporting of the extent to which the intervention was delivered as intended
	17. Reporting of costs associated with intervention delivery
MAINTENANCE	18. Reporting of outcome assessments $\geq$ 6-months post intervention
	19. Reporting of whether or not the intervention was still in place
	20. Reporting of whether or not the intervention has been institutionalized

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Table 5. Study quality organised by RE-AIM domain

Study	Author, Year	Reach				Effectiveness				Adoption				Implementation				Maintenance				TOTAL	OVERALL TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
Play ZONE	Austin et al., 2011	1	0	1	0	1	1	0	0	1	0	0	1	0	1	0	1	0	0	1	1	10	10 - MOD
NFL Play 60	Bai et al., 2017	0	0	1	0	0	1	0	0	0	0	1	0	1	0	0	0	0	1	0	0	5	8 - MOD
	Welk et al., 2016	1	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	5	
SPARK & adaptations	Belansky et al., 2016	1	0	1	0	1	1	0	0	1	1	0	1	1	1	0	0	1	1	0	0	11	15 - HIGH
	Dowda et al., 2005	0	0	0	0	0	1	0	0	1	1	0	1	0	1	0	1	0	0	1	0	7	
	McKenzie et al., 2009	0	0	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	5	
	Nigg et al., 2017	1	0	1	0	1	1	0	0	1	0	0	0	1	1	0	0	0	0	0	1	8	
	Bice et al., 2014	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	1	0	0	5	
CATCH & adaptations	Heath et al., 2002	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	1	0	0	1	1	6	10 - MOD
	Heath et al., 2003	0	0	1	0	0	1	0	0	1	0	0	0	0	1	0	1	0	0	0	1	6	
	Hoeschler et al., 2004	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	0	1	1	6	
	Hoeschler et al., 2001	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	3	
	Hoeschler et al., 2010	0	0	1	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	4	
MA-CORD	Blaine et al., 2017	0	0	1	1	1	0	0	0	1	1	0	0	0	0	1	1	0	0	1	1	9	9 - MOD
HLCK	Chomitz et al., 2010	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	5	5 - LOW
MTI	Dunn et al., 2012	1	0	0	0	0	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0	5	5 - LOW
EYO	Dunton et al., 2009	0	0	1	1	1	1	0	0	1	0	0	1	0	1	1	1	0	0	1	0	10	10 - MOD
Take 10!	Goh et al., 2014	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3	4 - LOW
	Goh et al., 2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	
Action Schools! BC	Masse et al., 2012	0	0	1	0	0	1	0	0	1	1	0	0	1	1	1	1	0	0	0	1	9	10 - MOD
	McKay et al., 2015	0	0	1	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	1	0	5	
Pathways	Page-Reeves et al., 2015	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	2	2 - LOW
Health Choices	Peterson et al., 2015	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	1	0	0	0	0	5	5 - LOW
Project Energize	Rush et al., 2016	0	0	1	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	1	0	5	5 - LOW
DOiT	Van Nassau et al., 2014	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	8 - MOD

	Van Nassau et al., 2016	1	0	1	0	0	1	0	0	0	0	0	0	0	1	1	0	0	1	1	8	
		7	0	17	2	10	20	0	0	13	6	1	6	7	19	7	13	1	4	11	8	

Abbreviations: BC, British Columbia; CATCH, formerly Child and Adolescent Trial for Cardiovascular Health now Coordinated Approach to Child Health; EYO, Exercise Your Options; DOiT, Dutch Obesity Intervention in Teenagers; MA-CORD, Massachusetts Childhood Obesity; Research Demonstration; MTI, Move-To-Improve; NFL, National Football League; SPARK, Sports, Play, and Active Recreation for Kids.

869 Supplemental Table 1. Key recommendations and examples aligned with RE-AIM

<i>Key recommendations & how-to?</i>	
Reach	<p>What: Report actual or estimated student sample size. How: School enrollment data, study enrollment data, state/national census data</p> <p>What: Report student participation rate. How: Divide those receiving the intervention by those eligible (using above sample size data)</p> <p>What: Report characteristics of participants/non-participants. How: Utilising student/school data, compare those students receiving the intervention to those eligible (local/state/national census data will be of use here, dependent on eligible population and scale of program delivery).</p>
Effectiveness	<p>What: Evaluation of intervention effectiveness across all research phases. How: Selection and utilisation of robust measures in efficacy/effectiveness phases to ascertain cause-effect of intervention improvements. During at-scale dissemination, researchers should select more feasible methods of assessing effectiveness (i.e., self-report) that can then be compared to efficacy/effectiveness findings.</p>
Adoption	<p>What: Report characteristics of participating/non-participating schools, including location. How: Utilising school data, compare those schools who adopted the intervention to those that were eligible, but did not (local/state/national school demographic data will be of use here, dependent on eligible schools and scale of program delivery)</p> <p>What: Report the characteristics of the delivery agents (i.e., teachers), and how these individuals were targeted. Additionally, the characteristics of those eligible to deliver the intervention, but declined. How: Questionnaires and interviews with delivery agent, including demographic questions, may assist in the collection of this data.</p> <p>What: Report on the number of teachers receiving training to deliver the program. How: Training enrolment data. This can then be compared to the total number of eligible individuals to calculate teacher-level participation, and may be linked with demographic information to determine representativeness of those attending.</p>

<i>Implementation</i>	<p>What: Reporting of intervention quality and/or quantity. How: Teacher completed surveys and/or interviews may assist in determining fidelity at-scale. Researchers may conduct this in a sub-sample (or all if possible) of adopting schools to assess potential adaptations that have occurred. Lesson observations may also act as a useful tool to assess implementation quality, and may be done by researchers or a fellow staff member (utilising a pre-determined lesson observation checklist to maximise reliability of collected data).</p>
<i>Maintenance</i>	<p>See recommendations for <i>Effectiveness</i>. This should be conducted $\geq$ 6-months after the intervention, to determine the <i>Maintenance</i> of findings.</p> <p>What: Reporting of whether the intervention is still in place/if it has been institutionalized. How: Contact with schools/teachers to determine if the intervention and/or components of it are still being utilized. Additionally, have the school/teachers taken any steps to indicate that the intervention is now part of regular practice (i.e., if teacher training is required, have additional teachers been sent to receive training?)</p>

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