Interventions promoting active transport to school in children: a systematic review and meta-analysis.

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Abstract

The systematic review investigated the effectiveness of active travel (AT) interventions on physical activity and fitness in primary school children. The review assessed intervention effectiveness, design, complexity, and study quality.

Searches were conducted in five databases on 30/08/2018. Studies with an AT intervention compared to an inactive control, in 4 to 11 year olds, measuring AT or fitness outcomes were included. Two-stage screening identified relevant studies. Relevant data were extracted using Cochrane Extraction Form, Quality Assessment Tool for Quantitative Studies, Active Living by Design model, and intervention Complexity Assessment Tool for Systematic Reviews. Meta-analysis and Cohen's D effect size assessed effectiveness.

Seventeen eligible studies were included. Effectiveness assessment found a statistically significant standardised mean difference (SMD) in AT outcomes in favour of the intervention (continuous AT - SMD 0.78 (CI 0.11-1.46); frequency AT - SMD 1.87 (CI 0.88-2.86)). Cohen's D calculation concurred with this finding. Fifteen studies had SMD favouring the intervention – two studies had SMD favouring the control. Sixteen studies received a weak quality rating - one study rated moderate.

Active travel shows promise in increasing physical activity in primary school children. The review found walking school buses and educational strategies most effective for increasing relevant outcomes, although overall study quality was weak. Effect size did not associate with the complexity of an intervention, therefore supporting efforts to promote active travel through interventions may be easier to scale. Further intervention studies of greater methodological quality are necessary to confirm these findings due to the limited evidence available.

Key words: Active travel; School children; Public health; Intervention programs; Physical activity; Transport.

Introduction

Regular participation in physical activity (PA) reduces overall cardio-metabolic risk, with inactive children at a significantly greater risk of hypertension, obesity and cancer than their physically active peers.[1-2] Associated psychological benefits include improved cognition, self-esteem and emotional well-being, with reduced risk of depression and anxiety.[3-8] Furthermore, there are improvements to academic behaviour and performance from PA interventions in schools.[9] In 2017, National Health Service reported an increase in the proportion of children meeting the PA guidelines between 2012 to 2015 (boys: 21% to 23%; girls: 16% to 20%).[10] Although this rise is promising, the proportion of children meeting the guidelines is still low. Overall, only 22% of children aged 5 to 15 years met the national guidelines for PA.[10-11] Similarly low physical activity participation rates are evident globally.[12]

Active travel is widely recommended for promoting PA, with research suggesting it is one of the simplest and most acceptable forms of PA that is easily incorporated into everyday lives.[13-17] In 2016, researchers stated that comprehensive national and international initiatives to re-normalise active transport to school are necessary to address the decline in children's PA levels.[18] International research shows a decrease in the number of children using an active form of transport to school.[19-21] The global decline in the use of active travel modes to school by children is of concern. Active travel not only benefits child health through PA, it reduces injury rates, minimises environment damage and improves body composition.[21] Additional benefits include reduced traffic congestion, economic savings and minimised noise pollution.[21] Active travel is a practical and sustainable way to increase PA, with the benefits beyond health gains.[22] The Institute of Medicine reports that active transport provides an excellent opportunity to be active, with family and community involvement increasing sustainability.[19]

In 2010, a systematic review investigated the effectiveness of school-based active transportation interventions in increasing active commuting to school in 6-18 year olds.[23] The search identified 14 studies from various countries including United States, Australia and United Kingdom. Although the eligibility criteria included ages up to 18 years, all included studies (except one) focused on children between 5 to 12 years old. The review concluded that there was a small positive effect on active transport to school, noting heterogeneity in 'size, scope and focus' of the included interventions.[23] In 2018, Villa-Gonzalez and colleagues produced an update of this review, with 23 included studies.[24] Most included studies reported a small effect size on active travel to school, with 21 studies rated poor quality. [24]

Active travel research has grown substantially in past years, however there lacks a recent, comprehensive review of the effectiveness of interventions to promote active travel. Furthermore, previous research and review findings present conflicting conclusions. An updated systematic review to evaluate the effect of active travel interventions in primary school aged children is necessary to fill a gap in knowledge, and provide a comprehensive summary of effectiveness. Furthermore, the lack of intervention description in previous research highlights the need for descriptive analysis, including complexity analysis, in the current review. Therefore the aim of this study was to systematically review the effectiveness of active travel interventions in primary school children.

Method

This systematic review adhered to the PRISMA reporting guidelines for systematic reviews.[25]

Search procedure

A literature search was conducted in MEDLINE, Web of Science, PsychINFO, EMBASE and TRIS for published studies up to 30th August 2018, without date restrictions. No restriction on language was placed at this stage to allow authors to attempt to identify English language translations of articles. The search was inclusive of all publication types, with search terms identified from previous review studies and relevant MeSH headings.[23-24,26-27] Search strategies and terms were adapted as necessary for each database (Supplement A).

Eligibility criteria

Participants: Only studies in which all participants, or the majority (>50%) of participants, were 4 – 11 years old attending primary school or equivalent were included.

Intervention: Eligible studies involved school-based active travel interventions among primary school children. Active travel interventions were defined as targeting the journey to and from school using a physically active form of transport (e.g. walking, cycling). Studies including additional PA co-interventions (e.g. sport participation or active school lessons) were excluded to ensure the findings were directly related to active transport only. Non-PA co-interventions (e.g. nutrition, mental health) were deemed acceptable.

Comparator: Only studies with a control group, where no PA intervention was provided, were eligible for inclusion.

Outcome: Studies with at least one outcome related to active transportation or physical fitness, measured either objectively or subjectively at baseline and on at least one occasion post intervention, were eligible for inclusion. Outcomes included, but were not exclusive to, daily steps, frequency of active travel and PA levels.

Study design: Eligible studies were controlled quantitative designs. Included study designs were randomised control trials (RCT), cluster RCT and controlled quantitative quasi-experimental studies. Within the context of this review, quasi-experimental studies are controlled before and after evaluations of planned but non-randomised interventions, often used when randomisation is not possible because the delivery of the intervention is outside of the control of researchers.[28-29] Non-controlled, cohort, and case studies were excluded, as were studies written in a non-English language. Authors manually searched for published English language translations of non-English language papers.

Selection and review process

Potentially relevant studies were compiled and duplicates removed using a reference manager (RefWorks, ProQuest, Michigan, USA).[34] Titles and abstracts were screened for inclusion independently by three investigators (RJ, MT, NB). Relevant reviews were included at this stage for reference screening. The full-text

of potentially relevant studies were subsequently assessed for inclusion independently by investigators (RJ, MT, NB). Any discrepancies were discussed by investigators for an agreed decision. A third investigator (MT) assisted to resolve any discrepancies where required.

Data extraction

Characteristics of Included Studies

Data extraction was completed independently by two investigators (RJ and MT) using a modified Cochrane Public Health Group Data Extraction Form.[35] Extraction forms were piloted with two studies to ensure it was fit for purpose.

Quality Assessment of Individual Studies

The methodological quality of included studies was assessed using the Quality Assessment Tool for Quantitative Studies (QATQS).[36] This tool has been recommended by the Cochrane Collaboration for use in systematic reviews.[35] An overall rating of methodological quality (strong/moderate/weak) was assessed by extracting information across six domains: selection bias; study design; confounders; blinding; data collection methods; withdrawals and dropouts. All six components contributed to the calculation of the study's global rating. A study's global rating is dependent on the number of component rated weak study (weak – 2 or more; moderate – 1; strong – none). Intervention integrity and analysis assessment were also included in the tool but did not contribute to the global rating. The component 'blinding' was modified to exclude participant blinding from influencing the study quality due to the inability to blind participants in active travel interventions. The characteristics of the QATQS have been evaluated and shown validity, test-retest reliability and inter-rater reliability[35]. Information from quality assessment was used for descriptive analysis of study quality and risk of bias. Two authors (RJ and MT) independently appraised study quality of all included studies, with discrepancies resolved through discussion.

Assessment of Intervention Strategy Usage

The design of each intervention was described using the Active Living by Design Community Action Model.[37] This model has been successfully applied in active transport to school studies previously.[38-39] The included studies were assessed for explicit referral of the model strategies (5P's): preparation, promotions, programs, policies and physical projects.

Assessment of Intervention Complexity

The complexity of the studies included was assessed using the intervention Cochrane Collaboration's intervention Complexity Assessment Tool for Systematic Reviews (iCAT_SR).[40] The tool assessed various

dimensions of the studies and categorised the level of complexity as 'complex', 'moderately complex' or 'simple'. The dimensions assessed included: the number of active components, level of skill required for intervention delivery and the level of component interaction. The global score for each included study was calculated by the sum of the individual component rating scores (simple=1, moderately complex=2, complex=3). The tool was piloted on two studies by both investigators to ensure consistency in the way it was applied. Two authors (RJ and MT) independently appraised intervention complexity of all included studies, with discrepancies resolved through discussion.

The relationship between complexity and effectiveness was assessed through scatter plot and correlation using IBM SPSS Statistics 23 software. In a scatter plot, each study's global score for complexity was plotted against effect size (Cohen's D). If a study had multiple outcomes, the mean of the calculated effect sizes was used. From the scatter plot, identification of a possible correlation was determined. A Spearman's rank-order correlation test was used as the data did not meet parametric assumptions (Shapiro-Wilk: $p<0.05$). The purpose of conducting a correlation test was to investigate if there was a relationship between complexity and effectiveness in terms of strength of association (r-value) and significance (p-value).

Statistical Analyses of Intervention Effectiveness

Continuous data were synthesised using random effects meta-analysis (RevMan v5.3, Cochrane Collaboration). Differences in outcomes between the intervention and controls at follow-up were compared. As a variety of outcomes measures were used, standardised mean difference was calculated. Separate meta-analyses were conducted for continuous measures of active travel (e.g. minutes per week), frequency of active travel (e.g. active travel journeys per week) and continuous measures of physical fitness (e.g. aerobic capacity). Within these outcome types, studies were further sub-divided by outcome type for sub-group and overall effect analysis. Heterogeneity using the I^2 statistic was calculated for all analyses. Publication bias of the studies included in the meta-analysis was assessed using a funnel plot.

Study data, regardless of data type, were further synthesised by the calculation of Cohen's d effect size. The effect size between intervention and control groups and baseline and follow-up was calculated using standardised mean/proportion difference. Cohen's D classified effect size as trivial ($d < 0.2$), small ($d = 0.2$-0.5), moderate ($d = 0.5$-0.8), large ($d = 0.8$-1), and very large ($d < 1$).[23,41]

Results

Study selection

The electronic search of the selected databases produced a total of 3,431 potentially relevant studies (Medline (*n=266*), EMBASE (*n=320*), PsycINFO (*n=358*), Web of Science (*n=2,403*), TRIS (*n= 84)*). Duplication checks resulted in the removal of 248 studies.

A total of 3,183 potentially relevant studies remained for title, abstract and key word screening. 3,099 studies were excluded, leaving 84 studies for full-text screening. The screening of reference lists of potentially relevant studies and reviews identified 19 additional potentially relevant studies. After full-text screening and eligibility assessments of 103 studies, 17 studies met the inclusion criteria and were included in the review.[30,32,42-56] Any disagreements during screening were discussed by the investigators for a jointly agreed decision. Figure 1 represents the selection and review process in flow diagram format in line with PRISMA guidelines.[57]

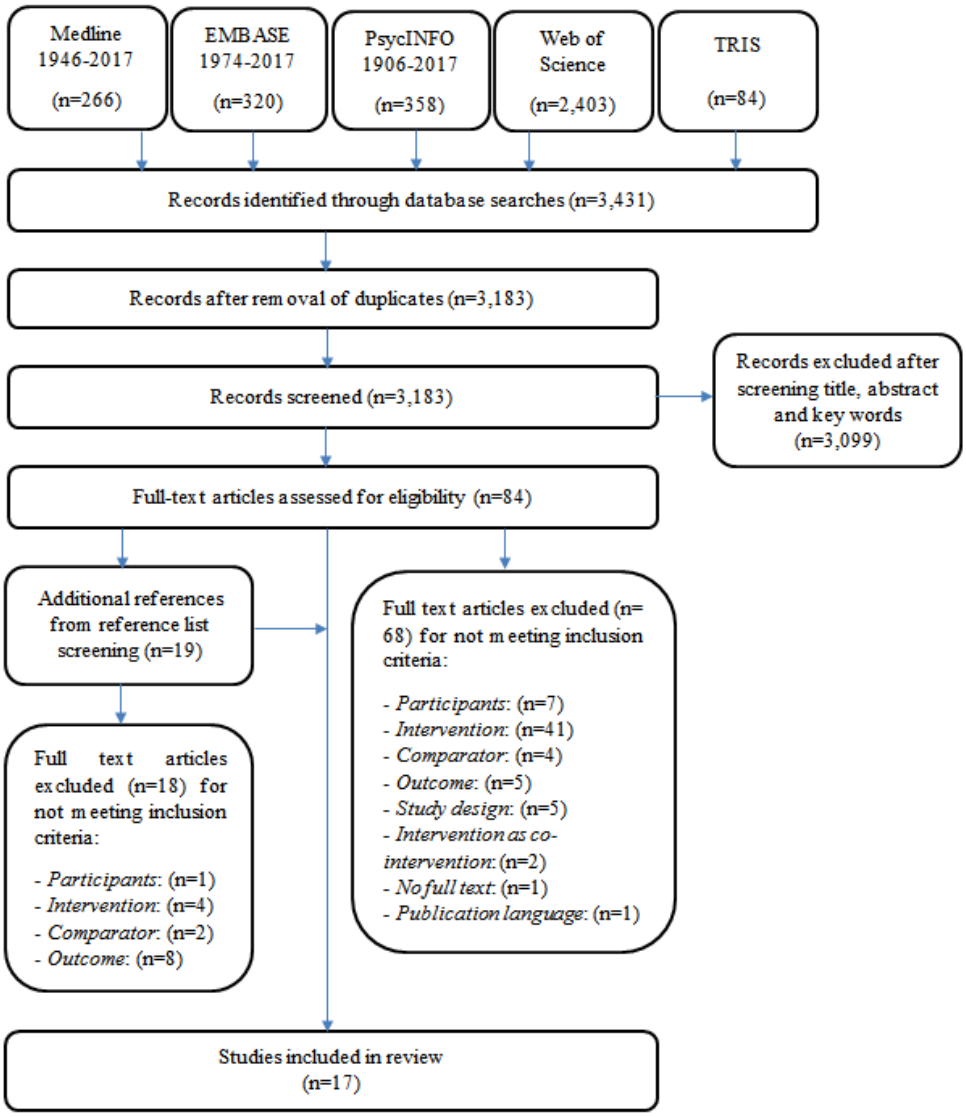

Figure 1. Flow diagram representing the selection and review process.

Study characteristics

The characteristics of the included review studies are included in Supplement B. Whilst the participant groups were relatively similar across studies, the interventions were significantly heterogeneous in terms of study duration, intervention type, outcome measures and duration of follow-up.

Eight quasi-experimental studies, four randomised control trials, three controlled trials, one cluster randomised control trial and one controlled cohort analytic study have been included in this review. Seven studies were conducted in United States and four studies were conducted in the United Kingdom. The remaining studies were conducted in Australia, Norway, Belgium, Demark and Spain.

Intervention types across studies were diverse. Four interventions were walking school buses, and seven focused on education and encouragement of active travel. One study involved both education and encouragement

alongside a one-day active travel event. Two studies provided cycling training, and one study utilised modern technology through street sensor activation. The remaining two interventions were in the form of infrastructure changes, with one of these studies also incorporating funding allocation as part of the intervention. Intervention duration also varied greatly across the included studies ranging from a 1-day event to 2 year interventions. The majority of interventions lasted between 4-12 weeks.

The majority of studies included children at the upper end of the age range (8-11 years old), with only one study including children as young as 5 years old. The outcome measures varied significantly, increasing the difficultly of study comparisons. All studies, excluding one, provided an outcome measure of active travel with only one study providing only a measure of fitness (maximal oxygen consumption (VO^2_{max})).

Many studies used self-report methods completed by the student or parent, increasing the likelihood of response recall or social desirability bias.[58] Despite many studies using these methods, some studies used valid and reliable objective forms of measurement (e.g. Actigraph[47], cycle ergometer[51]), evidencing the feasibility of using more sensitive and accurate methods.[49,52]

Quality of Included Studies

The methodological quality of included studied was completed using the EPHPP tool. All studies, excluding one, were concluded to be of weak overall quality (global rating). Despite the inclusion of only controlled experimental designs, nine studies scored weak quality for study design. Quasi-experimental studies were all rated as of weak quality as they were rated as weak in both the study design and blinding domains. The EHPP tool defines weak quality studies as those with a rating of weak in two or more domains. Supplement C presents the quality of each included study for each component and global rating of quality. Figure 2 presents the summary of methodological quality of included studies.

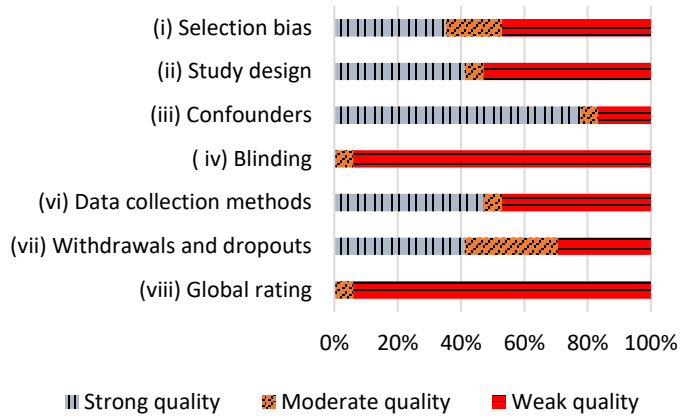

Figure 2. Summary of methodological quality of included studies.

Intervention strategy assessment

None of the review studies included all five of the Active Living by Design strategies from the model. Two studies included four strategies; Mendoza et al. (2009) did not include a 'policies' component, and Ostergaard et al. (2005) did not include a 'preparation' component.[51,55] The majority of interventions used three strategies, and the most commonly used strategies were 'preparation', 'promotion' and 'programs'. The least used strategy was 'policies', closely followed by 'physical projects'. Two studies used one strategy, 'promotion', each.

Effectiveness

Of the 17 studies included in the review, 11 studies provided data for inclusion in the meta-analysis. The remaining studies outcome measures were inappropriate data types for meta-analysis. Figure 3 and 4 show forests plots of continuous and frequency data for active travel outcomes. Figure 5 shows a forest plot of the continuous data for physical fitness outcomes. Funnel plot asymmetry suggested publication bias may be present.

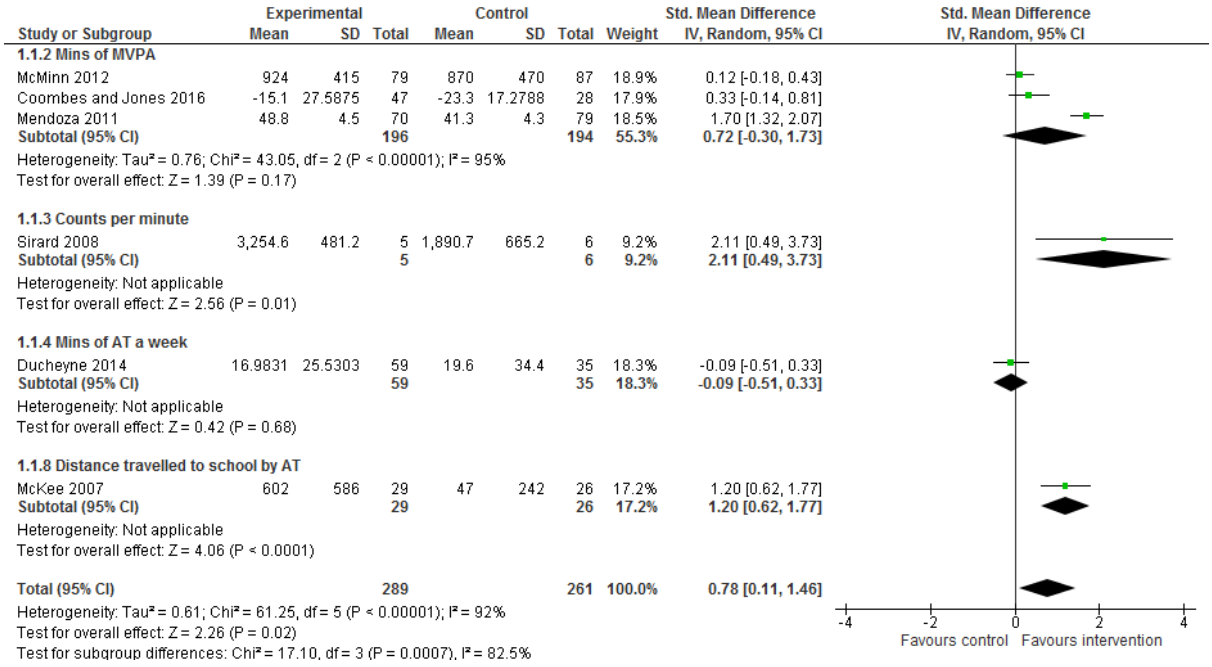

Figure 3. Forest plot of continuous active travel data (6 studies).

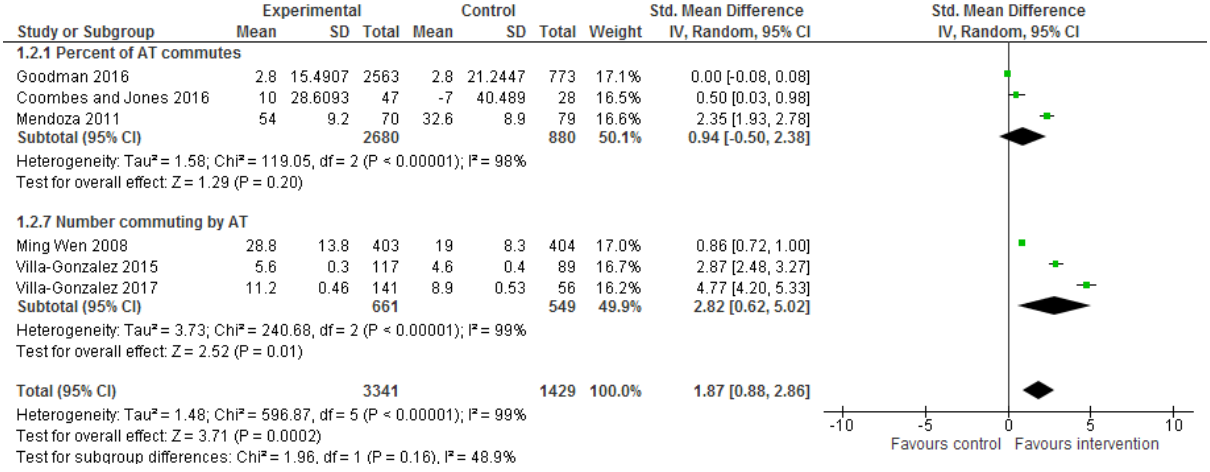

Figure 4. Forest plot of frequency active travel data (6 studies).

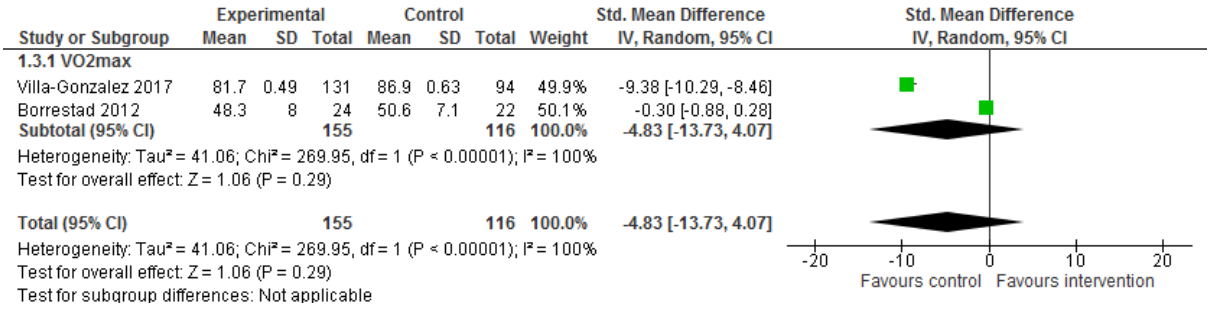

Figure 5. Forest plot of continuous physical fitness data (2 studies).

Assessment of the effect of interventions on continuous active travel outcomes resulted in a statistically significant difference in favour of the intervention (SMD 0.78, 95% CI 0.11-1.46, n=550) (Figure 3). The majority of studies had standardised mean differences in favour of the intervention, with only two study's results favouring the control.[30,53] The confidence interval and *p*-value (*p*=0.02) for overall effect shows a statistically significant effect favouring the intervention. The heterogeneity of the results was very high (I^2=92%), reducing the confidence in the consistency of the findings.

Frequency active travel outcomes (figure 4) had a range of standardised mean differences from 0.00 (-0.08, 0.08) to 4.77 (4.20, 5.33).[32,44] All studies favoured the intervention, with only one study showing no difference.[43] The overall standardised mean difference for frequency active travel outcomes significantly favoured the intervention (SMD 1.87, 95% CI 0.88-2.86, n=4770). The heterogeneity of the frequency outcomes was very high (I^2=99%), decreasing the sureness of the consistency of the findings.

Continuous physical fitness outcomes (figure 5) had standardised mean differences ranging from -9.38 (-10.29, -8.46) to -0.30 (-0.88, 0.28).[32,52] The overall standardised mean difference favoured the control (SMD -4.83, 95% CI -13.73-4.07, n=271). The overall effect was not statistically significant, indicated by the confidence intervals and *p*-value (*p*=0.29). Both study's intervention included in this analysis focused upon education and encouragement. There were only two studies measuring cardiovascular fitness, reducing the applicability of these results to future public health practice. The heterogeneity was very high (I^2=100%).

Cohen's D effect size

Due to the large heterogeneity of the studies, few studies were able to be included in a meta-analysis at once. The calculation of Cohen's D effect size allowed the comparison of 14 included studies. It was not possible to calculate effect size for three studies due to missing data.[44,49,55] The method of calculation and effect sizes are shown in Supplement D. The majority of study outcomes showed positive effect sizes ranging from trivial to very large. The range of effect sizes across all included studies was from -9.48 to 12.24, with a mean effect size of 0.50 (±3.44) in favour of the intervention.

Complexity assessment

The complexity of each intervention was assessed using iCAT_SR (Table 1). There was significant diversity in the level of complexity of the included studies, global scores for complexity ranged from 11/30 to 23/30, with mean of 15.7 (±3.32). The most 'simple' intervention was a walking school bus, whereas the most complex intervention provided multiple components directed at varying levels (students, teachers, parents).[47-48] The most common complexity rating was simple, with exception of component 8 (the degree to which the effects of the intervention are dependent on the context), which received the highest rating of moderately complex or complex.

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)	Global score (/30)
Borrestad et al. (2012) [53]	1	1	1	1	1	2	1	2	1	3	14
Bungum et al. (2014) [44]	2	1	1	3	1	1	1	1	2	1	14
Coombes and Jones (2016) [30]	3	1	1	1	1	2	2	1	1	1	14
Ducheyne et al. (2014) [54]	2	2	2	1	1	1	1	3	1	1	15
Goodman et al. (2016) [45]	2	2	1	1	3	1	3	1	2	2	18
Groesz (2007) [46]	2	3	2	1	3	1	3	3	1	2	21
Heelan et al. (2009) [50]	1	1	1	1	1	1	1	3	1	1	12
Hoelscher et al. (2016) [56]	1	1	1	3	1	1	1	3	1	3	16
McKee et al. (2007) [47]	1	1	1	1	1	1	1	2	2	1	12
McMinn et al. (2012) [43]	2	3	1	3	2	1	1	1	2	2	18
Mendoza et al. (2009) [51]	3	1	1	1	1	1	1	3	1	1	14
Mendoza et al. (2011) [52]	1	1	1	1	1	1	1	3	1	1	12
Ming Wen et al. (2008) [48]	3	1	2	2	2	2	3	3	3	2	23
Ostergaard et al. (2015) [55]	3	2	1	3	1	2	1	2	2	3	20
Sirard et al. (2008) [49]	1	1	1	1	1	1	1	2	1	1	11
Villa-Gonzalez et al. (2015) [42]	3	3	1	1	1	1	1	2	1	3	17
Villa-Gonzalez et al. (2017) [32]	3	2	1	1	1	1	1	1	1	3	15
Mean	2	1.6	1.4	1.5	1.4	1.2	1.4	2.1	1.4	1.8	15.7
Mode	1	1	1	1	1	1	1	3	1	1	14

Key: 1 – simple; 2 – moderately complex; 3 – complex.

(i) Number of discrete, active components.

(ii) Number of behaviours or actions of intervention recipients or participants to which the intervention is directed.

(iii) Number of organisational levels targeted by the intervention.

(iv) The degree of flexibility or tailoring permitted across sites or individuals in intervention implementation / application.

(v) The level of skill required by those delivering the intervention.

(vi) The level of skill required for the targeted behaviour when entering the study by those receiving the intervention in order to meet the intervention's objectives.

(vii) The degree of interaction/independence between intervention components of intervention components.

(viii) The degree to which the effects of the intervention are dependent on the context or setting.

(ix) The degree to which the effects of the intervention are modified by participant or provider factors.

(x) The length of the causal pathway between the intervention and the outcome.

Table 1. Complexity summary graph.

Figure 6 presents the relationship between complexity and effectiveness by Cohen's D effect size, showing that there is no correlation. A Spearman's rank-order correlation assessed the relationship, resulting in a moderate negative non-significant relationship (r=-0.270; p=0.351) suggesting, that for these interventions, there was no increased effectiveness with more complex interventions.

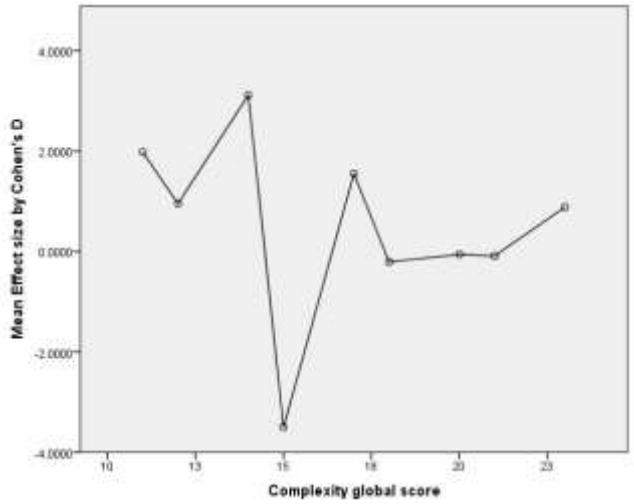

Figure 6. Scatter graph presenting complexity global score against effectiveness by Cohen's D effect size

Discussion

This review concluded that active travel interventions are effective at increasing PA in children. The effect was not observed for physical fitness, hypothesised to be due to the extremely limited available evidence. Active travel intervention studies included in this review were strongly heterogeneous in terms of intervention type and were of weak quality. Walking school buses and educational strategies were the most effective intervention types, with very few interventions using 'policies' despite strong evidence of effectiveness.[59] No relationship between complexity and effectiveness was observed.

Conclusions of effectiveness and the overall weak quality of included studies are in line with the findings of the reviews conducted by Chillon et al. in 2011 and Villa-Gonzalez et al. in 2018.[23-24] Comparison of review findings must be considered with caution due to the differing eligibility criteria such as the age of participants included and eligible study design types. Furthermore, the current review differed from previous as studies with a PA co-intervention were excluded to ensure the findings were the result of active travel promotion only. The included studies therefore differ greatly between the current and previous reviews. Chillon et al. evaluated 14 studies of children aged 6-18 years old; Villa-Gonzalez et al. followed the same procedure as the previously mentioned reviewed and included 23 studies.[23] The current review included 17 studies despite applying more restrictive criteria, highlighting the increase in research in this field since 2011.

The current review shows that despite diversity of intervention types in individual studies, the overall effect is a promising increase in active travel to school, and this effect does not seem to be related to the complexity of the intervention. The included studies varied greatly in many aspects, including intervention type and duration, outcome measures, follow-up duration, and study locality. Review findings of effectiveness must be interpreted with caution due to the heterogeneity in the included studies. It should be noted that heterogeneity of the included studies was high (99-100%), similar to the previous systematic review.[23-24]

A number of successful interventions provided a walking school bus (WSB), varying from simple WSB programme to a walking school bus alongside other activities/materials. Sub-group meta-analysis of WSB studies was not possible as one study did not provide sufficient data. Future research should ensure to provide complete data to allow the analysis of the pooled effect. Education based interventions (e.g. story reading, knowledge lessons) found success in improving active travel behaviours. Sub-group analysis (Figure 4) concluded a pooled effect of 2.82 (0.62-5.02) in favour of the intervention. The success of these programmes was limited in comparison to walking school buses, possibly due to limited attention to the complex range of determinants (e.g. family, social, environmental). Future studies are needed to assess the additional benefit of combining the successful elements of WSBs and educational interventions to increase the impact on active travel outcomes.

Assessment of the intervention strategies concluded that intervention research to date is insufficient at including the recommended 'Active Living by Design' elements. No consistent relationship could be determined between intervention strategy (5Ps) use and effectiveness. The inconsistent relationship indicates a need for further research. The framework used lacks the capacity to distinguish between 'active' or 'inactive' intervention strategies. Future research should consider the 'active' or 'inactive' nature of an intervention component as this may play an important role in effectiveness. The most commonly used strategies were 'preparation', 'promotion' and 'programs', with 'policies' and 'physical projects' as the least used strategies. Only two included studies explicitly referred to the use of active travel policy, despite active travel policies being shown to be highly likely to produce large individual health benefits, as well as reductions in air and noise pollutions.[59]

No previous research has explored the complexity of active travel interventions. Assessing the relationship between effectiveness and complexity suggested that there was no significant correlation. Therefore complexity may not be a key indicator of success within active travel interventions. The conclusion regarding the relationship between complexity and effectiveness must be considered with caution due to limitations of assessment. Further research is necessary to explore this relationship further, utilising rigorous techniques and controlling for external influences.

The review findings have the potential to influence the field of public health. Although the decline in childhood PA may not be solely addressed through enhanced active travel, the findings show promise to positively impact children's behaviours. Walking school buses are a promising method of increasing PA and active commuting rates in children, with educational strategies also showing success.

It is recommended for schools aiming to increase active commuting rates to implement walking school buses alongside educational strategies. More research is required in the field to allow stronger and more reliable review findings. Future studies should compare the effectiveness of active travel intervention components and durations to determine those that are most successful. Future research should assess the effectiveness of active travel policies, as well as investigating sustainability of health effects. All future intervention studies should seek to use robust controlled methodology.

Study limitations and strengths

The review findings add substantially to the active travel intervention evidence base. The previous reviews included non-experimental designs due to a lack of high quality research at the time.[23-24] The growth of active travel research allowed the current review to include only controlled experimental designs, increasing the strength of the review findings. However there were a number of limitations to be noted. The high heterogeneity in study designs and outcomes increases the complexity of summarising effectiveness, whilst weak study quality and the use of self-reported methods to assess changes in PA reduces the strength and reliability of study findings. The wide ranging types of intervention made comparison of study findings difficult. Generalisation of the review's summary evidence is limited by these factors. Furthermore, the exclusion of non-English language studies may result in incomplete representation of the relevant literature.

Conclusions

The review's primary aim was to summarise the effectiveness of active travel interventions on active travel rates and physical fitness in primary school children. The review found that active travel interventions are successful at increasing rates of active commuting to school in primary school children, yet did not find success for increases in physical fitness, hypothesised to be due to the extremely limited available evidence. Further research is required to strengthen review findings. Studies of active travel policies, intervention types, active intervention ingredients and outcome sustainability are necessary. Future intervention studies should apply more rigorous methods to improve research quality. Representative samples, larger sample sizes, randomised controlled designs and valid and reliable measures should be a priority within future active travel research.

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Conflict of Interest statement: The authors declare that there are no conflicts of interest.

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Supplement A: Search strategy

Four categories of search terms were identified:

1) Active transportation,
2) Interventions,
3) Age,
4) Study design.

The electronic search was conducted in 4 databases:

1. Medline:

WALKING/ OR *BICYCLING*/ OR *(activ* adj5 (travel* or transport*))* OR *"walk to school*"* OR *"safe routes to school*"* OR *"walking school?bus*"* OR *"walk* bus*"*) and (*exp HEALTH PROMOTION*/ OR *PUBLIC HEALTH*/ OR *intervention** OR *initiative** OR *implement** OR *project** OR *pilot** OR *scheme**) AND (*CHILD*/ OR *CHILD HEALTH*/ OR *"primary school*"* OR *"elementary school*"* OR *"infant school*"* OR *"junior school*"*) AND (*"randomi#ed control*"* OR *controlled* OR *trial** OR *randomly*))

2. EMBASE:

WALKING/ OR CYCLING/ OR (activ* adj5 (travel* or transport*)) OR "walk to school*" OR "safe routes to school*" OR "walking school?bus*" OR "walk* bus*") and (exp HEALTH PROMOTION/ OR PUBLIC HEALTH CAMPAIGN/ OR PUBLIC HEALTH/ OR HEALTH EDUCATION/ OR intervention* OR initiative* OR implement* OR project* OR pilot* OR scheme*) AND (CHILD/ OR CHILD HEALTH/ OR PRIMARY SCHOOL/ OR ((elementary or infant* or junior*) adj5 school*)) AND ("RANDOMIZED CONTROLLED TRIAL (TOPIC)"/ OR "randomi#ed control*" OR controlled OR trial* OR randomly))

3. PsycINFO:

(EXERCISE/ or TRAVELLING/ or WALKING/ or PHYSICAL ACTIVITY/ or "COMMUTING (TRAVEL)"/ or (activ* adj5 (travel* or transport*)).mp. or "walk to school*".mp. or "safe routes to school*".mp. or "walking school?bus*".mp. or "walk* bus*".mp.) and (INTERVENTION/ or SCHOOL BASED INTERVENTION/ or exp HEALTH PROMOTION/ or PUBLIC HEALTH/ or intervention*.mp. or initiative*.mp. or implement*.mp. or project*.mp. or pilot*.mp. or scheme*.mp.) and (("primary school*" or "elementary school*" or "infant school*" or "junior school*").mp. or school*.ti,ab.) and ("randomi#ed control*" or controlled or trial* or randomly).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures]

4. Web of Science:

TS=(*walk**) OR TS=(*cycl**) OR TS=(*activ* near/2 (travel* or transport**)) OR TS=(*"walk to school*"* or *"safe routes to school*"* or *"walking school$bus*"* or *"walk* bus*"*) AND TOPIC: (*intervention** or *initiative** or *implement** or *project** or *pilot** or *scheme**) OR TOPIC: (*"health promotion*"*) OR TOPIC: (*"public health*"*) AND TOPIC: (*child**) OR TOPIC: ((*primary or elementary or infant* or junior*) near/5 school**) AND TOPIC: (*"randomi?ed control*"*) OR TOPIC: (co*ntroll*ed or *trial** or *randomly*)

5. TRIS:

(walk* OR cycl* OR activ* (travel* or transport*) OR "walk to school*" OR "safe routes to school*" OR "walking school bus*" OR "walk* bus") AND (intervention* OR initiative* OR implement* OR project* OR pilot* OR scheme* OR "health promot*" OR "public health") AND (child* OR primary OR elementary OR infant* OR junior* OR school*) AND (random* OR control* OR trial*)

Supplement B: Characteristics of studies

Study author and year	Methods	Participants	Intervention	Outcomes	Notes
Borrestad et al. (2012) [53]	**Design:** RCT **Country (locality):** Norway	**Setting:** School based **Intervention group:** 26 students in Kristiansand community – living less than 5 km from school, access to bicycle, not cycling to school in last 3 months. **Control group:** 27 students in Kristiansand community – living less than 5 km from school, access to bicycle, not cycling to school in last 3 months. **Age:** 10-13 years old. Mean 10.8 years (±0.7). **Gender:** 47.1% female, 52.9% male **Ethnicity:** Not stated	**Name of intervention:** N/A **Duration:** 12 weeks. **Components:** Intervention group encouraged to cycle to school. 30 minute group sessions every other week focusing on raising awareness, health benefits and helping parents support. Control group received healthy eating program for 2 years.	**Primary outcome:** Cardiovascular fitness ($VO2_{max}$). **Number of follow-ups:** 2 **Follow up time points:** Baseline and 2 years	**Conflict of interest:** No **Funding source:** University of Agder
Bungum et al. (2014) [44]	**Design:** Quasi-experimental **Country (locality):** USA	**Setting:** School based **Intervention group:** 66 students at baseline at 1 school participating in Nevada Moves Day. **Control group:** 78 students at baseline at 1 school not participating in Nevada Moves Day. **Age:** In K5 grade - no specific age range stated. **Gender:** 43.8% female, 56.2% male **Ethnicity:** Not stated.	**Name of intervention:** Nevada Moves Day **Duration:** 1 day plus promotion prior. **Components:** NMD schools allowed to promote intervention as they wish. Intervention school used following strategies: Morning announcements; Letter to parents; Telephone message to parents; Marquis advertisement; Teacher promotion; Sticker for students actively travelling. Control group received no intervention.	**Primary outcome:** Mode of travel to school **Number of follow-ups:** 3 **Follow up time points:** 1 week prior, on NMD, and 1 week after.	**Conflict of interest:** No **Funding source:** Not stated.
Coombes and Jones (2016) [30]	**Design:** Controlled trial **Country**	**Setting:** School based **Intervention group:** 51 students in year 4 and 5 at 1 school.	**Name of intervention:** Beat the Street **Duration:** 9 weeks **Components:** Beat boxes installed in	**Primary outcome:** Mode of travel to school **Number of follow-ups:** 3	**Conflict of interest:** No **Funding source:**

Study author and year	Methods	Participants	Intervention	Outcomes	Notes
	(locality): UK	**Control group:** 29 students in year 4 and 5 at 1 school 7.5 km away from intervention school. **Age:** 8-10 years old (*Intervention*: 66.7% in year 4; *Control*: 44.8% in year 4). **Gender:** *Intervention*: 62.7% female; *Control*: 41.4% female. **Ethnicity:** Not stated.	street environment. Students awarded when touch smartcard on sensor. Target setting Between school competitions Group level competitions Promotion events Control group received no intervention.	**Follow up time points:** Baseline, week 7 (during) and week 20 (post).	CEDAR – UK Clinical Research Collaboration
Ducheyne et al. (2014) [54]	**Design:** RCT **Country (locality):** Belgium	**Setting:** School based **Intervention group:** Group 1 (Intervention): 25 students in 4th grade at 1 school in Flanders, Belgium. Group 2 (Intervention+Parents): 34 students in 4th grade and their parents at 1 school in Flanders, Belgium. **Control group:** 35 students in 4th grade at 1 school in Flanders, Belgium. **Age:** 9-10 years old (Mean 9.33 years old (±0.5)). **Gender:** 52.17% female, 47.83% male. **Ethnicity:** Not stated.	**Name of intervention:** N/A **Duration:** 1 month **Components:** Intervention group received cycle training consisting of 4 sessions. Intervention+Parents group received cycling training with 4 sessions and parental involvement tasks. Control group received no intervention.	**Primary outcome:** Minutes cycling to school per week **Number of follow-ups:** 3 **Follow up time points:** Baseline, post-intervention, and 5 months.	**Conflict of interest:** No **Funding source:** Lifeline campaign of the Research Foundation, Flanders FWOAL

Study author and year	Methods	Participants	Intervention	Outcomes	Notes
Goodman, van Sluijs and Ogilvie (2016) [45]	**Design:** Cohort analytic (two group pre and post) **Country (locality):** England	**Setting:** School based **Intervention group:** 2563 children from Millennium Cohort Study **Control group:** 773 children from Millennium Cohort Study. **Age:** 10-11 years; 36% 10 years, 64% 11 years **Gender:** 50% female, 50% male **Ethnicity:** 86% White, 3% Mixed, 9% South Asian	**Name of intervention:** Bikeability **Duration:** 1 month – 4 sessions lasting 2 hours. **Components:** Cycle training scheme to give children both practical skills and understanding of how to cycle on roads. Scheme has 3 levels: Level 1 – off road training, Level 2 – on road training, Level 3 – advanced on road training. Level 3 rarely delivered at Primary school level. Control group received no intervention.	**Primary outcome:** Cycling behaviour – 'Child ever cycles', 'Child usually travels to school by bike' **Number of follow-ups:** 2 **Follow up time points:** Baseline and median 5 months.	**Conflict of interest:** No **Funding source:** Economic and Social Research Council (ESRC)
Groesz (2007) [46]	**Design:** Controlled trial **Country (locality):** USA	**Setting:** School based **Intervention group:** 74 students in 4th or 5th grade from 4 schools in medium sized southwestern city. **Control group:** 45 students in 4th or 5th grade from 3 schools in medium sized southwestern city. **Age:** 9.16 – 12.04 years old (Mean 10.41 years old (±0.64)). **Gender:** 59.3% female, 40.3% male. **Ethnicity:** 61.40% White, 17.5% Hispanics, 10.53% Blacks, 7.1% Other, 2.63% Native Americans, 0.98% Asian American	**Name of intervention:** BikeTexas Safe Routes to School **Duration:** 2 years **Components:** Educational component: 15 lessons during 6 hours of training – safety, laws and bike/body maintenance. Curriculum handouts. Encouragement – e.g. contests. Control group received no intervention.	**Primary outcome:** Concurrent ten-day bicycling and walking to school; Retrospective five-day bicycling and walking to school. **Number of follow-ups:** 2 **Follow up time points:** Baseline and 7 months.	**Conflict of interest:** No **Funding source:** The University of Texas at Austin.
Heelan et al. (2009) [50]	**Design:** Quasi-experimental **Country (locality):** USA	**Setting:** School based **Intervention group:** 201 students in 1st to 5th grade at 2 schools with no walk to school programs in school district. **Control group:** 123 students in 1st to 5th grade at 1 schools with no walk to school programs in school district. **Age:** *Intervention*: Mean 8.1 years old (±1.7); *Control*: Mean 8.4 years old (±1.6)	**Name of intervention:** Walking School Bus (WSB) **Duration:** 2 years **Components:** Walking school bus lead by adult WSB leader with designated walk-stops within 1 mile radius of the school. Control group received no intervention.	**Primary outcome:** Prevalence of walking to/from school; Daily physical activity levels. **Number of follow-ups:** 6 **Follow up time points:** 3 times a year (August, February, May) over 2 year period.	**Conflict of interest:** No **Funding source:** American Heart Association.

Study author and year	Methods	Participants	Intervention	Outcomes	Notes
		Gender: 55.2% female, 44.8% male. **Ethnicity:** 90% White, 7% Hispanics			
Hoelscheret al. (2016) [54]	**Design:** Quasi-experimental **Country (locality):** USA	**Setting:** School based **Intervention group:** Group 1 (Infrastructure project): 4th grade students at 23 schools with awarded infrastructure projects. Group 2 (Non-infrastructure project): 4th grade students at 21 schools with awarded non-infrastructure projects. **Control group:** 4th grade students at 34 matched schools. **Age:** 4th grade – no specific age range stated. **Gender:** 48.3% female, 51.7% male. **Ethnicity:** *Intervention group 1:* 18.8% White, 7.1% Black or African American, 70.3% Latino or Hispanic, 3.8% Other *Intervention group 2*: 25.7% White, 7% Black or African American, 63.6% Latino or Hispanic, 3.7% Other *Control*: 25.9% White, 7% Black or African American, 63.5% Latino or Hispanic, 3.6% Other	**Name of intervention:** N/A **Duration:** Varying **Components:** Funding allocation as intervention: Infrastructure schools had an SRTS plan prior to any structural changes - had several years to complete plan. Non-infrastructure schools had to submit an SRTS plan by 2008 - implementation was not required. Control schools were matched but received no SRTS funding.	**Primary outcome:** Active commuting to school counts. **Number of follow-ups:** 4 **Follow up time points:** Baseline (2009), interim 1 (2010), interim 2 (2011) and follow-up (2012).	**Conflict of interest:** No **Funding source:** Robert Wood Johnson Foundation, Michael & Susan Dell Foundation, The University of Texas School of Public Health, Texas A&M Health Science Center School of Public Health, Texas Health Institute, Live Smart Texas, and the Texas Department of State Health Services.
McKee et al. (2007) [45]	**Design:** Quasi-experimental **Country (locality):** Scotland	**Setting:** School based **Intervention group:** 31 students at 1 school, living within statutory walking distance. **Control group:** 29 students at 1 school, living within statutory walking distance. **Age:** 9-10 years old - Mean 9 years old. **Gender:** 60% female, 40% male. **Ethnicity:** Not stated.	**Name of intervention:** Travelling Green **Duration:** 10 weeks **Components:** Written interactive resources used by teachers, children and families – 'curriculum materials', and 'children and family resources'. Control group received no intervention.	**Primary outcome:** Distance travelled to school by walking. **Number of follow-ups:** 2 **Follow up time points:** Baseline and 10 weeks.	**Conflict of interest:** No **Funding source:** NHS Greater Glasgow.

Study author and year	Methods	Participants	Intervention	Outcomes	Notes
McMinn et al. (2012) [41]	**Design:** Quasi-experimental **Country (locality):** Scotland	**Setting:** School based **Intervention group:** 79 students in P5 at 2 schools – 1 school from low deprivation quartile and 1 school from high deprivation quartile. **Control group:** 87 students in P5 at 3 schools – 1 school from low deprivation quartile and 2 school from high deprivation quartile. **Age:** 8-9 years old. *Intervention*: Mean 8.7 years old (±0.51). *Control*: Mean 8.6 years old (±0.48). **Gender:** 40.5% female, 59.5% male. **Ethnicity:** Not stated.	**Name of intervention:** Travelling Green **Duration:** 6 weeks **Components:** Teacher's handbook with introductory activities – series of 13 lessons. Pupil pack describing project and including activities and handouts. Control group received no intervention.	**Primary outcome:** Steps during total commute; Moderate-to-vigorous physical activity (MVPA) time during total commute. **Number of follow-ups:** 2 **Follow up time points:** 5 days pre-intervention and 5 days post-intervention.	**Conflict of interest:** No **Funding source:** National Physical Activity Research Evaluation Group and Sustrans.
Mendoza et al. (2009) [49]	**Design:** Quasi-experimental **Country (locality):** USA	**Setting:** School based **Intervention group:** 347 students at 1 school in Seattle (Washington) with no Parent Teacher Organisation and low parent involvement at school. **Control group:** 473 students at 2 schools in Seattle (Washington) with no Parent Teacher Organisation and low parent involvement at school. **Age:** 5-11 years old. **Gender:** *Intervention*: 44% female; *Control school 1*: 43% female; *Control school 2*: 52% female. **Ethnicity:** *Intervention*: 4% American Indian, 21% Asian, 50% African American, 20% Latino, 5% Caucasian. *Control school 1*: 0% American Indian, 12% Asian, 67% African American, 18% Latino, 3% Caucasian. *Control school 2*: 3% American Indian, 2% Asian, 80% African American, 8%	**Name of intervention:** Walking School Bus **Duration:** 1 year **Components:** Walking school bus School wide activities Materials on safety Allocated WSB coordinator Control group received no intervention.	**Primary outcome:** Proportion of student walking to school. **Number of follow-ups:** 4 **Follow up time points:** Baseline, 1 month, 6 months and 12 months.	**Conflict of interest:** No **Funding source:** Washington State Department of Transportation, Robert Wood Johnson Foundation, Feet First, University of Washington, United States Department of Agriculture.

Study author and year	Methods	Participants	Intervention	Outcomes	Notes
		Latino, 8% Caucasian.			
Mendoza et al. (2011) [50]	**Design:** RCT **Country (locality):** USA	**Setting:** School based **Intervention group:** 70 4th grade students at 4 low income public schools in Houston (Texas), living within 1 mile of schools. **Control group:** 79 4th grade students at 4 low income public schools in Houston (Texas), living within 1 mile of schools. **Age:** *Intervention*: Mean 9.7 years old (±0.6). *Control*: Mean 9.8 years old (±0.7). **Gender:** 53% female, 47% male. **Ethnicity:** *Intervention*: 2.9% Non-Hispanic White, 22.9% Non-Hispanic Black, 67.1% Hispanic, 4.3% Other, 2.9% Missing data. *Control*: 0% Non-Hispanic White, 39.2% Non-Hispanic Black, 55.7% Hispanic, 3.8% Other, 1.3% Missing data.	**Name of intervention:** Walking School Bus **Duration:** 5 weeks **Components:** 3 walking school bus routes with trained staff leading the walk. Control group received no intervention.	**Primary outcome:** Percentage of trips made by active commuting over 1 school week; Daily minutes of MVPA. **Number of follow-ups:** 2 **Follow up time points:** Baseline and during week 4 and 5 of intervention.	**Conflict of interest:** No **Funding source:** National Institutes of Health

Study author and year	Methods	Participants	Intervention	Outcomes	Notes
Ming Wen et al. (2008) [46]	**Design:** Cluster RCT **Country (locality):** Australia	**Setting:** School based **Intervention group:** 1094 students from 12 schools in inner West Sydney. Average 92 students per cluster. **Control group:** 1164 students from 12 schools in inner West Sydney. Average 97 students per cluster. **Age:** 10-11 year olds **Gender:** 52.7% female, 47.3% male **Ethnicity:** Not stated	**Name of intervention:** Multi-component programme. **Duration:** 2 years **Components:** *School* – student survey, home to school mapping exercise, preparation for high school; *Teachers* – training, classroom materials, travel access guide; *Parents* – survey, newsletter, meetings; *Council* – Review of safety and walkability near schools and efforts to improve.	**Primary outcome:** Mode of travel to school – student and parent reported **Number of follow-ups:** 2 **Follow up time points:** Baseline and 2 years	**Conflict of interest:** No **Funding source:** Central Sydney Walk to School Research Program – NSW Department of Health
Ostergaard et al. (2015) [55]	**Design:** Quasi-experimental **Country (locality):** Denmark	**Setting:** School based **Intervention group:** 1296 students in 4th and 5th grade at 13 schools in Copenhagan, Fredericia and Funen **Control group:** 1105 students in 4th and 5th grade at 12 schools in Copenhagan, Fredericia and Funen **Age:** *Intervention*: Mean 11 years old (±0.64). *Control*: Mean 10.9 years old (±0.63). **Gender:** 50% female, 50% male. **Ethnicity:** Not stated.	**Name of intervention:** N/A **Duration:** Varying **Components:** Infrastructural changes near schools. Hard interventions – structural changes near the school. Soft interventions – focused on increasing motivation and safety. Control group received no intervention.	**Primary outcome:** Long term frequency of cycling to school; Cycling to/from school frequency last week. **Number of follow-ups:** 2 **Follow up time points:** Baseline and 1 year.	**Conflict of interest:** No **Funding source:** Trygfonden
Sirard et al. (2008) [47]	**Design:** RCT **Country (locality):** USA	**Setting:** School based **Intervention group:** 5 students in 3rd to 5th grade, at 1 school, being driven to school at least 4 times a week. **Control group:** 6 students in 3rd to 5th grade being driven to school at least 4 times a week – from same school as intervention students. **Age:** *Intervention*: Mean 9.5 years old (±1.02). *Control*: Mean 9.7 years old	**Name of intervention:** Walking School Bus **Duration:** 2 weeks **Components:** 1 week of no intervention. 2nd week consisted of a walking school bus led by study personnel with use of a wagon to transport backpacks and instruments. Control group received no intervention.	**Primary outcome:** Percentage of time in MVPA during before/after school commute time. **Number of follow-ups:** 14 **Follow up time points:** Daily for 14 days.	**Conflict of interest:** No **Funding source:** National Heart, Lung, and Blood Institute

Study author and year	Methods	Participants	Intervention	Outcomes	Notes
		(±0.90). **Gender:** 45% female, 55% male. **Ethnicity:** *Intervention:* 100% Caucasian. *Control:* 83% Caucasian, 16% Chinese.			
Villa-Gonzalez et al. (2015) [40]	**Design:** Controlled trial **Country (locality):** Spain	**Setting:** School based **Intervention group:** 117 students from 5 schools in Granada and Jaen. **Control group:** 89 students from 5 schools in Granada and Jaen. **Age:** 8-11 years. **Gender:** Not stated. **Ethnicity:** Not stated.	**Name of intervention:** N/A **Duration:** 6 months **Components:** Monthly activities of 60-120 minutes duration during school hours: Introductory activities Story reading related to active travel Knowledge of environment near school Road safety Street behaviour Traditional games Control group received no intervention.	**Primary outcome:** Percentage of time in MVPA during before/after school commute time. **Number of follow-ups:** 3 **Follow up time points:** Baseline, post-intervention and 6 month follow-up.	**Conflict of interest:** No **Funding source:** University of Granada
Villa-Gonzalez et al. (2017) [30]	**Design:** Quasi-experimental **Country (locality):** Spain	**Setting:** School based **Intervention group:** 141 students from 5 schools in Granada and Jaen. **Control group:** 110 students from 5 schools in Granada and Jaen. **Age:** 8-11 years old. Mean 9.13 years old. **Gender:** *Intervention:* 48.3% female. *Control:* 50.9% female. **Ethnicity:** Not stated.	**Name of intervention:** N/A **Duration:** 6 months **Components:** Monthly educational and encouraging activities of 60-120 minutes duration during school hours. Control group received no intervention.	**Primary outcome:** Mode of commuting to school; Physical fitness. **Number of follow-ups:** 2 **Follow up time points:** Baseline and 6 months.	**Conflict of interest:** No **Funding source:** Not funded.

Supplement C

Methodological quality of each quality assessment component for included studies.

	(i) Selection bias	(ii) Study design	(iii) Confounders	(iv) Blinding	(vi) Data collection methods	(vii) Withdrawals and dropouts	(viii) Global rating
Borrestad et al. (2012) [53]	🔴	🟢	🔴	🟠	🟢	🟢	🔴
Bungum et al. (2014) [44]	🟢	🔴	🔴	🔴	🔴	🔴	🔴
Coombes and Jones (2016) [30]	🔴	🟢	🟢	🔴	🟠	🟠	🔴
Ducheyne et al. (2014) [54]	🟢	🟢	🟢	🔴	🟢	🟢	🟠
Goodman et al. (2016) [45]	🔴	🟠	🟢	🔴	🔴	🟠	🔴
Groesz (2007) [46]	🔴	🟢	🟢	🔴	🔴	🟠	🔴
Heelan et al. (2009) [50]	🔴	🔴	🟢	🔴	🟢	🔴	🔴
Hoelscher et al. (2016) [56]	🟠	🔴	🟢	🔴	🟢	🟠	🔴
McKee et al. (2007) [47]	🟢	🔴	🔴	🔴	🔴	🟢	🔴
McMinn et al. (2012) [43]	🟠	🔴	🟢	🔴	🟢	🟢	🔴
Mendoza et al. (2009) [51]	🟠	🔴	🟢	🔴	🟢	🟠	🔴
Mendoza et al. (2011) [52]	🔴	🟢	🟢	🔴	🟢	🟢	🔴
Ming Wen et al. (2008) [48]	🔴	🟢	🟢	🔴	🔴	🔴	🔴
Ostergaard et al. (2015) [55]	🟢	🔴	🟢	🔴	🔴	🟢	🔴
Sirard et al. (2008) [49]	🔴	🟢	🟢	🔴	🟢	🟢	🔴
Villa-Gonzalez et al. (2015) [42]	🟢	🔴	🟢	🔴	🔴	🔴	🔴
Villa-Gonzalez et al. (2017) [32]	🟢	🔴	🟢	🔴	🔴	🔴	🔴

Key: Green – strong quality; Amber – moderate quality; Red – weak quality

(i) *Selection bias* – Are the individuals selected to participate in the study likely to be representative of the target population?; What percentage of selected individual agreed to participate?

(ii) *Study design* - Study design; Was the study described as randomised?; If yes, was the method of randomisation described?; If yes, was the method appropriate?

(iii) *Confounders* – Were there important differences between groups prior to the intervention?; If yes, indicate the percentage of relevant confounders that were controlled (either in the design (e.g. stratification, matching) or analysis)?

(iv) *Blinding* - Was (were) the outcome assessor(s) aware of the intervention status of participants?

(v) *Data collection methods* - Were data collection tools shown to be valid?; Were data collection tools shown to be reliable?

(vi) *Withdrawals and drop-outs* - Were withdrawals and drop-outs reported in terms of number and/or reasons per group; Indicate the percentage of participants completing the study.

(vii) *Global rating* – Strong – no weak ratings; Moderate – one weak rating; Weak – two or more weak ratings.

Supplement D: Cohen's d effect size

The table below details the method of calculating the effect size with the final value for Cohen's d and the interpreted classification.

Study author and year	Outcome measure	Formula	Cohen's d and classification
Borrestad et al. (2012) [53]	Maximal oxygen consumption in VO^2_{peak}.	d = Xe – Xc / SDp SDp = ((Ne * SDe) + Nc* SDc)) / SD total	d= -0.3038 Class: Negative, small
Bungum et al. (2014) [44]	Number of students using active travel to school.	P one-tailed = P two-tailed / 2. Look up associated Z in normal probability table. (Meta-calculator)	d= 0.0446 Class: Positive, trivial
Coombes and Jones (2016) [30]	Percentage of school commutes using active travel.	P one-tailed = P two-tailed / 2. Look up associated Z in normal probability table. (Meta-calculator)	d= 0.4886 Class: Positive, small
Ducheyne et al. (2014) [54]	Minutes of cycling to school a week.	P one-tailed = P two-tailed / 2. Look up associated Z in normal probability table. (Meta-calculator)	d= 0.0855 Class: Positive, trivial
Goodman, van Sluijs & Ogilvie (2016) [45]	Percentage of children that usually travel to school by bike.	Accurate calculation not possible because the standard deviation was not provided for either group. A specific P-value was also not stated.	
Groesz (2007) [46]	10 day concurrent bicycling / walking to school. Retrospective 5 day bicycling / walking to school.	d = Xe – Xc / SDp SDp = ((Ne * SDe) + Nc* SDc)) / SD total	*10 day concurrent bicycling:* d= 0.1184 Class: Positive, trivial *10 day concurrent walking:* d= 0.1140 Class: Positive, trivial *Retrospective 5 day bicycling:* d= -0.1008 Class: Negative, trivial *Retrospective 5 day walking:* d= -0.6867 Class: Negative, moderate

Heelan et al. (2009) [50]	Minutes of physical activity a day.	Accurate calculation not possible because the sample size was not provided for either group. A specific P-value was also not stated.	
Hoelscheret al. (2016) [56]	Total number active commuting to school.	Accurate calculation not possible because the both sample size and standard deviations were not provided for either group. A specific P-value was also not stated.	
McKee et al. (2007) [47]	Mean difference in distance travelled to school by walking between baseline and follow-up.	d = Xe – Xc / SDp SDp = ((Ne * SDe) + Nc* SDc)) / SD total	d= -0.1312 Class: Negative, very large
McMinn et al. (2012) [43]	Steps during total commute. MVPA time during total commute.		*Steps during total commute:* d= -0.2906 Class: Positive, trivial *MVPA time during total commute:* d= -0.1217 Class: Positive, trivial
Mendoza et al. (2009) [51]	Number of students transported to school by walking.	d = Xe – Xc / SDp SDp = ((Ne * SDe) + Nc* SDc)) / SD total	d= 12.2347 Class: Positive, very large
Mendoza et al. (2011) [52]	Weekly percentage of active commuting. Daily minutes of MVPA.	d = Xe – Xc / SDp SDp = ((Ne * SDe) + Nc* SDc)) / SD total	*Weekly percentage of active commuting:* d= 2.3670 Class: Positive, very large *Daily minutes of MVPA:* d= 1.7069 Class: Positive, very large
Ming Wen et al. (2008) [48]	Change in percentage of active travel commutes to school in usual week between baseline and follow-up.	d = Xe – Xc / SDp SDp = ((Ne * SDe) + Nc* SDc)) / SD total	d= 0.887 Class: Positive, large
Ostergaard et al. (2015) [55]	Change in long term school cycling. Change in school cycling	P one-tailed = P two-tailed / 2. Look up associated Z in normal probability table.	*Change in long term school cycling:*

	trips in the last week. Change in cardiovascular fitness.	(Meta-calculator)	d= -0.036 Class: Negative, trivial *Change in school cycling trips in the last week:* d= 0.038 Class: Positive, trivial *Change in cardiovascular fitness:* d= -0.1773 Class: Negative, large
Sirard et al. (2008) [49]	Counts per min (accelerometer) during general commute time before school. Counts per min (accelerometer) during general commute time after school. Percentage of time in MVPA during general commute time before school. Percentage of time in MVPA during general commute time after school.	d = Xe – Xc / SDp SDp = ((Ne * SDe) + Nc* SDc)) / SD total	*Counts per min - before school:* d= 4.1634 Class: Positive, very large *Counts per min - after school:* d= -0.1247 Class: Negative, trivial *Percent of MVPA time – before school:* d= 3.7273 Class: Positive, very large *Percent of MVPA time – after school:* d= 0.1642 Class: Positive, trivial
Villa-Gonzalez et al. (2015) [42]	Number commuting by walking a week. Number commuting by bicycling a week.	d = Xe – Xc / SDp SDp = ((Ne * SDe) + Nc* SDc)) / SD total	*Number commuting by walking a week:* d= 3.2051 Class: Positive, large *Number commuting by bicycling a week:* d= -0.1 Class: Negative, trivial
Villa-Gonzalez et al. (2017) [32]	Frequency of active commuting to school per week. Maximal oxygen consumption (VO^2_{max}).	d = Xe – Xc / SDp SDp = ((Ne * SDe) + Nc* SDc)) / SD total	*Frequency of active commuting:* d= -4.6874 Class: Positive, very large *Maximal oxygen consumption:*

	Data provided is categorised by gender.		d= -9.4806 Class: Negative, very large