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Glossary of terms

Abbreviation	Definition
ACS	Active Commuting to School
AST	Active School Travel
BMI	Body mass index
METS	Metabolic Equivalent Unit
NCDs	Non-communicable diseases
OB	Obesity
OW	Overweight
PA	Physical activity
PE	Physical Education
PICO	Population, intervention, comparison and outcome
PROSPERO	Prospective Register of Systematic Reviews
SES	Socioeconomic Status
STP	School Travel Plan
WP	Work Package
WSB	Walking School Bus

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Part one: Effectiveness of school-based physical activity interventions in the prevention of childhood obesity for children from the age of 6 to 12 years: a systematic review

1 Background

Non-communicable diseases (NCDs) remain the leading cause of death in most parts of the world, with a large part of this mortality being ascribed to insufficient physical activity (PA) and obesity (WHO, 2009a). Specifically, physical inactivity and obesity have been ranked as the fourth and fifth leading risks of global mortality respectively (WHO, 2009a). At the same time, the prevalence of overweight and obesity is rising worldwide among all age groups The current obesity epidemic is especially pronounced among children and adolescents (NCDRisC, 2017). Childhood obesity has increased dramatically during the last few decades of the 20th century, especially in developed countries (NCD-Risk, 2017).

Obesity in children has been linked to both short (Reilly et al., 2003) and long-term adverse health outcomes (Reilly & Kelly, 2011). Insufficient PA, alongside unhealthy dietary habits, is proposed as one of the major contributors to childhood obesity (Lobstein, 2004). Still, at present the evidence on the importance of PA and exercise in the prevention of childhood obesity is equivocal. On the other hand, PA has been linked to many other favourable health outcomes in children as well as to improved academic performance (Janssen and Le Blanc, 2010). Thus, there is a need to provide each child with the opportunity to reach the recommended level of PA (Physical Activity Guidelines Advisory Committee, 2008).

Both obesity and physical activity are complex phenomena that require population-based solutions. For children, schools are frequently identified as key locations for the introduction of healthy lifestyles and the prevention of obesity. In most countries, schools are attended by all children to at least mid-adolescence. In addition, schools are the place where children spend most of their awake time. Previous systematic reviews on the effect of interventions to prevent childhood obesity have shown that school-based interventions are most effective when a PA component is included (Bleich et al., 2018, Wang et al., 2015, Waters et al., 2011). However, the characteristics of successful PA intervention are not well known.

This study aims to assess what PA interventions in schools are effective in improving obesity-related outcomes. We identified several systematic reviews published in the last 10 years that covered this topic (Bleich et al., 2018, Dobbins et al. ,2009, Dobbins et al., 2013, Harris et al., 2009, Lavelle et al., 2012, Waters et al., 2011). However, none of these studies attempted to document and analyse specific elements of PA programmes. Moreover, a large Cochrane review might have missed large

studies as it was restricted to randomised designs (Dobbins et al., 2013). Others were restricted to high-income countries (Wang et al., 2015) or to only a single outcome (Harris et al., 2009, Lavelle et al., 2012)). In addition, we found only one prior systematic review that has analysed the effectiveness of obesity prevention initiatives according to socio-economic position, albeit this was not specific to either PA, school-setting, or children. Thus, in order to cover a complete spectrum of PA interventions we included all school-based interventions that targeted PA, regardless of the type or duration of the intervention. The wide range of included interventions will serve to identify features that enhance the effectiveness of obesity prevention, with special focus on the type, duration and intensity of physical activity employed. In addition, we focused on vulnerable groups of children, including, but not limited to, economically disadvantaged children.

2 Methods

The search strategy was planned according to the PICO framework (population, intervention, comparison and outcome) as presented in Table 1 (Huang et al., 2006). The search strategy was designed in consultation with a librarian from the Faculty of Kinesiology (Zagreb, Croatia), with initial guidance from a specialist subject (health) librarian from Imperial College London. We searched MEDLINE, The Cochrane Central Register of Controlled Trials (CENTRAL), Scopus and LILACS for peer-reviewed studies published in the last 25 years (between 1/1/1994 and 15/4/2019). We used MeSH terms in Medline plus keyword searches structured around four constructs (population – children; intervention – physical activity, fitness and sedentary behaviour; setting – school; outcome – adiposity) and adapted this strategy to individual databases (full search strategy for Medline is available in *Appendix 1*). We did not limit our search to any specific geographical region, but we included only studies written in European languages. The search strategy was validated by conducting sensitivity analysis in MEDLINE with a test set of 10 key papers selected as exemplary papers answering the PICO question. Adjustments to the search strategy finished when all 10 key papers were identified by the search. All database search results were extracted and imported into the web-based reference manager: Rayyan. After removing duplicates, results were screened initially by abstract and title. The first 500 results were screened independently by two reviewers. Given that 95% agreement between reviewers in included studies was recorded, each of the two reviewers screened half of the remaining results. Ambiguities on study eligibility were resolved through discussion with a third reviewer. In addition to this, we checked reference lists of key systematic reviews in the same area for eligible studies (Beauchamp et al., 2014, Bleich et al., 2018, Dobbins et al. ,2009, Dobbins et al., 2013, Harris et al., 2009, Lavelle et al., 2012, Waters et al., 2011). Papers reporting on the results of the same study were collated so each study is the unit of analysis rather than each paper. The table of study characteristics and study outcomes was extracted by two reviewers working independently, each on half of the included studies.

The protocol was registered with Prospective Register of Systematic Reviews (PROSPERO 2019 CRD42019129295,http://www.crd.york.ac.uk/PROSPERO/display_record.php?ID=CRD42019129295)

Table 1. PICO table

PICO feature	Criteria
Population	**Inclusion:** Children 6 to 12 years of age (mean age at the start of the study = 5.5-12.49) **Exclusion:** Special populations (e.g. children with a specific illness, blind, physically disabled). Also, studies including exclusively overweight or obese children were excluded.
Intervention(s)	We restricted this review to interventions that have been primarily based in a school setting. We included interventions that have aimed to either: 1) increased physical activity and/or physical fitness; 2) reduced sedentary behaviour. We also included complex interventions if they included physical activity or sedentary behaviour component and labelled them combined interventions. Interventions of any length with a follow-up period >12 weeks were included.
Comparison(s)	Comparators may include no intervention or alternative intervention.
Outcomes	**Primary outcomes**: change in BMI, BMI z-score, BMI percentile, prevalence or incidence of overweight or obesity, % body fat, skinfold thicknesses, waist circumference, waist circumference percentile and waist-to-height ratio. **Adverse outcomes:** detrimental effects on primary outcomes, new-onset of eating disorders, injuries, stigmatisation, reactance, health inequity.

For the purpose of this report, an intervention was deemed effective when at least one of the reported outcomes was improved by the intervention, in at least one group of participants (e.g. in boys, but not in girls). Comparisons of effectiveness were conducted by the following: setting, study design, study size, intervention type, intervention duration, follow-up length and outcome.

3 Results

The search strategy retrieved 16 805 studies from the four databases. After removing duplicates, 15 580 records were screened by title and abstract. 1 072 were selected for screening of the full-text paper and 241 were found to conform to our inclusion criteria (listed in Appendix 2). Searching the reference list of 7 systematic reviews led to the addition of 11 papers (Figure 1). All in all, this review includes 252 papers. A large majority of the papers were in English (245 or 97%), while other languages included Spanish (7 papers), German (2 papers) and Dutch (1 paper). Most of the papers were published in the last 15 years (229/252; 91%), with 102 papers published in the last five years. Several of the included papers reported on outcomes of the same intervention study at different time

points or in different subpopulations. Hence, 197 intervention studies are analysed in this review. Characteristics of the included studies are described in Table 2.

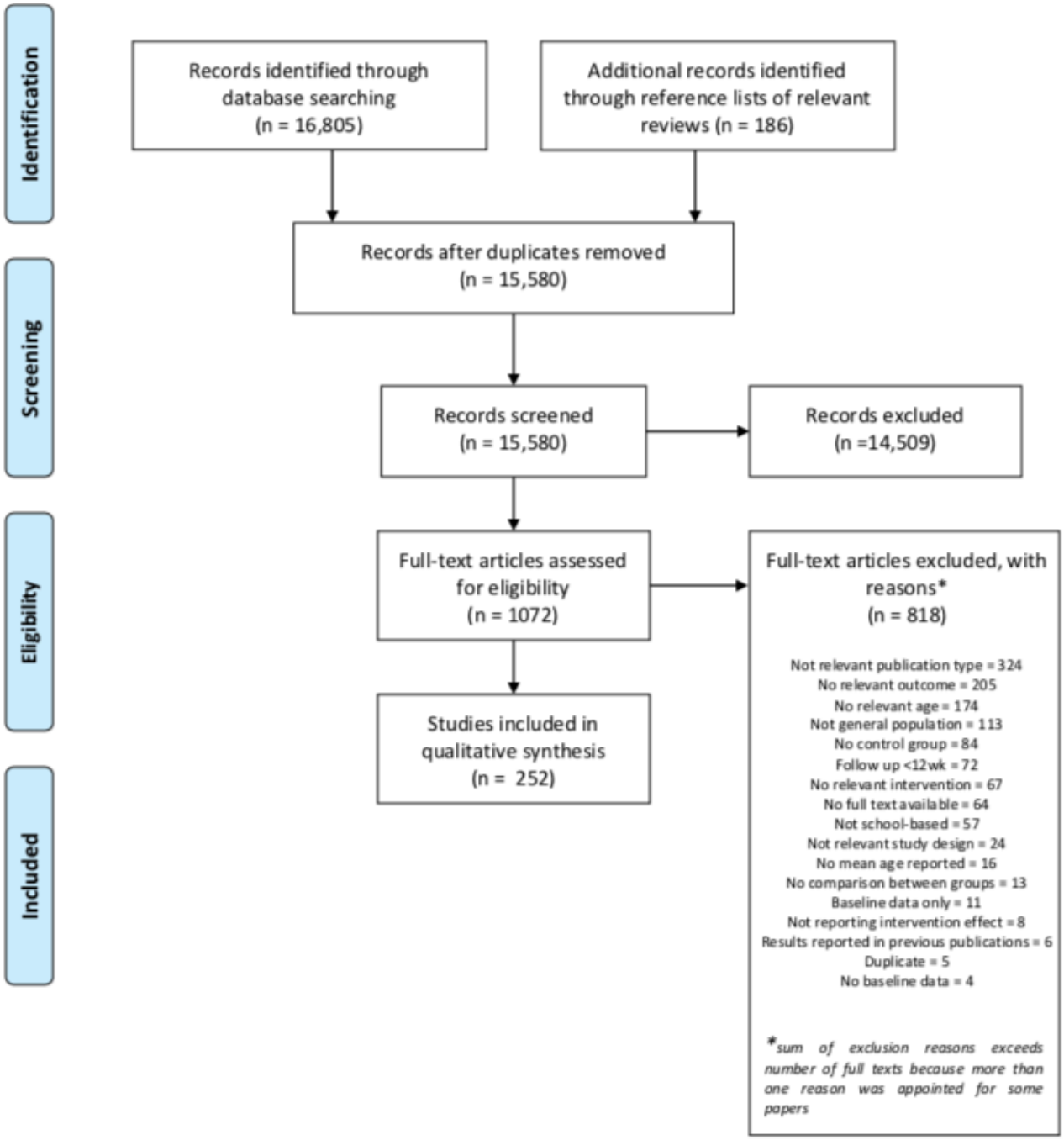

Figure 1: PRISMA flow chart showing the study selection process (from Moher et al., 2009)

A majority of the studies were performed in Europe (42%), although studies from Central and Eastern Europe are scarce. Slightly lower share of studies was situated in North America (39%), while, on the other hand, only two studies (1%) were performed in Africa (both in South Africa). In addition, only one study was performed in multiple countries (i.e. in eight European countries).

Randomised controlled design was applied in over 60% of the included studies, with over 90% of these studies being cluster RCTs, a type of experimental study in which groups of subjects and not individual subjects are randomised (e.g. randomisation is performed by class or by school). Of note, 10 RCTs were performed with only two clusters which is known to seriously increase the risk of bias and impede conclusions.

Table 2. Characteristics of the included studies

Study Characteristics		N	%
Location			
	Europe	82	42
	North America	76	39
	South America	10	5
	Asia	16	8
	Oceania	11	5
	Africa	2	1
Study design			
	RCT	121	61
	Non-RCT	20	10
	CBA	56	29
No of Participants[a]			
	<100	58	29
	100-500	97	49
	500-1000	24	12
	>1000	18	9
Characteristics of Participants			
	Girls	6	3
	Boys	1	1
	Both genders	190	96
	Vulnerable groups	46	23
Characteristics of intervention			
	Lifestyle Education	44	23
	PA	76	38
	PA+Education	68	35
	Other	9	4
	Diet component	128	65
Duration of intervention			
	<6 months	48	24
	6-12 months	83	42
	>12 months	66	34
Follow up[b]			
	no f-up	144	73
	< 1 year	28	14
	> 1 year	25	13
Additional setting			
	Community	19	10
	Home	14	7

CBA=controlled before-after study; non RCT= non-randomised controlled trial RCT=randomised controlled trial; PA=physical activity; [a]studies were stratified by the number of participants in each group; [b]follow-up period is given in months after the end of the intervention

Over 2/3 of the studies included more than 100 participants in each trial group, while 42 studies involved more than 500 students in each study group (including 30 RCTs). There were very few studies that were limited to one gender (seven studies or 4%), whereas 46 (23%) studies involved predominantly or exclusively vulnerable groups of children (43 studies on economically deprived children and three studies on migrants). It is worth noting that only 10 Europe-based studies on underprivileged children were available for analysis.

Interventions included in this review involved some form of PA in 143 studies (68 of these studies supplemented PA with lifestyle education), mostly in the form of additional hours of Physical Education (PE), after-school organised PA, active recess and classroom activity breaks. The intensity of these interventions varied greatly. Weekly duration of introduced PA ranged from 10 to 400 minutes, with a median of 100 minutes/week. In addition, 1/4 of the interventions were restricted to a lifestyle curriculum, while six studies focused on changing the orientation of PE, without affecting its duration, two interventions introduced standing desks and one intervention initiated changes in the playground that were expected to foster PA. Almost 2/3 of interventions have included a diet component, largely via education or changes in food provision and environment.

Around 1/5 of interventions extended over several years, with a couple of programmes spanning over 4-6 years. The sustainability of intervention effects was analysed in 53/197 studies (27%), although only about half of these studies followed participants for at least one year after the end of intervention.

Finally, a similar number of school-based interventions extended to the community and home settings (19 and 14 studies, respectively), and just under half of the school-only interventions attempted to involve parents and guardians (82/183 of non-home-based studies).

3.1 Overall results

Results of the analysis of the effectiveness of PA interventions are presented in Table 3. All in all, almost 60% of the studies reported beneficial effect of the intervention on at least one weight-related outcome. On the other hand, we recorded seven studies (3%) that found a negative impact of the intervention on weight regulation. The characteristics of these seven studies are described in detail in section 3.3.

3.2 Results by study characteristics and outcomes reported

The share of studies with beneficial effects was higher in non-randomised and quasi-experimental studies than in randomised controlled experiments. Still, positive findings were predominant in all study designs. Scale-wise, the lowest proportion of studies that reported beneficial effect was detected among studies that had included less than 100 participants per group, while larger studies

had a similar share of positive studies across three size categories. The outcome of the highest interest, i.e. the prevalence or incidence of overweight/obesity, showed the highest proportion of positive studies. Conversely, for BMI and indices of abdominal obesity less than half of studies found a beneficial effect of the interventions.

Table 3. Effectiveness of PA interventions stratified by various study and intervention characteristics

Study Characteristics		N	Beneficial effect N (%)	Null effect N (%)	Negative effect N (%)
Total*		**196**	**113 (58)**	**76 (39)**	**7 (3)**
Study design					
	RCT	121	65 (54)	51 (42)	5 (4)
	Non-RCT	20	14 (70)	5 (25)	1 (5)
	CBA	55	34 (62)	20 (36)	1 (2)
No of Participants[a]					
	<100	58	26 (45)	30 (52)	2 (3)
	100-500	97	62 (64)	33 (34)	1 (2)
	500-1000	24	13 (54)	8 (33)	3 (13)
	>1000	18	12 (67)	5 (28)	1 (5)
Outcomes					
	BMI	124	48 (39)	72 (58)	4 (3)
	BMI z-score/percentile	96	48 (50)	47 (49)	1 (1)
	Body fat	82	40 (49)	37 (45)	5 (6)
	WC/WHtR	61	21 (34)	38 (62)	2 (4)
	OW/OB prevalence/incidence	71	41 (58)	30 (42)	0
Components of the intervention					
	Lifestyle Education	44	21 (48)	23 (52)	0
	PA	76	41 (54)	30 (39)	5 (7)
	PA+Education	68	44 (65)	22 (32)	2 (3)
	Other	9	4 (44)	5 (56)	0
	Diet component	127	79 (62)	45 (35)	3 (3)
	No diet component	69	34 (49)	31 (45)	4 (6)
Duration of the intervention					
	<6 months	48	23 (48)	23 (48)	2 (4)
	6-12 months	83	52 (63)	29 (35)	2 (2)
	>12 months	65	37 (57)	25 (38)	3 (5)
Follow up[b]					
	< 1 year	28	15 (54)	11 (39)	2 (7)
	> 1 year	24	16 (67)	8 (33)	0
Setting					
	Community	14	9 (64)	4 (29)	1 (7)
	Home	9	6 (67)	3 (33)	0
	Both	4	3 (75)	1 (25)	0

** one study has not provided statistical significance and was, thus, excluded from the analysis*

BMI=body mass index; CBA=controlled before-after study; non RCT= non-randomised controlled trial RCT=randomised controlled trial; PA=physical activity; OW=overweight; OB=obesity; WC=waist circumference; WHtR=waist-to-height ratio

3.3 Results by intervention characteristics

The lowest share of beneficial effects was spotted for interventions that lasted less than six months. On the other hand, interventions that spanned over a few years do not appear to be more effective than one-year interventions. Although persistence of effects was reported in only 27% of studies analysed in this report, it appears that a large share of interventions had long-lasting positive effects (2/3 of the studies that followed participants for at least one year after the end of intervention). Of note, persistence of effects on BMI z-score was reported for up to eight years from the end of the intervention in a study among German children, albeit only in children of high SES (Plachta-Danielzik et al. 2011).

The largest share of positive findings was detected for interventions that combined added PA with a form of lifestyle education (65%), followed by PA interventions without an educational component (54%) and lifestyle curriculum interventions (48%). In addition, interventions were more effective if they extended to other settings (i.e. home and community), and if they included a dietary component.

The detailed description of the interventions by its contents are presented in the following paragraphs.

Lifestyle education

About half of the studies that introduced only a lifestyle curriculum saw beneficial effects, although in a quarter of these improvements were restricted to a subgroup of children (by gender, age or weight status). Positive studies extended to other settings more frequently (25% vs. 4%) and were more often of longer duration (62% vs. 43% implemented over at least one year). On the other hand, studies with null effects included less than 100 participants per group on more occasions (29% vs. 10%). No studies with negative finding were detected in this type of PA intervention.

PA interventions without an educational component

A little over half of these studies reported on beneficial effects of described interventions. Studies with positive and null or negative findings were similar regarding the inclusion of other settings, but effective interventions involved parents more frequently (24% vs. 11%), added more PA (median time=120 vs. 100 min/week), included diet more often (39% vs. 25%), and had shorter duration (12.5 vs. 17 months on average). Five studies in this group reported on the negative effects of PA intervention. One was a large trial in Swedish seven-year olds that lasted for five years, and included only bone strengthening activities. Another was a large study in the USA that introduced short bursts of classroom PA in schools in deprived neighbourhoods and reported a larger increase in BMI in the intervention group. It should be noted that fat-free mass change was not assessed, hence confounding effects of muscle mass increase in the intervention groups could not be excluded. Third

was an intervention in Chile that reported positive effects on BMI overall, but a larger increase in overweight prevalence in girls in intervention schools. Lastly, two were small European studies that added 75-90 min PA/week, without a diet component.

Combined PA/lifestyle curriculum interventions

Among combined interventions, studies with positive findings did not vary greatly regarding the size, parent involvement, inclusion of a diet component, extension to other settings or median time of added PA compared to studies that had reported null or negative findings. The only notable difference was the duration of the studies. Although the average duration was the same in both groups of studies (16 months), the number of interventions that were implemented for more than one year was more than twice higher among studies that reported beneficial effects (36% vs. 16%). In this group of studies, three interventions exhibited negative effects on weight-related outcomes. One study was a large, multi-country quasi-experiment in six-year olds. It was implemented for two consecutive school years, included PA (duration not reported) and a diet component and produced negative effects for girls, but positive effects among boys. The second study was conducted in German six-year olds, lasted four years and included small amounts of PA (25 min/week) and a diet component. A larger increase in BMI was reported in the intervention group, especially for children with overweight at the baseline. Again, the confounding effect of muscle mass increase in the intervention group could not be excluded. The third study was a small study on migrants in Germany that reported negative effects of the 90 min of PA/week on %BF in girls, but at the same time positive effects were seen in boys.

Other interventions

This group mostly included interventions that aimed to modify the content of PE without changing its duration, or interventions that replaced a classroom teacher with a PE specialist. Out of six such studies, three had reported positive effects and the other three reported null effects. Studies with positive finding were generally longer in duration and included lifestyle education more often. The other two interventions in this group introduced standing desks to the classrooms with mixed effect. After eight months of intervention in one of those two studies, no effect on BMI z-score was spotted. Similarly, the other study was also not able to show effectiveness after one year of implementation. Still, after the second consecutive year of standing desk usage, the difference between groups in BMI percentile was 5.2 (95%CI=0.3-10.1). The remaining intervention in this group introduced changes to the school's playground facilities and found no effect on indices of adiposity after two years.

3.4 Adverse outcomes

Only 19/197 studies (20%) reported on adverse outcomes of PA interventions. 11 of these studies focused on possible increase in prevalence of eating disorders or underweight, but only one adverse event related to child's eating and activity behaviour was reported in one study (dieting and excessive exercise). Injuries were recorded in eight studies. One small study reported one minor injury, while a large study in the U.S. (FitKid after-school program) recorded 24 adverse musculo-skeletal injuries (20 mild, three moderate, and one serious). Still, considering the large volume of PA introduced in this study (240 min/week for 3 years) this amounts to just 0.0006 adverse events per program hour (or incident rate 0.06 per student).

3.5 Effectiveness of interventions in vulnerable groups of children

Our search identified 46 studies that included predominantly children from vulnerable groups, focusing on either economically deprived children or migrants. Interventions that focused on children of low SES were effective in over 50% of the studies (22/42), but two studies detected deleterious effects of interventions on weight maintenance. Effective interventions tended to involve education and diet components more often than the those that had no effect and were more frequently implemented for at least one year. In contrast, interventions in migrants had little effect on weight maintenance. Only one of these three studies reported beneficial effect that was restricted to children with obesity at the baseline.

Apart from the studies focused on vulnerable groups of children, six other studies have presented subgroup analysis by SES and one by migrant status. Three of the studies that have analysed the effect of SES have shown smaller effects in children of low SES, two have reported similar effects across several socio-economic strata and a study in France has even found effects that tended to be larger in least wealthy children, although the interaction effect did not reach statistical significance. The only study that has performed sub analysis by migrant status found similar effect in migrants as in native Italian children.

4 Discussion

This systematic review aimed to evaluate how effective school-based PA interventions are in the prevention of childhood overweight in 6-12-year-old children, and to identify the characteristics of the most effective interventions. The main result of this study is that school-based PA interventions appear to be a reasonably effective strategy in the prevention of childhood obesity. In general, the majority of the studies analysed in this report have found at least some evidence for the effectiveness of school-based PA interventions on indices of adiposity. Available evidence did not allow us to identify the contents of the PA interventions that would guarantee effectiveness. Still, programmes that span over at least one year, include a diet component, involve parents and extend to the home

and community appear to be the most promising approach. These findings echo the recommendations from the WHO (WHO, 2009b), supplementing it with the recommended duration of the intervention.

The probability of finding beneficial effects increased when several weight-related outcomes were assessed, and it was not uncommon to see positive effects for one adiposity index, but no effect for the others. This is not surprising given that adiposity is usually assessed by proxy measures, and that each of these measures has inherent limitations. Moreover, this finding points to a need for tracking several adiposity indices in order to better evaluate the effectiveness of intervention programmes. The largest proportion of positive studies was seen when prevalence or incidence of overweight were examined, followed by body fat and BMI z-score. It is worth noting that the effects of the intervention are probably underestimated due to the well-known limitations of BMI in distinguishing fat from fat-free mass on one side, and the large measurement error of commonly used methods for assessing body composition on the other side.

Interventions that have introduced additional PA during the school day or after school were more effective compared to interventions that aimed to increase knowledge and change attitudes about physical activity. Still, it seems that the most effective approach includes combining education with episodes of physical activity. This research was not designed to detect the threshold of PA needed for effective prevention of childhood obesity. We noted a large heterogeneity in the volume of PA used by the programmes which ranged from only 10 minutes per week to more than six hours/week. Somewhat unexpectedly, the duration of PA was not associated with higher odds of effectiveness when lifestyle curriculum was included. In contrast, among interventions that relied exclusively on PA, a higher duration of PA was noted among the studies with positive findings, compared to interventions that had no effect on weight maintenance. It is interesting to note that not even 60 minutes of daily PA guaranteed a beneficial effect on weight status. In addition, as 2/3 of the included studies have included a diet component, it is not possible to ascribe positive findings specifically to PA. Although the addition of a dietary component to the intervention was related to a higher chance of seeing a beneficial effect in our analysis (see Table 3), the fact that even among interventions without a component directed to nutrition about half of the studies reported beneficial effects. This is in line with the findings of prior reviews that found that diet-only interventions are less effective than the ones that focused exclusively on PA (Wang et al., 2015, Bleich et al., 2018). Still, targeting both sides of the energy equation should be advocated as the most effective approach.

On the other hand, the effects of interventions on PA level over the whole day were not analysed in this report. Increasing overall PA level is difficult since PA is a complex behaviour determined by numerous personal, social, environmental and political factors (Bauman et al., 2012). Although an earlier review found that school-based PA interventions can increase PA by 5-45 minutes per week

(Dobbins et al., 2013), the effects on the PA outside the school are less clear. For example, a recent meta-analysis of accelerometer-based studies found no effect from interventions on PA over the full day (Love et al., 2019)

Schools are often advocated as an ideal setting for preventive strategies. Indeed, in most countries school is obligatory, hence all children can be reached, which makes schools a perfect setting to reduce health inequalities. In addition, children spend a significant portion of the day in school, so ample opportunities for PA should be provided in order to introduce the well-known benefits of PA on health and academic performance. In spite of the obvious need to create a school-environment conducive to PA, the results of our analysis indicate that, in order to exert a greater impact on weight control, the interventions should at a minimum strive to engage the parents, either via school events or remotely. Ideally, the programmes should also involve a home component and a community approach.

Although in most instances positive findings were seen in both genders, more benefits in girls than in boys were reported in several studies, while only a few studies found more effects in boys than girls. It is well known that school-aged girls are less physically active compared to boys (Riddoch et al, 2004). To that end, the amount of PA typically used in intervention studies contributes more to the overall PA of girls. This, in turn, usually leads to higher effects on energy expenditure and weight regulation.

The increasing burden of obesity and inactivity across SES has been well-documented (Love et al., 2019). Interventions in economically deprived children analysed here were mostly able to induce favourable effects on weight control. Yet, the few studies that have compared the effects across SES groups indicated smaller effects in children of lower SES. Furthermore, a long-lasting study in Germany has shown that the positive effects of the intervention were sustained over 4 and 8 years after the end of the intervention in high SES children only (Plachta-Danielzik et al. 2007, Plachta-Danielzik et al. 2011). In contrast to our findings in smaller children, a similar review that focused on disadvantaged adolescents reported that only two out of nine interventions managed to produce beneficial effects on BMI (Beauchamps et al., 2014). Nevertheless, as parents of this group of children are very hard to reach, schools and the community remain the settings that should be a focus of public health policies aimed at reducing health inequalities. On the other hand, the few interventions included in the current review that have focused on migrants in European countries failed to induce favourable changes in adiposity outcomes.

Finally, although only a handful of analysed studies provided data on adverse outcomes, we found no evidence for changes in body satisfaction, eating behaviours or underweight prevalence. In addition, the incidence of injuries was very low, even in studies with large volume of PA.

Several limitations of this review are worth noting. First, although unlike prior reviews, we extended our search beyond English language, we could not include non-European languages, so we might have missed studies from Asia or Africa. Second, large variability in study characteristics made comparison between studies difficult. Next, a large number of studies describing PA interventions failed to document the exact duration of PA and even fewer studies have assessed the intensity of implemented activities. This precluded us from describing the dose-response relationship. Last, the variability in reporting made us reduce the effectiveness of the interventions to a binary outcome, instead of applying a more nuanced approach that would enable us to describe the clinical significance, as well as the time-course of the effects.

Notable gaps in the evidence were also uncovered. For example, very few studies that aimed at decreasing sedentary behaviour identified by our study went beyond educational activities. Moreover, no studies that have evaluated the effectiveness of wearable technology (e.g. activity trackers) or smartphones in physical activity promotion and weight control were found. In addition, a clear need was identified for more studies that analyse the effectiveness of interventions across SES, or compare intervention effects in different groups of vulnerable children to the effects in the general population.

5 Conclusion

This review included a very large number of school-based PA interventions. The findings of our analysis support the overall effectiveness of these interventions in the prevention of overweight among 6-12-year-old children. At the same time, the interventions appear to be very safe as very little adverse outcomes were detected. Several features that enhance the effectiveness of these interventions were identified. First, although we found firm evidence on the effectiveness of PA-only interventions, it is also evident that including a dietary component leads to even greater effects. Second, this study has shown that it is of added value to extend interventions to community and home settings. Next, as short-lasting interventions showed limited effectiveness, it is advocated that intervention programmes are delivered over at least one year. On the other hand, several gaps in the evidence were also revealed by the current review. For example, poor reporting on the volume and the intensity of introduced PA precluded detection of a “best-buy” dose of PA that would provide optimal effects with as little time and resources invested. Similarly, although more research in vulnerable groups of children is needed, preliminary evidence suggests that at present the interventions are not equitable, exhibiting less effect in economically deprived children and migrants. Further research is needed to corroborate these observations. Finally, the effectiveness of technologies that are both very appealing and universally available to contemporary children, such

as activity trackers and smartphones, in the prevention of childhood obesity is still in need of investigation.

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Appendix 1: search strategy on Medline for part one (systematic review on school-based physical activity interventions)

1. exp Obesity/
2. obes*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
3. exp Body Weight/
4. body weight.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
5. exp Body Weight/ or exp Weight Gain/
6. exp Body Weight Changes/
7. exp Body Fat Distribution/
8. body fat distribution.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
9. exp Body Composition/
10. body composition.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
11. Body Mass Index/ or BMI.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
12. exp Body Mass Index/
13. (body adj2 mass).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
14. overweight*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
15. exp Overweight/
16. overeat*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
17. over eat$.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
18. weight.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
19. (body adj2 fat).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
20. exp Waist Circumference/
21. waist circumference.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
22. exp Skinfold Thickness/
23. skinfold thickness.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
24. skin fold*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
25. (body fat and percent$).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

26. exp Weight Loss/
27. weight loss.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
28. adipos*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
29. exp Adipose Tissue/
30. (weight adj1 (prevent$ or reduc$ or los$ or control$ or manage$)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
31. (body weights and measures).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
32. exp Schools/
33. school$.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
34. (class or classes or classroom*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
35. exp child/
36. child$.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
37. preteen$.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
38. school$.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
39. boy*1.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
40. girl$.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
41. kid*1.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
42. p?ediatric$.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
43. 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42
44. exp Exercise/
45. exercise$.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
46. physical activit*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
47. physical inactivity.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
48. motor activit*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
49. exp "Physical Education and Training"/

50. physical education.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
51. physical training.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
52. (life style or lifestyle or life-style).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
53. leisure activit$.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
54. leisure activities/ or exp recreation/ or exp relaxation/
55. exp Weight Lifting/
56. weight lift$.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
57. exp sports/
58. exp Exercise Therapy/
59. exercise therapy.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
60. (physical$ adj5 (fit$ or train$ or active$ or endur$)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
61. (physic$ adj (activ$ or fit$)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
62. (phys$ adj3 education).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
63. (exercise$ adj5 (train$ or physical$ or activ$)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
64. (walk$ or jog$ or swim$ or weight lift$ or danc$ or aerobics sport$).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
65. cycle$.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
66. ((chair or sitting or car or automobile or auto or bus or indoor or indoor or screen or computer) adj2 time).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
67. sedentar*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
68. exp Sedentary Behavior/
69. seat*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
70. sedentary lifestyle.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
71. ((chair or sitting or car or automobile or bus or indoor or in-door or screen or computer) adj time).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading

word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
72. low energy expenditure.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
73. exp energy intake/ or exp caloric restriction/
74. (screen based entertainment or screen-based entertainment or screen time).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
75. exp screen time/
76. bed rest.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
77. sitting.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
78. stationary behaviour.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
79. stationary behavior.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
80. standing.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
81. reclin*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
82. recumben*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
83. lying.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
84. bout*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
85. television viewing.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
86. computer viewing.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
87. television game*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
88. computer game*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
89. video game*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
90. exp physical fitness/ or exp cardiorespiratory fitness/
91. physical fitness.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
92. ((physic* or strength* or resist* or circuit* or weight or aerob* or cross or endurance or structur*) adj3 train*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-

heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
93. (physical conditioning or fitness).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
94. musculoskeletal fitness.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
95. cardiovascular fitness.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
96. 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53 or 54 or 55 or 56 or 57 or 58 or 59 or 60 or 61 or 62 or 63 or 64 or 65 or 66 or 67 or 68 or 69 or 70 or 71 or 72 or 73 or 74 or 75 or 76 or 77 or 78 or 79 or 80 or 81 or 82 or 83 or 84 or 85 or 86 or 87 or 88 or 89 or 90 or 91 or 92 or 93 or 94 or 95
97. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31
98. 32 or 33 or 34
99. 43 and 96 and 97 and 98
100. limit 99 to yr="1994 -Current"
101. limit 100 to "all child (0 to 18 years)"
102. 100 not 101
103. exp Obesity/
104. obes*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
105. exp Body Weight/
106. body weight.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
107. exp Body Weight/ or exp Weight Gain/
108. exp Body Weight Changes/
109. exp Body Fat Distribution/
110. body fat distribution.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
111. exp Body Composition/
112. body composition.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
113. Body Mass Index/ or BMI.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
114. exp Body Mass Index/
115. (body adj2 mass).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
116. overweight*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
117. exp Overweight/
118. overeat*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
119. over eat$.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
120. weight.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

121. (body adj2 fat).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
122. exp Waist Circumference/
123. waist circumference.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
124. exp Skinfold Thickness/
125. skinfold thickness.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
126. skin fold*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
127. (body fat and percent$).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
128. exp Weight Loss/
129. weight loss.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
130. adipos*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
131. exp Adipose Tissue/
132. (weight adj1 (prevent$ or reduc$ or los$ or control$ or manage$)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
133. (body weights and measures).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
134. exp Schools/
135. school$.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
136. (class or classes or classroom*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
137. exp child/
138. child$.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
139. preteen$.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
140. school$.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
141. boy*1.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
142. girl$.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
143. kid*1.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

144. p?ediatric$.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
145. 137 or 138 or 139 or 140 or 141 or 142 or 143 or 144
146. exp Exercise/
147. exercise$.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
148. physical activit*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
149. physical inactivity.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
150. motor activit*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
151. exp "Physical Education and Training"/
152. physical education.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
153. physical training.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
154. (life style or lifestyle or life-style).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
155. leisure activit$.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
156. leisure activities/ or exp recreation/ or exp relaxation/
157. exp Weight Lifting/
158. weight lift$.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
159. exp sports/
160. exp Exercise Therapy/
161. exercise therapy.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
162. (physical$ adj5 (fit$ or train$ or active$ or endur$)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
163. (physic$ adj (activ$ or fit$)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
164. (phys$ adj3 education).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
165. (exercise$ adj5 (train$ or physical$ or activ$)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
166. (walk$ or jog$ or swim$ or weight lift$ or danc$ or aerobics sport$).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

167. cycle$.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
168. ((chair or sitting or car or automobile or auto or bus or indoor or indoor or screen or computer) adj2 time).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
169. sedentar*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
170. exp Sedentary Behavior/
171. seat*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
172. sedentary lifestyle.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
173. ((chair or sitting or car or automobile or bus or indoor or in-door or screen or computer) adj time).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
174. low energy expenditure.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
175. exp energy intake/ or exp caloric restriction/
176. (screen based entertainment or screen-based entertainment or screen time).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
177. exp screen time/
178. bed rest.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
179. sitting.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
180. stationary behaviour.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
181. stationary behavior.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
182. standing.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
183. reclin*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
184. recumben*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
185. lying.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
186. bout*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
187. television viewing.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

188. computer viewing.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
189. television game*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
190. computer game*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
191. video game*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
192. exp physical fitness/ or exp cardiorespiratory fitness/
193. physical fitness.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
194. ((physic* or strength* or resist* or circuit* or weight or aerob* or cross or endurance or structur*) adj3 train*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
195. (physical conditioning or fitness).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
196. musculoskeletal fitness.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
197. cardiovascular fitness.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
198. 146 or 147 or 148 or 149 or 150 or 151 or 152 or 153 or 154 or 155 or 156 or 157 or 158 or 159 or 160 or 161 or 162 or 163 or 164 or 165 or 166 or 167 or 168 or 169 or 170 or 171 or 172 or 173 or 174 or 175 or 176 or 177 or 178 or 179 or 180 or 181 or 182 or 183 or 184 or 185 or 186 or 187 or 188 or 189 or 190 or 191 or 192 or 193 or 194 or 195 or 196 or 197
199. 103 or 104 or 105 or 106 or 107 or 108 or 109 or 110 or 111 or 112 or 113 or 114 or 115 or 116 or 117 or 118 or 119 or 120 or 121 or 122 or 123 or 124 or 125 or 126 or 127 or 128 or 129 or 130 or 131 or 132 or 133
200. 134 or 135 or 136
201. 145 and 198 and 199 and 200
202. limit 201 to "child (6 to 12 years)"
203. limit 202 to yr="1994 -Current"
204. 102 or 203

Appendix 2: List of included studies in part one (systematic review on school-based physical activity interventions)

Adab, P., Barrett, T., Bhopal, R., Cade, J. E., Canaway, A., Cheng, K. K., . . . Passmore, S. (2018). The west midlands active lifestyle and healthy eating in school children (waves) study: A cluster randomised controlled trial testing the clinical effectiveness and cost-effectiveness of a multifaceted obesity prevention intervention programme targeted at children aged 6–7 years. Health Technology Assessment, 22(8), 1-644. doi:10.3310/hta22080

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Adab, P., Pallan, M. J., Lancashire, E. R., Hemming, K., Frew, E., Barrett, T., . . . Cheng, K. K. (2018). Effectiveness of a childhood obesity prevention programme delivered through schools, targeting 6 and 7 year olds: Cluster randomised controlled trial (WAVES study). BMJ (Online), 360 doi:10.1136/bmj.k211

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Annesi, J. J., Walsh, S. M., Greenwood, B. L., Mareno, N., & Unruh-Rewkowski, J. L. (2017). Effects of the youth fit 4 life physical activity/nutrition protocol on body mass index, fitness and targeted social cognitive theory variables in 9- to 12-year-olds during after-school care. Journal of Paediatrics and Child Health, 53(4), 365-373. doi:10.1111/jpc.13447

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Part two: Evaluation of policies on active transport and built environment

1 Background

The initial objective of this research was to assess if urban spatial design and mobility solutions might be able to foster physical activity and fitness, encouraging the shift from the motorized travel modes to the active ones. Within this general objective, the research aimed at verifying if there is evidence of the effectiveness of these policies, if the evidence takes into account young people and, in particular, children, and if the corresponding impact is measured.

The research initially aimed to address the analysis of the policies promoting these mobility solutions at general level and, indeed, we found many studies proving that well addressed measures are able to promote active travel (see, among others, the systematic reviews carried out by De Nazelle, A. et al. (2011), Heat, G.,W et al. (2006), Scheepers, C.,E et al. (2014) and Winters, M. et al. (2017)). These policies concern community-and street-scale urban design, like architectural and urbanistic adjustments, land-use policies and practices as well as, modal shift interventions especially for what concerns cycling. The cited studies found that these policies are generally able to achieve their objectives, but considering that all the quoted references agree on the fact that it remains considerably uncertain what the exact effects of these achievements are, none of them provide any evidence on the impact of the analysed policies on the youngest part of the population. This impact should reasonably be there, although it is probably indirect, as it passes through the example and the educational patterns of the parents, and is certainly not easy to prove.

We thus decided to abandon this line of research and focus on mobility solutions directly addressed at children and adolescents under the belief that children's active travel "is one of the simplest and most acceptable form of physical activity that can be easily incorporated into everyday lives" (Jones et al., 2019).

In this framework, we addressed two different, but linked, topics: the evaluation of the effectiveness of active travel interventions addressed to children and adolescents and the analysis of the factors hindering or promoting the active travel of the youngest people. The reason why we divided the bibliographic research into these two branches of analysis is because, in general, the studies concerning the impact evaluation of the children AST did not examine in depth the influence of moderators and mediators (the definition of what moderators and mediators are is given in paragraph 3.2) of travel behaviour change (Larouche, R. et al., 2018). A better understanding of moderators and mediators would indeed enable researchers and policy makers to understand what works for whom and why.

We found a notable quantity of relevant studies on both these topics (see the following sections and Appendix 1) but none of them make explicit reference to the general mobility and built environment policies outlined before. Some of these studies note that "obviously", some general measures aimed at traffic calming or improving the aesthetic and walkability of the city/district streets, or, even, to control the neighbourhood rate of crime, help children to walk or cycle alone, but these observations remain at narrative level without bringing any quantitative evidence. Another consideration about such specific sets of measures is that they could be seen as a sub-set of more general city transport and built environment policies. In practice, they are different as they are designed and implemented by a wide audience of actors including parents in the first instance, and then the traffic engineers and city designers, sociologists and the school personnel.

It is finally worth noting that, as evidenced by the systematic reviews covering the last 10 years of investigation into the effectiveness of school-based active transportation interventions (see section 3), the research on this topic has also grown substantially in recent years. This research generally provides a good overview of the impact of these interventions in terms of increased percentage of children that changed their travel behaviour, however there is a lack of a comprehensive review of the robustness of interventions to promote active travel in terms of resilience (the outcome of these interventions is often entrusted to the good will of parents and school personnel), duration over time, economic and social commitment. Furthermore, the influence of different ethnic cultures within the same city or the different acceptance and effectiveness of the same type of intervention among cities of different countries should be better investigated. More evidence and data on all

these aspects may in fact better help policy makers and social and health operators to transfer or replicate a given intervention in their own city.

2 Methods

2.1 General settings: The PICO framework

The PICO (Population, Intervention, Comparison and Outcome) framework has been followed in this study. The literature search was conducted including three electronic databases: MEDLINE (PubMed), Web of Science and the Transportation Research Databases (TRID/TRB) as well as Google Scholar queries. As outlined in the previous paragraph, the initial scope of the search was rather wide including the analysis of the urban transport policies aiming at changing the populations' travelling behaviour. These policies neither considered at all the youngest part of the population nor was there any relationship between adults' travelling behaviour and that of the youngest people. The scope has thus been better focused and narrowed and, at the end, four main categories of research terms were eventually identified: *children or adolescents, active transportation, interventions and enabling/hindering physical* (environmental and built environment) *factors*. Specific terms used in the search were then further refined thanks to the analysis of the first retrieved studies and from the medical subject headings (MeSH) within PubMed. The bibliographic references language was restricted to English and the time span was from 2,000 up to 2,019. All studies identified were eligible if they fulfilled our PICO search strategy. In this study we have also included references from four relevant systematic reviews (Audrey et al. (2015), Larouche et al. (2018), Chillon et al. (2011), Villa-Gonzalez et al. (2018)). These four systematic reviews were selected from a wider set of studies of this kind because they were the only ones that reported a detailed description of the contents and the outcomes of the reviewed bibliographic references. The studies included in this work from these reviews has been those which contents were closer to the requirements of the PICO strategy.

Table 1: PICO Table

PICO feature	Criteria
Population	School age children and adolescents.
Intervention(s)	Evaluation of Policies and Best Practices promoting active travel among (that is, the development of physical activity through walking and cycling) the targeted population. *Policy and best practices promoting active travelling behaviour and addressed to the general public will be excluded.* *The impact of Policies and Best Practices on the children health will not be analysed** Studies concerning physical (environmental, built environment) factors and/or other factors in addition to the physical ones (safety, social, parental influence, etc.) correlated to the children and adolescents active travel.
Comparison(s)	Studies including baseline and follow-up analysis as well as control and intervention groups will be primarily included.
Outcomes	Analysis, comparison and, even, ranking among the selected policy and best practices based on the quantitative evidences (i.e.: number of children using AST, physical activity level, physical fitness) provided by the selected studies Identification of the environmental factors that can be modifiable in order to be readily translated into population-level interventions and policies

* This review focuses on the children and adolescent physical activity deriving from walking and cycling activities. The impact of these physical activity on the children and adolescent health, and, in particular, obesity ratio is faced by another task of WP 7.

2.2 Detailed statistic information

As outlined in the background, the initial bibliographic research was addressed to general urban transport policies to assess if these measures might be able to foster the shift from the motorized travel modes to the active ones. This research was carried out on the Transportation Research Databases (TRIS/ITRD) electronic databases and Google Scholar and provided more than 400 bibliographic references. After having found that this research didn't lead to any useful result for what concerns the scopes of the STOP project, it has been refocused and narrowed according to the requirement of the PICO table. In this way, based on titles and abstracts, a total of 296 references have been selected of which 110 from the Transportation Research Databases, 116 from Google scholar and 70 from PubMed. Of this set of bibliographic references 21 were Systematic Reviews. The retrieved documentation has been then further analysed again basing on full texts review, determining if the articles met the inclusion criteria stated in the PICO table:

This analysis brought to the selection of a final set of 26 individual papers and eight systematic reviews. Four out of these eight systematic reviews (as outlined before, those that reported a detailed description of the contents and the outcomes of the reviewed bibliographic references) were extracted and included in the reference documents set, further to 27 individual relevant papers, with a total of 61 key documents. Of these documents 35 refer to the policies and best practices to increase the active travel among children (27 from the selected systematic reviews) and 18 to the analysis of factors and barriers influencing this travel mode. It is worth noting that a fairly high number, about 30%, of the same bibliographic sources have been selected both by the systematic reviews and by our research. The main descriptive and quantitative information of the papers included in the final reference documents set have then been outlined in Table 6 and Table 7 annexed in Appendix 2 and discussed in paragraphs 3.1. and 3.2. The PRISMA flow diagram below summarizes the whole process carried out to identify, screen and analyse the selected bibliographic references.

3 Results

3.1 Results from the studies providing the quantitative evaluation of interventions focused on **increasing active travel to school**

Study population

The 35 studies concerning the quantitative evaluation of the interventions focused on increasing AST (described in Table 6 of Appendix 1) took place in three continents: North America, 51% Europe 29% and Oceania 20%. Table 2 shows the distribution of these studies by country and by authors.

The participants number varied across the selected studies ranging from 58 (Vanwolleghem et al (2014)) and 80 (Coombes et al (2016)) to 10 studies that reported between 1000 and more than 4,000 participants (Buliung et al., 2011; Bungum et al., 2014; Christiansen et al., 2014; Goodman et al., 2016; Hunter et al., 2015; McDonald et al., Mendoza et al (2013), 2013; Ostergaard et al., 2015, Stauton, C, E. et al (2003), Wen et al (2008)). A further two studies were carried out with a higher number of students, from about 16,700 (Hickson et al (2011)) up to 65,000 students and 16,000 parents (McDonald et al., 2014). In one case only the number of parents was reported: 7,827 (Mammen et al (2014)) while three studies only reported the number of schools who participated in the study (n = 79 (Hoelscher et al., 2016), n=192 (Moodie, M. et al (2009)) and n = 1019 (Stewart et al., 2014)) rather than the number of participants. Finally, most of the studies focused on elementary schools, with an age range of between 5 and 11.

According to the results reported by the selected systematic reviews, none of the studies they have analysed have expressly stratified their survey samples by family income, ethnicity or other socio-economic factors in order to appraise the influence of these factors on the parent's willingness to let their children walk or cycle to school. The same approach has been observed in all the selected individual studies. Nonetheless some researchers (Hinckson E.A. Balland, H.M. (2011) and Hinckson E.A. et al (2011),), Mammen et al (2014 and 2014b), Menzoza et al (2012)) provided qualitative observations on the influence of the socio-economic status (SES) on the parents and children AST propensity.

The influence of gender and age has not been expressly analysed in these studies. Most of them generally refer to “children” thus including both genders in the survey samples, and some (like i.e. Christiansen et al (2014), Crawford, S. (2013), Jordan, J. (2008), Hoelscher et al (2016), Villa Gonzales, E. et al (2017)) provide figures on the number of boys and girls surveyed, but without then analysing in depth the different AST behaviour by gender.

These results substantiate the observation made at the beginning of this work that the studies concerning the impact evaluation of the children AST did not examine in depth the influence of moderators (namely ethnicity, SES, parents’ attitudes toward PA) and mediators (like, gender and age).

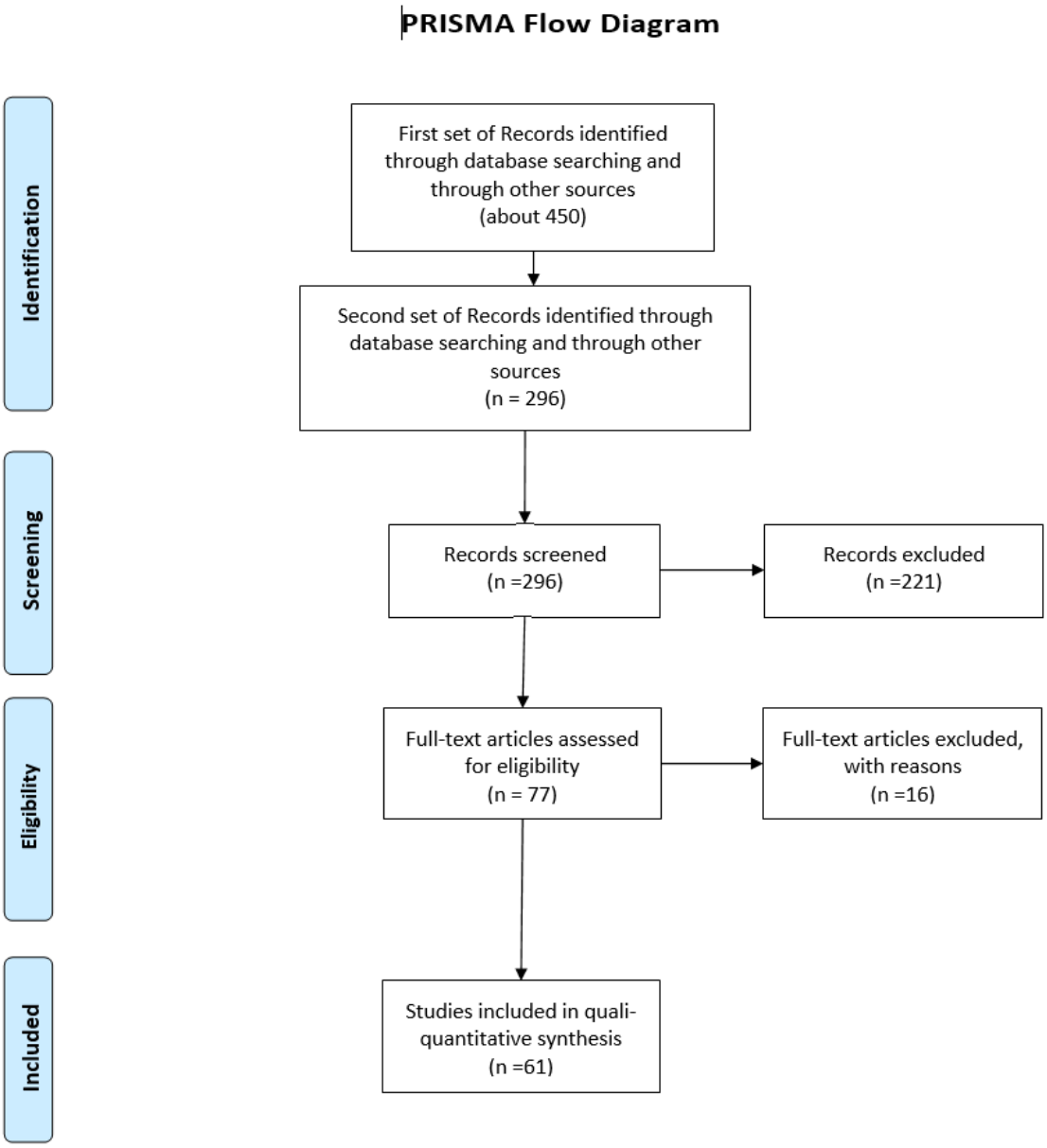


Figure 2: The PRISMA flow diagram

Table 2: Country of Origin of the selected studies (from Table 6)

	USA	*Canada*	*Australia*	*New Zeland*	*Belgium*	*Denmark*	*Spain*	*UK*
Boarnett, M. (2005a) and (2005b)	x							
Buliung et al (2011)		x						
Bungum et al. (2014)	x							
Christiansen et al (2014)						x		
Coombes and Jones (2016)								x
Crawford an Garrard (2013)			x					
Garrard et al (2010)			x					
Goodman et al (2016)								x
Heelan et al (2009)	x							
Hickson and Balland (2011)				x				
Hickson et al (2011)				x				
Hoelscher et al (2016)	x							
Hunter et al (2015)		x						
Grimaldi, D. et al (2017)							x	
Jordan, J. (2008)	x							
Mammen et al.		x						
Mammen et al. (2014b)		x						
McDonald et al (2013)	x							
McDonald et al (2014)	x							
McMinn et al (2012)								x
Mendoza, J. et al (2009)	x							
Mendoza et al (2011)	x							
Merom (2005)								x
Moodie, M. et al (2009)			x					
Moudon et al (2012)	x							
Ostergaard et al (2015)						x		
Sirard et al (2008)	x							
Steward et al (2014)	x							
Staunton, C., E. (2003)	x							
Tenbrink et al (2009)	x							
Vanwolleghem et al 2014					*x*			
Villa Gonzalez (2016)							x	
Villa Gonzales, E. et al (2017)							x	
Wen et al (2008)			x					
Zaccari and Dirks (2003)			x					
Total	**14**	**4**	**5**	**2**	***1***	**2**	**3**	**4**

Assessment methods

Out of the 35 selected studies, 33 assessed the main parameters used to evaluate the effectiveness of a given intervention, that is the mode and frequency of transportation to school, through interviews, generally addressed to both parents and children, while two studies carried out objective measurements like accelerometer (McMinn et al (2012)) and pedometer, (Vanwolleghem et al (2014)). Regarding the interviews, the questions and the way of asking them differed in each study and this is likely to have decreased the comparability of the results.

As for the research design, all studies were quasi-experimental (with some design variations) generally based on cross-sectional design, which is logical due the nature of these investigations. This approach may lead to a bias in the selection of the observation groups, which was stressed by all the selected systematic reviews (Audrey et al (2015), Chillon et al (2011), Larouche et al (2018) and Villa Gonzales et al (2018)). All the studies carried out pre and post evaluations and 16 of them confronted the experimental group with a control one.

Due to all these limitations, the quoted systematic reviews rated the overall quality of these studies from weak to moderate. It is nonetheless important to note that, at least for what concerns the research design of these studies, Hoelscher et al. (2016) argues that a cross-sectional design might works better than a longitudinal one, even if this last is generally considered as more effective. In fact, Hoelscher et al notes that: “it is documented that ACS rates change by grade level, mostly due to parental concern about letting children walk or bike to school before they are in fourth or fifth grade, and ACS rates can change when children transition to middle school. Both of these factors indicate that a cross-sectional design might in fact work better for this type of study” (ibid.).

Interventions description

The selected studies evaluate the impact on the active travel behaviour of children and adolescents of several interventions, some of them undertaken at national level and some at regional, or even school level. All in all, these interventions can be seen as an independent and, often, not correlated, sub-set of the more general city transport and built environment policies, having very specific targets and different design criteria. The city transport policies address the general public and specifically vehicle users and aim at decreasing the vehicle’s environmental impact and increasing the citizens safety. However, the interventions analysed in this document are only addressed at children and their parents as well as the school communities and aim at encouraging children to be more active by walking or riding their bikes, to reassure parents about the safety and security of the school journeys and to involve the institutional actors to make all this possible.

Moreover, for what concerns the design, most of these interventions inspire to the “Community Action Model” strategies (Chillon et al (2011), Villa Gonzales et al (2018)). The model entails a multidisciplinary and participatory approach involving urban designers, sociologists, local authorities, teachers and school principals, and parents (Lavery, S., H. T (2005)). Consistently with this approach, the interventions about active transportation to school involve three main elements: schools, parents, and communities. School involvement was obviously the common element in all interventions and almost all the studies also reported the involvement of parents and the community, except two which focused only on schools (Goodman et al., 2016; McMinn et al., 2012). The tools through which the various interventions analysed the selected studies intended to achieve objectives that were quite similar to one other. All the interventions foresee, at least, promotion and education actions, whose effectiveness depends on how these are structured and continued over time. In addition to this, few interventions (only three) also envisaged infrastructural measures to improve the built environment in order to make home-school journeys safer and more walkable. Only one intervention, named the walking school bus (WSB), proposes a different approach by directly involving adults (parents and/or teachers) in a chaperoning activity of the children to and from school.

Table 3 below provides an overview of these interventions indicating their name, the country in which they are (or have been) implemented and the studies, from those listed in Table 6, that have analysed and evaluated them. A short description of some of these initiatives is provided in Appendix 2.

In Table 3 the first intervention refers to the chaperoning activity of the WSB initiative, the following three interventions entail infrastructural measures, with the remaining activities being promotion and educational ones. The interventions are tentatively sorted according to their robustness in terms of approach and continuation over time on the basis of the information provided by the systematic reviews (Chillon, et oth P. (2011) and Villa-Gonzalez,E., (2018)) and information retrievable on internet on their purposes and organization (see Appendix 2).

It is finally worth noting that the evaluation process of these AST interventions has been evaluated rather robustly by all the selected systematic reviews, both for what concerns the duration of the studies and the approach. Indeed, the 66% of the selected studies lasted more than one year and more precisely: 9 studies lasted from 3 to 6 years, 14 lasted from 1 to 2 years, 5 from 6 to 11 months and 7 from 3 up to 6 weeks (see Table 3). Moreover 33 out of the 35 selected studies compared the follow up data with the initial baseline while two (McDonald et al (2013) and Mammen et al. (2014a)) provided only follow up data.

Table 3: The policies and best practices promoting active travel behaviour to children and adolescents[1]

Policies and best practices	***Countries in which they are or have been implemented***	***Author, year, duration of the intervention****	***Main measures implemented***	***Impact (qualitative evaluation)***
Titled initiatives and programs				
Walking School Bus	USA (evaluations in: California, Nebraska, Texas, Washington) and Australia (Moodie et al.)	Heelan et al. (2009), **2y**	Chaperoning	Rather high
Safe Routes to School program	USA (evaluation carried out in: Alaska, California, Florida, Michigan, Oregon, Texas, Washington, Wisconsin)	Boarnet et al (2005a and2005b), **3y**	Promotion, education, infrastructural measures	Rather high
		Hoelscher et al (2016)**3y**		From Modest to rather high
		McDonald et al (2013, 2014), **4-5y**		Rather high
		Moudon et al (2012), **5y**		High
		Steward et al (2014), **6y**		Rather high
		Tenbrink et al (2009), **4y**		Rather high
Ride2School	Australia, Victoria	Crawford and Garrand (2013), **2y**		Modest
Safe and Secure Cycling Initiative	Denmark	Ostergaard et al. (2015), **1y**		No effect
		Mendoza et al. (2009), **1y**	Promotion and education measures	Rather high
		Mendoza et al. (2011), **5 w**		Rather high
		Sirard et al. (2008), **2 m**		High
		Garrard et al (2010), **8m**		Modest
School Travel Plan	New Zeland	Hickson and Balland (2011), **3y**		Modest
		Hickson et al. (2011) (1year follow up), **3y**		Rather High
School Travel Planning		Buliung et al (2014) **1y**		Rather high

[1] Note: the information provided in the fourth column of this table should be better provided within the next paragraph (effectiveness) but, for sake of compactness and readability we kept this information in this table.

Policies and best practices	***Countries in which they are or have been implemented***	***Author, year, duration of the intervention****	***Main measures implemented***	***Impact (qualitative evaluation)***
	Canada (evaluation carried out in: Alberta, Nova Scotia, Ontario, British Columbia)	Mammen et al. (2014a), **1y**		Modest
		Mammen et al. (2014b), **1y** (1 year follow up)		Modest but with some improvement (qualitative data) with respect the previous year
Beat the Street	UK	Coombes et al. (2016), **9 w**		Modest
		Hunter et al. (2015), **4 w**		Initially rather high but impact declining over the time
Walk to School Research program	Australia, Sidney	Wen et al. (2008), **2y**		Rather high
		Zaccari and Dirks (2003), **4 w**		Modest
Gold Medal School Program	USA, Utah	Jordan et al. (2008), **1y**		Modest
Walk safely to school days	Australia, New South Wales	Merom et al. (2005), **4y**		Rather high
Safe Walking and Biking to School	USA, California	Staunton et al. (2003), **2y**		High (but up to 2002)
Nevada Moves Day	USA, Nevada	Bungun et al. (2014), **3w**		Rather high
Bikeability	UK	Goodman et al., **7m**		No effect
Camino Escolar (School Road Program)	Spain	Grimaldi et al. (2017), **1y**		No data
Travel Green Initiative	UK, Glasgow	McMin et al (2012), **6w**		No effect
Generic initiatives				
Physical activity intervention package	Denmark	Christiansen et al. (2014), **2**y	Promotion and education measures	No effect
Drop-off spot intervention implemented during one school week.	Belgium	Vanwolleghem et al (2014), **1m**		Rather high
Intervention aimed at increasing AST through changing children safety perception and attitudes	Spain	Villa Gonzalez et al. (2016), **11m**		Modest
School-based intervention on active commuting to school and health-related fitness in school-age children	Spain, Granada and Jaén provinces	Villa Gonzalez et al. (2017), **6m**		Rather high

* m= years, m= months, w = weeks

Note: the qualitative rating has been attributed as follow:

- Modest: increase from 1 or 2% up to 10% of the number of children using active transport with respect the baseline.;
- Rather high: from 10% up to 20% of children switched to AST (with respect the baseline);
- High: over 20% of children switched to AST.

Effectiveness.

To synthesise, only four studies reported no effect due to the interventions (of which three concerning cyclability, see below). All the other 31 studies (those reporting impact data) reported an increase in the percentage of active transportation to school following the interventions; however, the degree of change varied

widely, and some interventions were evaluated differently. The “rather high” evaluation was attributed to 50% of the evaluations, modest to 39% and high to 10%.

Even if the overall picture does not look bad, it is important to remember that these evaluations are not comparable, as even those using the same intervention are based on subjective data (interviews) and not measurement (apart from two studies: McMinn et al (2012) and Vanwolleghem et al (2014)) and the selected cohorts are subject to bias, as stressed by all the systematic reviews analysed.

As mentioned at the beginning of this paragraph, three of the four studies found no effect on the increase in active travel concern cycling (Christiansen et al. (2014), Goodman et al. (2016) and Ostergaard et al. (2015)). We therefore consider it important to investigate these results in more depth, due to the policy relevance of this physical activity, by at least relying on the results discussion provided by these three studies. To this end, the three authors provide different explications about this failing. According to Ostergaard, who analysed the impact of a Danish well-structured and multifaceted school cycling promotion programme, which included structural changes near the school (Safe and Secure Cycling Initiative), the results can be attributed to a “failure to implement the intervention as planned” but also to the data quality. Both failed implementation and data quality may depend on the scarce collaboration offered by the teachers to this project and during the data collection. In fact, “though the principal of some schools had agreed to participate in the study, some teachers involved in the data collection considered the project irrelevant or disruptive”. This may have “caused biased results and potentially influenced the external validity”. To this end the author argues that “hiring more project consultants thus relying less on the willingness of teachers and other stakeholders and keeping a closer contact to the schools may contribute to the higher compliance at schools in analysed region”.

Goodman’s study concerns a UK government’s cycling training programme reaching around half of children in England in their final years of primary school. The main result was that there was no evidence that offering Bikeability in school had a short-term effect on cycling frequency in children. The author argues that this may be due to the relatively short period of follow-up (7 months): it is indeed possible that the effects of cycle training may not emerge until children progress to secondary school (when they are more independent). Another problem may come to the study limitation. Here the author recognizes that the interviews should have been complemented by more detailed questions covering different types of cycling (for leisure, with parents, off road, etc.). To this end the author stresses that there exists strong evidence of a positive association between a child having completed formal cycle training and that child’s cycling frequency. In conclusion it seems that the Bikeability program increases the cycling behaviour of children who are already cycling but has a modest impact on those who do not use the bicycle. As Goodman argues: “insofar, as one primary aim of cycle training is to improve cycling skills and cycling safety, then children who are already cycling are arguably those who need it most.”

Finally in the Danish study, Christiansen evaluates the effect of a multicomponent school-based physical activity intervention (specially bicycling) on adolescent active school transport, justifies the disappointing results of the program with the fact that the proportion of active transport was already very high at baseline (86.0%). The intervention just maintained this level at the two-year follow-up (87.0%). Thank to this program more students perceived parental encouragement and had a positive attitude towards cycling at the intervention schools. This difference was however only borderline significant. In practice it seems that in Denmark the remaining possibilities to convince other children to ride a bike are largely limited.

The fact that of the 35 studies analysed, only 3 relate to cycling, can be justified by what McDonald reports in his study and that, probably, can be generalised to the others: “no bicycle-specific environmental measure was included because bike score data were not universally available for all schools. However, the vast majority of reported active school travel was walking, not bicycling, and therefore we do not believe the lack of bicycle-specific environmental metrics is problematic.” (McDonald et al (2013, 2014)).

The effectiveness of the AST interventions not only depends on how they are structured, designed or, even, financed: it exists several other factors that may strongly contribute to their success. A good synthesis of these factors (named “moderators” by Larouche et al (2018)) is provided by Hinckson et al. (2016) that noted that longer follow-up periods, smaller school size, higher school SES, and higher pre-intervention rate of AST predicted higher rates of AST at follow-up. Moreover Mammen (Mammen et al (2014a &b)) reported that

parents of older students, those living closer to school and attending urban or suburban schools (relative to rural) were more likely to report "driving less" following the implementation of an STP.

Before closing this section, a mention should be made to the study conducted by Moodie et al. (Moodie et al. (2009)) that calculated the increased energy expenditure for a child who moved from car to foot transportation. The analysis was done to evaluate the WSB initiative but can be generalised to every other AST intervention. Moodie then calculated this expenditure by subtracting the energy costs of walking (3.5 metabolic units [METS]) from the energy costs of sitting in a car (1.0 METS)[2]. The net 2.5 METS was multiplied by the assumed average weight of the target age children (kg) and the assumed time to walk to and from school to derive total increased energy expenditure (kJ/d). This roughly corresponds to an energy increase of 116 kj/day for a to and from school walk of the average duration of 28,30 minutes/day. As mentioned before, Vanwolleghem et al. (Vanwolleghem et al (2014)) carried out a quantitative evaluation of an AST intervention (again WSB) measuring the increase of the number of steps taken by the children due to the intervention itself. The measurement lead to a net increase of +732 step counts/day with respect the baseline (step counts per day before and after school hour) and to an increase of 2 walking trips per week. The total steps per day of the children pertaining to the intervention group was of 2443, corresponding to a walk of 1,500-1,700 meters/day (0,6-0,7 meters/step for a child, own estimation) lasting about 20 minutes/day. This time is close that estimated by Moodie, even if from the Vanwolleghem study it is not possible to understand how much time was dedicated only to the school-home walk. Both studies agree on an average of three days per week of AST for a total of 35-40 weeks/year (Moodie for Victoria, Australia, in other regions of the word this number may have to be adapted to the local weather and climatic conditions).

3.2 Results from the studies providing a quali-quantitative analysis of the physical factors enabling or hindering the active travel of targeted population.

Study population

The studies providing a quali-quantitative analysis on the factors associated to children's active travel are widely distributed throughout the world. In particular 18 out of the 19 studies described in Table 7 took place in three continents: North America, 41% Europe 41% and Oceania 18%, while one study (Larouche (2015)) analysed these factors in 12 countries distributed word-wide: North and South America, Asia, Africa, Oceania and Europe. Table 4 shows the distribution of the 17 studies by country and by authors.

Table 4: Country of Origin of the selected studies (from Table 7)

	USA	***Australia***	***New Zeland***	***Belgium***	***Ireland***	***Norway***	***UK***
Ahlport K. et al (2007)	x						
Carver, A et al (2013)							x
Chillon, P. et al (2014)	x						
D'Haese, S. (2011)				x			
De Meester, F. (2014)				x			
Easton, S. (2014)							x
Fyhri, A. and Hjorthol, R. (2008)						x	

[2] The bibliographic reference reported by Moodie for this energy expenditure is: Ainsworth BE, et al (2000). Compendium of physical activities: an update of activity codes and MET intensities. Med Sci Sports Exerc, 32(9 Suppl):S498-S516

Giles-Corti, B. (2010)		x					
Graziose, M. (2012)	x						
Henne, H. (2014)	x						
Ikeda, E. et al. (2018)			x				
Lee, C. (2013)	x						
McMillan (2005)	x						
Napier, M. (2010)	x						
Nelson, N. (2008)					x		
Seraj, S, L. (2012)	x						
Timperio, A. et al. (2006)		x					
Van Dick, D. (2009)				x			
Total	**8**	**2**	**1**	**3**	**1**	**1**	**2**

The participant number varies widely across the selected studies: five of them (Ahlport et al (2007), Giles-Corti et al. (2010), Van Dick et al. (2009), Henne, et al. (2014), Napier, et al. (2010)) involved less than 200 people, nine involved from 600 up to 1,200 people (Lee et al. (2013), D'Haese et al. (2011), Graziose et al. (2012), De Meester et al., McMillan (2005), (2014), Seraj et al., (2012), Carver et al. et al (2013), Chillon et al (2014), Fyhri, A. and Hjorthol, R. (2008)) and two involved between approximately 3,000 to 4,000 people (Ikeda, et al. (2018), Nelson, et al. (2008)). Two studies were carried out with a higher number of participants: Larouche, et al. (2015) with 6,555 students and Easton et al. (2014) with 26,709 students. The age of the involved students varied between 5 and 18 years with a focus on children aged 10 to 13 years.

Assessment methods

Due the nature and targets of these studies that aim to analyse the behaviour of the targeted audience, the data was collected through interviews even if, as in the first set of papers, the way of conducting them was quite different. It then deals with empirical and quasi experimental studies.

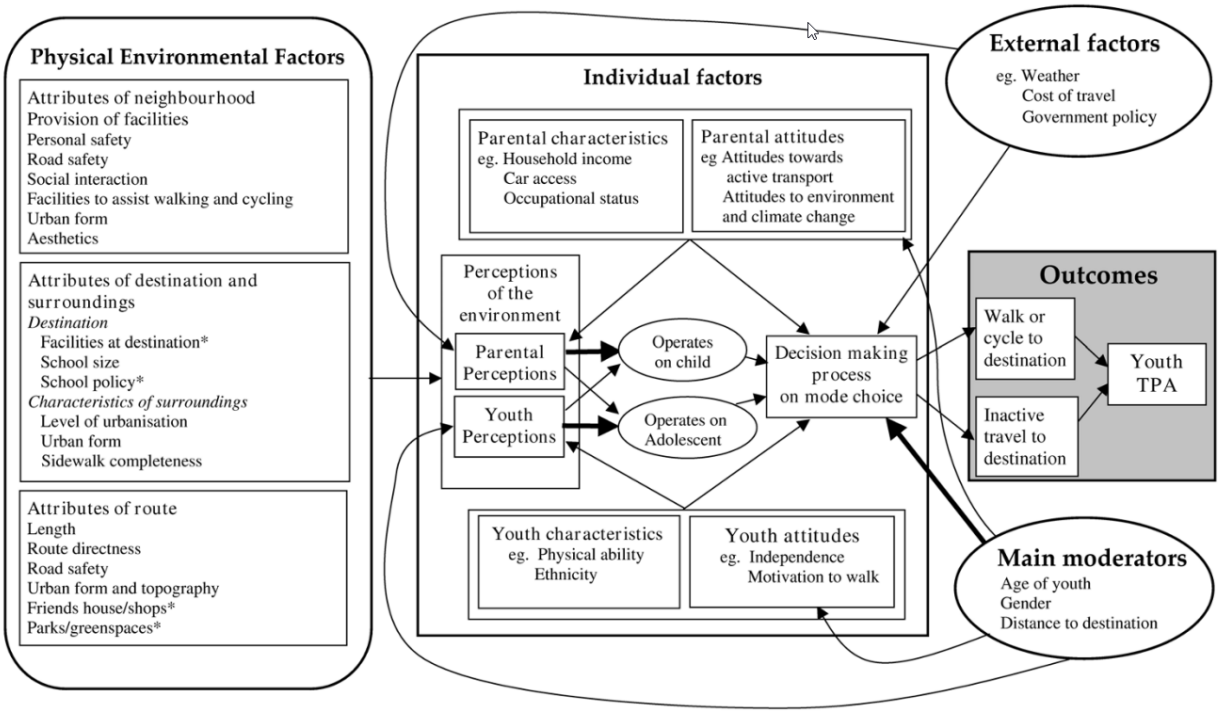
In some cases, the interviews were addressed to both parents and children (Ahlport et al. (2007), Chillon et al. (2014), D'Haese et al. (2011), Henne et al. (2014), Lee et al. (2013), Napier et al. (2010), Fyhri et al. and Hjorthol, et al. (2008)), in one case only to parents (Seraj et al. (2012)) and most frequently only to children (Carver et al. (2013), De Meester et al. (2014), Easton et al. (2014), Giles-Corti et al. (2010), Graziose et al. (2012), Ikeda et al. (2018), Larouche et al. (2015, Nelson et al. (2008), Van Dick et al. (2009)). In one case data was complemented by territorial analysis through the calculation of a walkability index (Gilles-Corti (2010)) and in another case the collected data were merged with those provided by a national survey (Fyhri (2008)). Generally, it is not clear how the respondent groups, and/or the schools where the children were registered, were selected. In four cases a selection criterion was the school distance (Carver et al. (2013), D'Haese et al. (2011), Henne et al. (2014), Nelson et al. (2008) and in one case one third of the interviewed children already walked or cycled to school (Nelson et al. 2008 (2008)). Finally, only one study (Van Dick et al. (2009) addressed adolescents (12 – 18 years), whose behaviour and perceptions are rather different from those of children.

Analysis of the factors enabling or hindering the children active travel

An interesting and comprehensive analysis of the factors influencing children's active travel is provided by the work of Panter (Panter J. R. et al 2008)) that, on the basis of the analysis of 24 studies on this topic (several of which selected in this study), worked out a conceptual framework for the environmental determinants of active travel in children (see Figure 3). In this conceptual framework diverse and detailed physical environmental factors including characteristics of the neighbourhood, destination and route environment are encompassed. These factors, according to the author view, have all been associated with active travel

behaviours in children, considering that “a wider range of factors is more appropriate to evaluate to better evaluate this associations”. It is to note that many of these factors (those with the asterisk) should be further analysed and measured. According to Panter, there are four main domains of influence on active travel behaviour: 1. individual factors, 2. those associated with the physical environmental, 3. external factors outside the most proximal domains of influence, and 4. main moderators. He suggests that the individual, physical environmental and external domains are most likely to influence decision making regarding mode of travel, while the main moderating factors, namely: distance, sex and age alters the strength and form of the association between those factors and the decision made. This observation is consistent with the study of Harten (Harten N. and Olds T. (2003)) that provides a possible correlation among two of these three factors (the graphs refers to 11-12 year old children) showing how the % of trips using AT decreases, in a different way for girls and boys, depending on the travelled distance (see Figure 4).

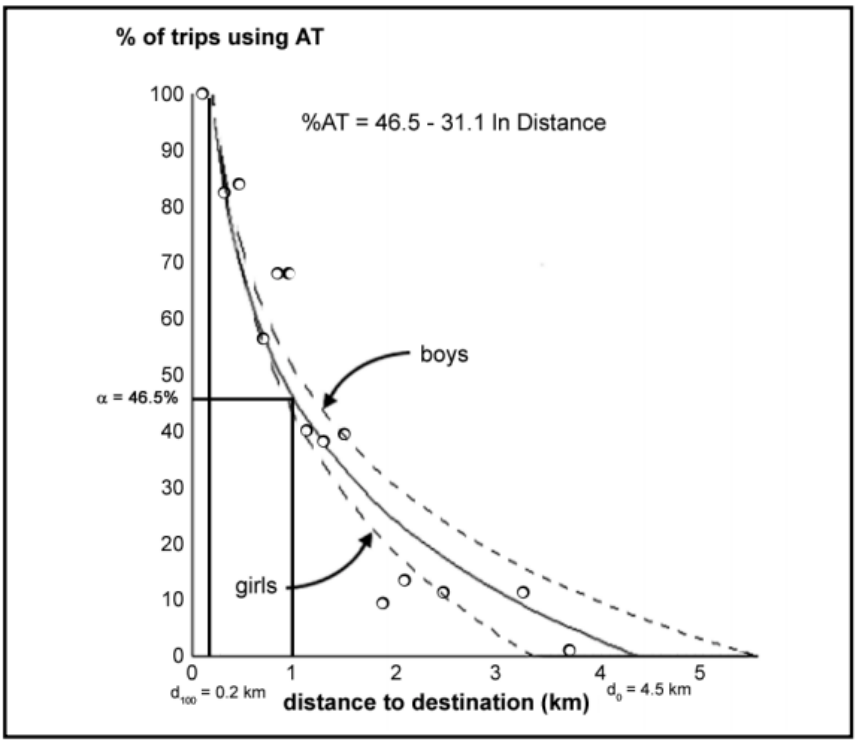
The perception, and then the decision of the suitability of the environment for active travel depend thus by the four domains of influence outlined before, but the question remains of who eventually decides. McMillan (McMillan (2005)) suggests that in children up to a certain age, parents are the main decision makers about mode of travel. Panter, including in his framework also adolescents, argues instead that either parents or youths may decide how to travel. To support this position Panter recalls that evidence from the retail sector consistently indicates that parents are influenced by children's opinions when making purchasing decisions. He thus believes that “similar processes will operate with regard to children's travel mode choice, and that most children and their parents will enter into a dialogue during the decision-making process”. This statement, in our view fully acceptable, reiterates even more the central role of the school in education for a healthier and more active life and, consequently, of all the policies that intend to strengthen this aspect.



* Not studied in relation to active travel behaviour in children. TPA = Transport-related Physical Activity. Arrows indicate a hypothesised direct relationship. Larger thicker lines indicate a stronger hypothesised direct relationship.

Source: Panter J. R. et al 2008

Figure 3: A conceptual framework for the environmental determinants of active travel in children



Source: Harten N. and Olds T. (2003)

Figure 4 Correlation between % of children using AT and travelled distance

The main outcome provided by the documents described in Table 7 , as well as from the systematic reviews dedicated to this argument, is that the distance from home to school is by far the main determinant concerning the children travel behaviour. As stressed above, also other factors like the built environment characteristics, the parents perception about the safety and security of the home-school journey, the socio-economic status of the families, the parents sensibility to the children physical activity and other minor factors, play an important role in the choices of the modes of transport, but they are only all relevant if the home-school distance is considered affordable.

A discussion and a synthesis on the main findings provided by the authors of the selected documents on the factors that hinder or enable the children AT is provided in Table 5.

For what concerns the quality of these findings it is worth noting that the selected studies, as well as those analysed by the systematic reviews included in this paper, provide, even if with different approaches, similar findings that allow to draw some general conclusions. This is a symptom of a generally good quality of the results provided by the selected studies and even if the selection criteria of the interviewed cohorts are not even provided, the risk of bias seems to be low.

Table 5: Factors enabling or hindering the children active travel

Factor	***Discussion***	***Main outcome/description/observed factors***	***Author, date***
Main moderators: distance home-school, age and sex.	Boys walk or bike more than girls. Adolescents are less engaged in active travel but, when walking, travel longer distances.	Average affordable distance is 1,5 km for waking (about 15-20 minutes) and 3 km for cycling	D'Haese et al. (2011) Easton et al. (2014) Fyhri and Hjorthol (2008) Larouche et al. (2015)

Factor	*Discussion*	*Main outcome/description/observed factors*	*Author, date*
	Child age is an important variable: one km decrease in distance equals approximately to a one-year increase in age It is important to note that the association between travel time and travel mode depends on the country where the children live. In fact, 'acceptable' duration of an active trip varies across country sites (Larouche et al. (2015)) Distance travelled to school increases as population density decreases. After controlling for gender and population density, a 1-mile increase in distance decreased the odds of active commuting by 71%.		Nelson et al. (2008) Timperio et al. (2006)
Physical environmental factors and built environment characteristics	The built environment characteristics determine the walkability (or cyclability) level of the streets/routes that lead to school. Nonetheless, it has been noted that traffic safety facilities (like sidewalks and safe pathways/routes to school) are a necessary but insufficient condition to encourage active travel to school: the absence of these supportive element may constitute a severe barrier to walking or cycling but alone they are not enough. Compared with children attending schools located in areas with low connectivity, low density and high traffic exposure, the odds of walking to school were three times higher in children attending schools located in high walkable areas. If the route to school of students living in a standard suburban community, traverses a walkable community, they also walk to school at relatively high rates. In particular traffic safety facilities (like sidewalks and safe pathways/routes to school) are a necessary but insufficient condition to encourage active travel to school: the absence of these supportive element may constitute a severe barrier to walking or cycling but alone they are not enough. Neighbourhood environmental interventions to increase	Main built environment factors are: Residential density, streets connectivity, traffic safety facilities well-maintained and high-quality walking/cycling infrastructures, roads/ neighbourhood aesthetics. According to Ikeda et al. (2018) children and youth living in neighbourhoods with the highest intersection density were almost three times more likely to use AST than those living in neighbourhoods with the lowest intersection density. This finding is, however, in conflict with other studies from Australia (Timperio et al., 2006), the US and Canada (Ikeda et al. (2018) which reported negative associations between intersection density and AST.	Ahlport et al (2007) Chillon et al. (2014) De Meester, et al. (2014) Giles-Corti et al. (2010) Ikeda et al. (2018) McMillan (2005) Napier et al. (2010) Nelson et al. (2008) Timperio et al. (2006)

Factor	*Discussion*	*Main outcome/description/observed factors*	*Author, date*
	children's active transport and physical activity can be effective when combined with awareness raising programs for parents. Furthermore, among girls, encouraging independent mobility may contribute to behaviour change. Children and youth living in neighbourhoods with the highest intersection density were almost three times more likely to use AST than those living in neighbourhoods with the lowest intersection density		
Individual factors: perceived safety and security barriers	Physical measures improving traffic safety need to be supplemented by information or campaigns in order to be effective for increased independent mobility. In conclusion, to promote walking to school, route/street physical improvements appear promising, but parallel educational and promotional efforts may be needed to address perceptual and attitudinal barriers	Traffic safety is one of the main concern of parents (together with crime threats in some cities and neighbourhoods), especially if drivers, but any measure aimed at increasing walking and cycling via improved traffic safety will only be effective if parents' experience of traffic safety is improved.	Fyhri and Hjorthol (2008) Ikeda et al. (2018) Timperio et al. (2006)
Individual factors: parental attitudes and preferences		Factors like school accessibility, parental work patterns, current mode use in the household, and socio-demographic characteristics shape parental attitudes towards children walking and bicycling to school.	Henne et al. (2014) Lee et al. (2013) McMillan (2005) Seraj, et. al (2012)

4 Discussion

The physical activity (PA) of the children, of which the active travel is an important component, can be divided into two main categories: school-related activities and non-school PA. In this review we have mainly focused on school-related activities and, namely, the Active Travel to School (AST) initiative. Indeed, AST not only fully pertains to the wider family of the policies addressing a more sustainable urban mobility, but seems to be a promising strategy to arrest and, possibly, reinforce, the decline of the children PA.

The effect of built environment on PA outside school hours is less clear. On the basis of the (relatively few) studies done in this sector, interventions made on built environment for this type of activity seems to be much less incisive even if the research results are rather contradictory.

For example Pont et al. (2008) noticed in its systematic review that of 10 papers concerning the analysis of the association between recreation facilities (parks, play areas, sporting venues) and children's PA, five report a positive relationship between the presence of these structures in the neighbourhood and the children's activity and five did not find significant associations. It is also interesting to note to this end that Fyhri and Hjorthol (2008) report that, even though leisure activities offer a relatively large potential for walking or cycling, the most typical travel mode to go to these facilities is by car. Even public transport is hardly ever used for getting to these activities. Moreover, it is worth noting that structural improvements made on these facilities do not seem to change this situation. In fact, in its systematic review Audrey et al. (2015) detected that six studies, out of the eight examined, reported no difference in children's park usage, despite the notable improvements made on the park structures (while it was observed some impact on the decreasing of the children accidents). To this end Panter (Panter J. R. et al 2008)) notes that "the importance of environmental features is amplified

when they occur together. For example, certain characteristics, such as the availability of parks and greenspaces, may only act as determinants of active travel if they are present on routes that children are likely to take."

So, from the policy interventions point of view, and without disregarding the importance of the recreational facilities for the children and adult's welfare, we think that the priority should be given to the reinforcement of the school-related activities, that, as described in paragraph 3.2, seem to have a good impact on the improvement of children's PA.

We have then fist analysed the studies that provide a quantitative evaluation of the interventions that promote the AST and then have gone through the papers that have analysed the factors that have positive or negative effect on AST, in order to evaluate how policies can interact on them.

The conclusion of the first part of our analysis is that that active travel interventions are effective at increasing ATS in children but these results have to be handled with care because of both their high heterogeneity in terms of intervention type and duration, number of involved subjects, outcome measures, follow-up duration, and study locality and their quality that, according all the systematic reviews concerning this topic we have found, is generally weak and at risk of bias (Audrey et al. (2015), Larouche et al. (2018) Jones et al. (2019), Chillon et al. (2011), Villa-Gonzalez et al. (2018)).

The most promising interventions are the USA program "Safe Route to School" (SRTS and its derivations like the School travel plan) and "Walking School Bus" (see Appendix 2.2). Despite the notable resources allocated to this program (also because investments on infrastructures are envisaged[3]) the impact evaluation of this initiative provided by 6 studies (see Table 3) are comparable with the 5 studies that have evaluated the Walking School Bus one, being this last much less expensive and less complex (from an organizational point of view) than SRTS.

The success of the other analysed interventions, mostly education based or informative ones, is limited in comparison with SRTS and Walking School Bus, possibly due to little attention to the complex range of determinants involved in the organization of these initiatives and because most of them are held few weeks or even just one day per year. It is worth considering to this end that, due to the continuous turnover of children and parents, these initiatives must be relaunched each year, starting from the first classes of the school cycle to which they are addressed.

The results of implementation evaluations were generally provided in terms increment of children that have changed their travel behaviour, opting to AST, due to the intervention. As mentioned before two studies (McMinn et al. (2012) and Vanwolleghem et al. (2014)) measured this change of behaviour in terms of increased number of steps. One study (Hoelscher et al. (2016)) instead provided the cost-benefit analysis of the SRTS intervention.

The second part of the analysis clearly showed that the main determinant of the choices concerning the school active travel is the home-school distance. There are certainly many other factors that determine this choice but, outside a maximum distance from the school, these quickly lose importance. On the contrary, within the range of convenience to travel by foot or by bike to school, these other factors acquire a decisive importance. As stated in paragraph 3.2 this distance is about 1,5 km (a walk of 15-16 minutes) for walking and 3 km for biking. It is likely that the walking time is even more important than the physical exercise required to cover this distance, given the fairly tight timeframe that families have between the morning wake-up call and the starting time of lessons. (This is purely conjecture, however, there is no evidence of this fact in the collected studies.)

Among the different factors that affect children's active travel the most important and those for which policies may act, are the built environment characteristics and the parental perceived safety risks and attitudes. The best policies are those that act on all these factors (see i.e. the SRTS or the Walking School Bus that works

[3] The larger part (70%–90%) of the funds granted by the national US SRTS program is allocated to projects aiming to improve infrastructure such as engineering treatments and constructions. The rest (10%–30%) is allocated to non-infrastructural measures like education and enforcement (Masoumi (2017))

very well if there are no severe safety risks along the home-school route). As Ahlport (2007) reports: “traffic safety facilities (like sidewalks and safe pathways/routes to school) is a necessary but insufficient condition to encourage active travel to school”. To change mind and behaviour and thus facilitate decisions toward AT, educational and informative actions addressed to parents and, especially (see page14), children are required.

Parents’ attitudes and preferences (among which includes the parents’ mobility patterns) may have a strong influence on their children (walking or not sedentary parents may more easily convince their children to choose active travel instead of buses or the private car, see Henne (2014), Lee (2013) and Seraj (2012)). In turn it is very possible that parents’ mobility patterns can be modified through the issuing of general sustainable transport measures (De Nazelle et al. (2011)) but, even if some studies (see i.e. Henne, H. M. et al (2014)) report that children using AT often have parents who reported themselves using active transport, there is no evidence that correlates the parent’s mobility patterns and their children’s AT.

Finally, it is worth noting that the analysed studies have been carried out in few advanced and rich countries like USA, Canada, Australia, New Zealand and European Countries. No studies have been carried out in South (apart of Spain) and Central - Eastern Europe and in the other part of the word. To respond to this absence in the literature, Larouche et al. (2015) conducted a study on travel to school and PA based on 12 country sites and found significant differences in transport mode choice for school transport. Larouche in fact argues that country-site is an important moderator of the main factors influencing children’s AST and so that it should be added to the three moderators (distance, age and sex) indicated by Panter in his conceptual framework. This finding suggests that, to increase the prevalence of AST, context-specific interventions should be preferred over a ‘one size fits all’ approach.

Nonetheless Larouche adds that “the heterogeneity in the correlates of AST across countries may be partly attributable to the diversity of the country sites”. For example he noted that, despite it being suggested that the lack of motorized alternatives could explain the relatively high prevalence of AST in low- and middle income countries, he found “a negative relationship between motorized vehicle ownership and AST only in China, Portugal and South Africa” and adds that: “despite a high country level rate of motorized vehicle ownership, Finland had the largest prevalence of AST”. This prevalence in Finland has been attributed to a combination of factors “including favorable social norm, supportive policies and high-quality walking and cycling infrastructure.”

In this framework it is interesting to note that a narrative systematic review conducted by Ruopeng (Ruopeng et al. (2018)) on the impact of built environment on PA and obesity among children in China found that the relationship between neighbourhood, built environment and PA among children and adults in this country is very close to that of the developed countries. In both sides of the word neighborhood features such as walkability, bikeability, and proximity to parks and recreational facilities were found to be associated with increased PA and active commuting for both children and adults. Ruopeng thus, to promote PA and prevent childhood obesity in China, suggests developing urban design policies that “incorporate sidewalks, bike lanes, and walking paths, reduce motorized traffic, and encourage lower population densities are likely to promote PA and prevent childhood obesity in China. Apart the recommendation on population density, all the other recommendations are straightforward and similar to those suggested for the developed part of the word.

Similar differences to those highlighted by Larouche were found by Masoumi (2017) in his narrative review where it is reported that “white European children were more likely to walk/cycle, black African Caribbeans to travel by public transport and South Asian children to travel by car”. Masoumi concludes this analysis rightly adding that: “this lack of empirical analysis exists possibly in several multi-ethnic countries and needs to be studied particularly with the new wave of migration from Global South”. We would like to add to this sentence that the importance of the "site" factor becomes decisive when assessing the transferability of a given AST intervention experience from one country to another, so much that it should be added as fourth factor to the “moderators” of the Potter’s conceptual scheme (age, gender and distance).

The analysis of the intervention’s transferability, or replicability, goes beyond the boundaries of the present study, and probably represents a limit for the study itself. Moreover, none of the analysed studies even mention this problem while the interventions transferability might represent a key issue for the policy makers and/or the

social, health and school operators that would like to take advantage of the lesson learned in other part of the word.

We therefore think that this opens up a considerable room for future researches which, in addition to verifying the local impact of the AST interventions, should also analyse them in broader terms to understand to which extent their factors of success (or failure) are related to the context: how resilient they are to the modification of the external conditions (physical, environmental and due to the continuous renewal of children in schools), how much do they depend on economic and social factors and on the involvement of the human resources involved.

5 Conclusions

The primary aim of this review was to summarise the effectiveness of active travel interventions on active travel rates in primary school children and secondary school adolescents. The review found that active travel interventions are successful to increase the odds of active commuting to school in primary school children, but very little evidence is provided for adolescents. Despite children's PA also concerning non-school activities, it has been decided not to deepen this argument due to the controversial evidence on the link between these activities and children's PA and the very modest impact of measures addressed to improve leisure facilities.

This review was moreover conducted with the purpose of investigating the factors affecting the active travel of children in order to provide ground for measures and interventions to better promote this practice. It has been found that environmental factors which appear to promote active travel in children include safety, social interactions, and the presence of facilities to assist walking and cycling. The influence of these factors may vary according to the part of the word where these measures have to be implemented and thus they should be designed in accordance with local cultures and behaviours taking into account the related country contexts. The transferability and replicability of these interventions should then represent a future field of investigation.

Finally, according to the findings of this review, the most important topics that deserve more comprehensive and detailed investigations are the following:

- Differences between perceptions of parents and children and associations with children's PA;
- associations between mobility patterns of parents and their children's PA;
- differences on factors affecting active travel in different cultures, subcultures, and ethnicities in national level;
- differences on factors affecting active travel in different regions of the world, e.g. continents.

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Appendix 1: Short description and main results of the selected documents

Table 6: Effects of built environment and transport policies to the children active transport (sorted by continent: Europe, North America and Oceania).

Author, year	Location, analysed policies or good practices	Study population and duration	Results (survey/analysis method)	Source: Task 7.2 analysis (T7.2) or Previous Synthetic Reviews (PSR, authors)
Christiansen et al. (2014)	Denmark. Evaluation of a physical activity intervention package which comprised 11 components of which four were directly targeting active transport: policy, programs and physical initiative.	1014 students (age 11-14 years): 498 in the experimental group and 516 in the control group. Duration: 2**y**	Experimental (randomized controlled trial) pre-post assessment at 7 experimental and 7 control schools. Duration: 2 years The frequency of AST increased 2-year follow-up (baseline: 86%; post-test 87%) with no difference between groups. Moreover 55% of students perceived parental encouragement in the experimental group compared with the control group (51%). 89% of students in the intervention group compared with 85% of students in the control group had a positive attitude towards bicycling at the intervention schools	PSR: Villa-Gonzales, E
Coombes and Jones (2016)	Norwich (UK) Evaluation of the *Beat the Street* initiative. A technology-based intervention aimed at increase AST via incentive-motivated approaches.	80 students (age 8-10years): 51 in the experimental and 29 in the control group. Duration: **9w**	Quasi-experimental pilot design with pre- 2post (week 0, week 7 and week 20) assessments at 1 experimental and 1 control school. Duration: 9 weeks. The mode of commuting was similar in both groups, but an increasing frequency of AST was observed in the experimental one: in fact, this one increased AST (10% equivalent to 1 extra active travel per week), whereas the control group decreased (7%).	PSR: Larouche, R., Villa-Gonzales, E.
Goodman et al (2016)	UK Evaluation of the *Bikeability* program: a national training program for children and adults.	3,336 students (age 10-11 years) of which 2,563 in the experimental group, 773 in the control group and their parents Duration: **7m**	Quasi- experimental design with prepost assessments at 1 experimental group and 1 control group. Duration:7 months The experimental group showed a similar frequency of cycling to and from school than the control group. Parents reported 68% of participation in the formal cycle training for the experimental group compared with 28% in the control group	PSR: Larouche, R., Villa-Gonzales, E

Grimaldi, D. Fernandez, V. (2017)	Two districts in the city of Barcelona, Spain: San Marti and Sant Andreu. The objective of this study was to identify and classify barriers related to the initiative on the School Road program (*Camino Escolar*) in Barcelona.	22 Interviews per each city district addressed to parents (10 people), parents associations (4 members), managers of the program (4 managers) and school managers (4 people). Duration: **1y**	Semi structured interviews with open questions for one hour, to capture the barriers and drivers perceived by different stakeholders. The methodology was divided in two phases. The first phase concerned an exploratory study based on interviews with the different stakeholder of the education system that concluded with a list of barriers against the development of School Road project. The second one concerned interview addressed to parents to prioritize these barriers.	T7.2
McMinn et al (2012)	Glasgow, Scotland Evaluation of the *Travel Green* initiative. A 6-week school-based interventions based on teacher lessons and students' packs.	166 students (age 8-9 years): 79 in the experimental group and 87 in the control group. Duration: **6w**	Quasi-experimental study with pre-post assessment at 2 experimental and 3 control schools. Duration: 6 weeks. The experimental group showed 56% of walkers and the control group 39% at baseline. Intervention had no effects on active travel.	PSR: Audrey S, Larouche, R., Villa-Gonzales, E.
Ostergaard et al (2015)	Denmark Evaluation of the *Safe and Secure Cycling* initiative aimed at increasing the AST behaviour having children walking in adult-supervised groups.	2,401 students (age 9-11 years): 1296 in the experimental group and 1105 in the control group. Duration: **1y**	Quasi- experimental design with pre- post assessment at 13 experimental schools and 12 control schools. Duration: 1 year. There were no differences in AST between experimental and control groups after the intervention.	PSR: Audrey S, Larouche, R., Villa-Gonzales, E.
Vanwolleghem et al (2014)	West Flanders, Belgium One drop-off spot intervention was implemented during one school week. The drop-off spot was located at a square along an approach road and was separated from the road. Prior to the intervention, a flyer with information was given to the children and the parents. The information included the exact location of the drop-off spot and specific time periods when parents could drop off their children, the fact that a teacher would be present at the drop-off spot and would walk with the children to school. Parents were also informed that when they arrived later at the drop-off spot, teacher supervision was no longer present.	216 parents and 58 students (age 6-12 years) Duration: **1m**	Quasi- experimental pilot study with pre- post assessment at 2 experimental schools Duration: 1 month. Experimental group showed an increase in step counts per day before and after school hours (+731 step counts/day) ($p < 0.001$) and number of walking trips (+2 trips/week) after intervention ($p < 0.001$). All teachers and parents agreed that the drop-off spot was well organized. Both school principals and the majority of the parents agreed that drop-off spots could be used in the future.	
Villa Gonzalez et al. (2016)	Spain Evaluation of an intervention aimed at increasing AST through changing children safety perception and attitudes.	206 children age 8-11 years: 117 in the experimental group and 89 in the control group.	Quasi- experimental design with pre-2post (baseline, after intervention and 6-month follow-up) assessments at 3 experimental and 2 control schools. Duration: 11 months	PSR: Larouche, R., Villa-Gonzales, E.

		Duration: **11m**	The frequency of walk and bike travels per week increased in the experimental group (0.4 travels/week), whereas it decreased in the control group (-0.4 travel/week) at 6-month follow-up (p = 0.019).	
Villa Gonzales, E. et al (2017)	Granada and Jaén provinces in Spain Evaluation of the effects of a school-based intervention on active commuting to school and health-related fitness in school-age children of Southern Spain	469 children recruited in 5 public schools. Duration: **6m**	Quasi experimental, pre-post: 5 schools were non-randomly allocated (i.e., school level allocation) into the experimental group (EG, 3 schools)) or the control group (CG, 2 schools). The EG received an intervention program for 6 months (a monthly activity) focused on increasing the level of active commuting to school and mainly targeting children's perceptions and attitudes. At follow up, the EG had higher rates of cycling to school than CG for boys only (p = 0.04), but not for walking to school for boys or girls. The EG avoided increases in the rates of passive commuting at follow up, which increased in the CG among girls for car (MD = 1.77; SE = 0.714; p = 0.010) and bus (MD = 1.77; SE = 0.714; p = 0.010) modes. Moreover, we observed significant interactions and main effects between independent variables (study group, sex and assessment time point) on health-related fitness (p < 0.05) over the 6-month period between groups, with higher values in the control group (mainly in boys)	T7.2
Boarnett, M. (2005a) and (2005b)	California (USA). *California's Safe Routes To School* (SRTS) program funds traffic improvement projects. The program focused on environmental changes aimed at increasing traffic safety (i.e. control of traffic signals) rather than to education or traffic law enforcement. 10 SRTS projects were constructed and assessed at 10 schools. The intervention works focused on sidewalks improvements, construction of a walking paths and crossing improvements.	10 Schools: 862 parents of children age 8-11: 486 in experimental group and 376 in control group. Duration: **3y**	Quasi-experimental design with retrospective post-test assessment without a comparison group (Boarnet et al.,2005a). Quasi-experimental pre– post evaluation design without a comparison group (Boarnet et al.,2005b) Parent-reported frequency of child walking and biking to school with the question: "Would you say that your child now walks or bicycles to school: (1) less than before the project described above was built; (2) the same amount as before the project was built; (3) more than before the project was built". 72% of parents stated that children walked/biked the same before and after the SRTS construction; 18% stated less and 11% stated more. All in all, there was a greater increase in walking among those who passed the SRTS project) after sidewalk improvements and traffic control projects (primarily traffic signals). Children who passed completed SRTS projects were more likely to show increases in walking or bicycling to school than were children who would not pass by projects.	PSR: Audrey, S. and Chillon, P.
Buliung et al (2011)	Albert, Nova Scotia, Ontario, British Columbia provinces, Canada. The objective was to conduct a pilot *School Travel Planning* intervention.	12 elementary schools were purposively selected based on school's willingness to participate. Students: all students present the day of data collection Duration: **1y**	Quasi-experimental pre–post evaluation design without a comparison group. Children-reported rates of active transportation increased from 43.8% to 45.9% at 1-year follow-up point (p-value not reported). 13.3% of families reported less driving at 1-year follow-up time point	PSR: Audrey, S., Larouche, R., Villa-Gonzales, E.

Bungum et al. (2014)	Las Vegas USA Evaluation of the *Nevada Moves Day* encouraging children and their families to walk or bicycle to and from school.	1,336 students age 5-11 years: 638 in the experimental group and 698 in the control one. Duration: **3w**	Quasi experimental design with pre and post assessment (one week before and one week after the event). The frequency of Active School Travel (AST) was significantly higher in the intervention school than the control school during event (17% vs. 7%, $p < 0.001$). A significant increase in the frequency of bicyclists and those who used other wheels was observed from pre- intervention to the event day in the experimental group (walkers: 54 to 64; bikers: 10 to 32; others wheels: 2 to 15).	PSR: Larouche, R., Villa-Gonzales, E.
Heelan et al (2009)	Midwestern Community in Nebraska (USA) Evaluation of the *Walking School Bus* program. An adult leader met the neighbourhood children at designated walk- stops at specified times each morning and walked the group to and back school. Eight routes were created for the 2 WSB schools. The WSB was conducted during the entire academic years and was only cancelled when temperatures were below 25 or if it was raining or snowing at the scheduled walk time.	3 Schools, 324 children: 201 (age 8-11) in experimental group and 123 in control group Duration: **2y**	Quasi-experimental with pre-post assessments with 1 control and 2 experimental schools. Duration: 2 years. Children at experimental and control groups used similar modes of transportation in the pretest: 27% actively commuted to school and 34.5% actively commuted home from school, at least once a week. Children at experimental group actively commuted more than children at control group at each post-test assessment ($P < 0.05$). 70.5% children at experimental group met the Healthy People 2010 recommendations (walking 50% of the time) compared with 24.7% of children at control group (results averaged across the 2 years). Experimental participants obtained significantly more daily physical activity than control participants ($P < 0.05$). Across all schools, frequent walkers obtained 25% more physical activity ($P < 0.05$), gained 58% less body fat ($P < 0.05$), and attenuated BMI by 50% ($P < 0.05$) compared with passive commuters. There were no statically significant differences in changes in body composition over 2 years intervention	PSR: Chillòn P-
Hoelscher et al (2016)	Texas, USA Evaluation of the *Safe Routes to School* program	78 schools (students age 9-10 years) and their parents:23 in the experimental group-1 (schools with awarded infrastructure projects and SRTS plan), 21 in the experimental group-2 (schools with awarded no infrastructure and SRTS plan), and 34 in the control group schools. Duration: **3y**	Quasi- experimental study with pre- 3post (baseline, 2- interim and 3-y-follow-up) assessments at 2 experimental and 1 control groups. Duration: 3 years (2009-2012). Morning frequency of AST in group-1 and group-2 were higher than in control schools ($p = 0.024$, $p = 0.013$, respectively). Afternoon frequency of AST in group-2 decreased more over time compared with control group schools ($p = 0.009$). Control school students reported an increased number of friends who walked or rode bikes to school ($p < 0.01$).	PSR: Larouche, R., Villa-Gonzales, E

Hunter et al (2015)	Reading, UK and Vancouver, Canada Evaluation of the international school competition *Beat the Street*, aimed to increase AS via incentive-motivated approaches.	12 schools and 2,068 students (age 9-13 years) Duration: **4w**	Quasi- experimental (uncontrolled mixed methods evaluation) design with pre-post assessment at 12 experimental schools. There was a gradual decline in the frequency of AST over the 4-week period (week 1: 29%; week 2: 18%; week 3: 14%; week 4: 12%). Post-intervention, 97% of children felt that walking to school helped them stay healthy, feel happy (81%), and stay alert in class (76%). 91% of parents and 71% of teachers thought that the participation in the competition encouraged children to walk to and from schools.	PSR: Larouche, R., Villa-Gonzales, E
Jordan, J. Et al. (2008)	Tooele County, Utah (USA) Impact analysis carried out via anthropometric measurement of the Utah *Gold Medal Schools* Program.	Four primary schools in Tooele County was selected: 2 of them participated to the program (intervention sample) and 2 did not (comparison sample). 969 survey packets including the involved children and their parents were distributed at baseline and one year after the implementation of the program. The survey included the collection of anthropometric data. 797 (79%) students return the survey Duration: **1y**	Data were entered into a dedicated system with double-key data entry. Statistical analyses were performed using a Statistical Package for the Social Sciences. Analysis of variance and Spearman and Pearson correlations were used to test for associations between independent variables and BMI z scores. Differences between baseline and year-1 survey results were determined using the nonparametric Wilcoxon signed rank test. 2 and Fisher's exact test analyses were performed for all questions as appropriate. A paired t test was used to evaluate the change in pre and post-BMI z scores, followed by an independent sample t test to compare differences between intervention and comparison groups. Significance was indicated by P0.05. There was a nonsignificant rise in BMI z scores. from baseline to year 1 (0.210.47; P0.484) for students in the intervention cohort. Conversely, BMI z scores increased significantly from baseline to year 1 in the comparison group (0.530.38; P0.05). Parent surveys also indicated that Gold Medal Schools children walked or biked to school more often than nonGold Medal Schools children (P0.001) at baseline and 1 year. While both Gold Medal Schools. For both data collection periods, there were no significant differences between Gold Medal Schools and nonGold Medal Schools children for other physical activity behaviors.	T7.2
Mammen et al. (2014a)	Canada To evaluate the Canadian *School Travel Planning* intervention (education, engineering, enforcement) by examining changes in school travel mode and predictors of mode change (Mammen et al., 2014a)	Baseline and 1year follow-up: Children aged 6 to 14 years old (number not provided). (Mammen et al., 2014a) Duration: **1y**	Quasi-experimental pre-post evaluation design without a comparison group (Mammen et al., 2014a). Active travel: Student-reported data showed there was no increase in active school travel at 1-year follow up time point (baseline 27%, follow up 31%, n and p-values not provided) (Mammen et al. 2014a). Infrastructure improvements and safety education were perceived by families as the most effective strategies implemented (Mammen et al., 2014b). Schools that collected baseline data in the Fall and follow-up data in Winter saw a decrease of active travel by up to 5% (po0.05) (Mammen et al., 2014a).	PSR: Audrey S, Larouche, R., Villa-Gonzales, E

Mammen et al. (2014b)	To evaluate the Canadian *School Travel Planning* intervention by examining child-, family-, and school-level characteristics (Mammen et al., 2014b)	1-year follow-up:7827 of 24,893 (31.4%) families attending schools that implemented School Travel Plan programme (Mammen et al., 2014b) Duration: **1y**	Quasi-experimental retrospective post-test assessment without a comparison group (Mammen et al.,2014b) Parent-reported data showed less driving in Children's age, household distance, and middle-class neighbourhoods schools were predictors of change. (Mammen et al., 2014b)	
McDonald et al (2013)	Eugene, Oregon (USA) Evaluation of the *Safe Route to School* program (non-infrastructure and infrastructure strategies to improve walking and biking)	9 primary schools and 5 middle schools (9 experimental and 5 control schools) Evaluation duration up to 4 years Duration: **4y**	Quasi-experimental pre–post evaluation design with a comparison group. Student self-reported data showed increased walking and biking for school travel: increase of 2 and 5 percent in walking and biking respectively was observed. (p-values not reported) In particular covered bike parking lead to 19% increase on 11% in biking and interventions in education and encouragement lead to 20% increase in walking and a non- significant increase in biking. School characteristics, such as racial composition and socioeconomic level did not affect walking and biking.	PSR: Audrey S, Larouche, R., Villa-Gonzales, E.
McDonald et al (2014)	Florida (USA) Evaluation of the *Safe Route to School* program (non-infrastructure and infrastructure strategies to improve walking and biking)	423 control and 378 experimental schools with approx. 65,000 students (age 6-15 years) and 16,000 parents annually Duration: **5y**	Quasi-experimental design with pre and up to 4 post assessments. Duration 5 years. Walking and bicycling frequency increased 31% after the SRTS programs adjusting by school and environment characteristics. Engineering interventions lead to 18% relative increase and the effects of both education and encouragement interventions lead to 25% relative increase, in walking and bicycling Walking and bicycling were higher in areas with greater population density and were 3% higher in the way from school than to school and were higher when reported by parents than by students	PSR: Audrey S, Larouche, R., Villa-Gonzales, E.
Mendoza, J. et al (2009)	Seattle, Washington (USA) Impact analysis of a *walking school bus* (WSB) program on student transport in a low-income, urban neighbourhood.	Three urban, socio-economically disadvantaged, public elementary schools (1 intervention vs. 2 controls) in Seattle, Washington, USA. Participants were ethnically diverse students in kindergarten-5th grade (aged 5–11 years).	Controlled, quasi-experimental trial with consecutive cross-sectional assessments with one intervention and two control schools. The "Stata version 9 for Window" tool was used comparing students transported to school at the intervention versus control schools at each time point with Pearson Chi-squared test. The control schools' data were pooled. The unit of study was the school group, i.e. intervention versus the pooled control schools. Due to multiple testing, we calculated adjusted p-values using the Ryan-Holm stepdown Bonferroni procedure At baseline, the proportions of students who walked to school at the intervention (20% +/- 2% versus control (15% +/- 2%) schools were not significantly different (p = 0.39). However, at 1-month (25% +/- 3% vs. 11% +/- 2%, p = 0.0012), 6-month (24% +/- 2% vs. 11% +/- 2%, p = 0.0011) and	T7.2

		Duration: **1y**	12-month follow up (25% +/- 2% vs. 7% +/- 1%, p = 0.001), higher proportions of students walked to school at the intervention school versus control schools, respectively	
Mendoza et al (2011)	Texas, (USA) Evaluation of the *Walking School Bus* program. Each intervention school had 1 to 3 walking routes based on children's home addresses. Trained study staff walked the children to and from school up to 5 days/week	149 students (age 9-10 years): 70 in the experimental group and 79 in the control group. Duration: **5w**	Experimental (randomized control trial) pilot study with pre-post assessment at 4 experimental schools and 4 control schools. Duration: 5 weeks The experimental group showed less frequency of AST (23%) than the control group (44%) at pre-test. The experimental group increased (from 24% to 54%) and the control schools decreased (from 40% to 33%) at post-test (p < 0.001).	PSR: Audrey S, Larouche, R., Villa-Gonzales, E.
Moudon et al (2012)	Florida, Mississippi, Texas, Washington, and Wisconsin (USA) To assess the *Safe Route to School* program in 5 USA States	53 schools that implemented the Safe Routes to School programme and provided data Baseline: 73,344 students (N at follow up not reported) Duration: **5y**	Quasi-experimental pre–post evaluation design without a comparison group. Across all projects and schools with pre- and post-project travel data in the four states, walking increased by 45% (from 9.8% to 14.2%, po0.001), bicycling increased by 24% (from 2.5% to 3.0%, p¼0.01), and all active travel modes increased by 37% (from 12.9% to 17.6%, po0.001).	PSR: Audrey S
Sirard et al (2008)	USA Evaluation of a *Walking Bus School* initiative. In this case students walked at their normal pace but were encouraged to stay together as a group A wagon, pulled by the study team member, was used to transport backpacks and instruments. If a student lived more than 1.6 km from the school, the parent/ guardian dropped the student off at one of the other student's homes (1.1 km from school), and he or she walked the remainder of the trip	11 Schools and 1,743 students age 6-15 Duration: **2m**	Quasi-experimental with pre and 3 post (spring-01, fall-01, spring-02) assessments at 11 experimental schools*. Duration: 2 school years. From fall 2000 to spring 2002, walking increased 64%, biking increased 114%, carpooling increased 91%, and private car use carrying one student decreased 39%.	PSR: Chillòn P
Steward et al (2014)	Alaska, Florida, Mississippi, Texas, Wisconsin and Washington To assess the *Safe Route to School* program in 6 USA States	354 projects and 1019 schools (students age 5-18 years):48 projects and 53 schools in experimental groups and 306 projects and 966 schools in control groups Duration: **6y**	Quasi-experimental study with pre-post assessment at 53 experimental schools. Duration: 6 years There were significant increases in the frequency of AST across projects (37%). All the active transportation modes increased (13% to 18%); walking (10% to 14%) and bicycling (2% to 3%).	PSR: Audrey S, Larouche, R., Villa-Gonzales, E.
Staunton, C., E. (2003)	Marin County, California (USA) Evaluation of the *Safe Walking and Biking to School* Program in the Marin County	The evaluation concerned 6 schools for the year 2000-2001 and 7 schools for the year 2001-2002,	The evaluation was carried out through direct interviews addressed to the children by a staff on volunteers. The interviews were carried out for two consecutive years prior the start of the program and then at the end of the school year. By direct admission of the author of this paper the quality of	T7.2

		out of the 15 elementary and middle schools (for a total of 4,665 students) where the program took place. Duration: **2y**	this assessment is weak due to the inexperience of the volunteers that carried them out. Nonetheless the results, even if do not have a robust scientific value, indicate the validity of the undertaken program. From the fall 2000 to the spring 2002 there was an 64% increase of the number of children walking, a 114% increase in the number of students biking and a 39% decrease in the number of children arriving at school by private car carrying only one student.	
Tenbrink et al (2009)	Jakson, Michigan (USA) Evaluation of the *U-Turn* project. The project was an integrated approach with the USA. Active Living by Design Community Action Model and the Michigan *Safe Routes to School* model. The project began with a Safe Routes initiative in local schools and then it was expanded from the schools to other destinations as worksites, churches, parks. Physical projects to support active transportation were made.	4 Schools with students age 6-11 Duration: **4y**	Quasi-experimental with pre-3 post (every year) assessment at 4 experimental schools*. Duration: 4 years The number of students walking to school increased: 5% of students walked to school in 2004; 7% in 2005, 11% in 2006 and 15% in 2007. Participation in WTS Day increased from 600 in 2003 to more than 1200 in 2008. There was improvement in physical projects, policies, and walking and biking in the community	PSR: Chillòn P
Crawford and Garrard (2013)	Victoria, Australia Assessment of the *Ride2School* program (mostly promotional and encouraging activities without infrastructure change)	4 primary schools (age 10-12 years) of which 2 experimental and 2 control. Duration: **2y**	Quasi experimental design with pre and post assessment, duration six months. Frequency of AST increase (+8%) in experimental group and control group decrease (-4%) from pre to post test.	PSR: Larouche, R., Villa-Gonzales, E.
Garrard and Garrard (2010)	Victoria, Australia Evaluation of the *Ride2School* multicomponent program	13 primary schools. Baseline: 479 students and 409 parents. Follow up (8 month after): 403 students and 358 parents Response rate: 29% Duration: **8m**	Quasi-experimental pre–post evaluation design without a comparison group. Parent-reported data showed a small increase in the proportion of active trips to and from school from baseline to follow-up approximately 8 months later (47.9–49.6%) (p-values not reported).	PSR: Audrey S.
Hickson and Balland (2011)	Auckland Region, New Zealand To determine the effectiveness of the *School Travel Plan* Programme in changing the school travel behaviour in children.	13,259 students (5-10-year-old) Duration: **2y** Baseline 16,686 students	Quasi-experimental pre–post evaluation design without a comparison group. Student-reported data showed by the second year of programme implementation, there was an increase in active travel by 5.9% (76.8%)	PSR: Audrey S, Larouche, R.

Hickson et al (2011)	To describe trends in active commuting to school in children	1 year follow up following the implementation of the program Duration: **3y**	Student-reported data showed by the third year of School Travel Plan implementation, there was an increase of active travel (40.5–42.2%) Students attending higher socioeconomic schools background showed greater improvements (38.9% to 39.1%) compared to those from mid	
Merom et al. (2005)	New South Wales, Australia Evaluation of the South Wales *Walk Safely to School Day* (WSTSD). The main objectives of WSTSD were to reinforce safe pedestrian behaviour, to promote the health benefits of walking, and create the habit at a very young age, to reduce car dependency and to promote the use of public transport.	812 parents of children age 5-12 and 717 schools Duration: **4y**	Observational with pre-3post (every year) assessment at 265 experimental schools. Duration: 4 years 31% more children walked to school on WSTSD than a normal Friday. WSTSD increased the prevalence of walking to school by 6.8%, at a population level. The school- reported prevalence estimate of walking to school (19%), was similar to rates reported by parents (21.8%). Over the 4 years, 53% of all primary schools in NSW had participated at least once in WSTSD and 15% had participated for at least 3 years. The overall increase in school participation from 2001 to 2004 is 66%. Significantly more schools from urban than rural regions had participated ($P < 0.05$). Most schools stated they would participate in next year's event because it raises awareness of road safety (84%) and reinforces students' knowledge of safe pedestrian behavior (79%).	PSR: Chillòn P
Moodie, M. et al (2009)	Local municipalities in Australia To assess from a societal perspective the incremental cost-effectiveness of the *Walking School Bus* (WSB) program for Australian primary school children as an obesity prevention measure. To this end a cost-effectiveness evaluation was undertaken, and the incremental cost-effectiveness ratio (ICER) calculated as the cost ($AUD) per Body Mass Index (BMI) unit saved and disability-adjusted life year (DALY) saved. The intervention time horizon was one year.	48 Municipalities recruit 4 local schools each for a total of 192 schools. 307 WSBs were active in these 192 schools. 2,143 children (age 7-11) was involved in these 307 WSB programme.	A logic pathway was used to model the effects on body mass index [BMI] and disability adjusted life years [DALYs] of the Victorian WSB program if applied throughout Australia. Cost offsets and DALY benefits were modelled until the eligible cohort reached 100 years of age or death. The reference year was 2001. Second stage filter criteria ('equity', 'strength of evidence', 'acceptability', feasibility', sustainability' and 'side-effects') were assessed to incorporate additional factors that impact on resource allocation decisions The modelled intervention reached 7,840 children aged 5 to 7 years and cost $AUD22.8M ($16.6M; $30.9M). This resulted in an incremental saving of 30 DALYs (7:104) and a net cost per DALY saved of $AUD0.76M ($0.23M; $3.32M). The evidence base was judged as 'weak' as there are no data available documenting the increase in the number of children walking due to the intervention. The high costs of the current approach may limit sustainability	T7.2
Wen et al (2008)	Inner west Sidney, Australia Evaluation of the Central Sydney *Walk to School Research* Program (Education, sensibilization, engineering)	12 elementary schools (1094 students, age 10-12) for the intervention group and 12 schools (1164 students) for the control group. Duration: **2y**	Cluster randomised controlled trial Students walking to/from school increased in both experimental and control schools, but it increased more in the experimental group (29% vs. 19% in control; $p = 0.05$). Students travelling by car to school decreased more in the experimental group (42%) than in the control group (32%) ($p = 0.14$).	PSR, Audrey, s., Chillòn, P.

Zaccari and Dirks (2003)	Sidney, Australia Evaluation of the pilot *Walk To School Research* Program having the objectives to: increase the number of children walking to school, reduce the number of short car trips and reduce traffic congestion around the school.	1 school with 234 students age 5-12 Duration: **4w**	Quasi-experimental (pilot study) with pre-and 4 post assessments (week-1, week-2, week-3, week-4 during the intervention) at 1 experimental school. Duration: 4 weeks At pretest, 47% were driven to school and 14% travelled by bus. There was a 3.4% reduction in car trips and a 3.4% increase in walking trips by week 4 of the intervention. For travel to school, the number of children being driven decreased while the number walking increased, for all ages. For travel from school, the number being driven decreased for all classes, and the number walking increased only from children from 5 to 9	PSR: Chillòn P

Table 7: Factors and barriers influencing the children active travel ((sorted by continent: Europe, North America, Oceania, all).

Author, year	Location, analysed barriers and factors influencing the children active travel	Study population	Results (survey/analysis method)	
Carver, A et al (2013)	Norfolk, UK The objective of the study was to examine cross-sectional and longitudinal associations between social/physical environmental variables and independent mobility on the school journey	At the starting time, T1: 1121 children 9–10-year-old residing within 1600 m of their school in urban/rural areas of Norfolk, UK). At year one (T2) 491 children were followed-up.	Quasi-experimental with pre and post assessments. Duration one year. Around half walked/cycled to school without adult accompaniment (T1, 43%; T2, 53%). Parents often allowing their child to play outside anywhere within the neighbourhood and household car access were associated longitudinally with boys walking/cycling independently to school. Land use mix, proportion of main roads in the neighbourhood and parental encouragement for walking/cycling were associated longitudinally with girls walking/cycling independently to school. In conclusion, despite relatively high rates of walking and cycling only around half of the children walked/cycled without adult accompaniment. Interventions increasing independent mobility are required. Interventions should develop parents0 skills to teach their children to be independently mobile and to build confidence regarding venturing out without parental accompaniment. Urban planners should consider designing neighbourhoods in which residences, business/retail outlets and sports facilities are co-located to promote active transport.	T7.2
De Meester, F. et al. (2014)	Flanders, Belgium The first aim of the study was to examine the association of the parental perceptions of neighbourhood environmental attributes with active transport and total physical activity in 10-12-year-old Belgian boys and girls. Secondly, the study examined the potential mediating effect of independent mobility on the associations of the parental perceptions of neighbourhood environmental attributes with the	749 children (age 10 – 12) from 44 schools	Quasi experimental design. The data collection phase lasted 6 months. Overall, boys reported more active transport when parents perceived more land use mix diversity, shorter distances to school, good land use mix access, higher residential density and less pleasing neighbourhood aesthetics. Higher total physical activity levels were reported when parents perceived shorter distances to school and availability of walking/cycling infrastructure. None of the associations was mediated by independent mobility in boys. Girls reported more active transport when parents perceived higher residential density, more land use mix diversity, shorter distances to school, good land use mix access, available walking/cycling infrastructure and convenient recreational facilities. Girls reported higher	T7.2

	level of active transport and total physical activity of 10-12-year-old boys and girls.		total physical activity levels when parents perceived high residential density, good land use mix access, well-maintained and high-quality walking/cycling infrastructures and more traffic safety. Independent mobility was found to be an important mediator of these associations in girls. Conclusions: Neighbourhood environmental interventions to increase children's active transport and physical activity can be effective when combined with awareness raising programs for parents. Furthermore, among girls encouraging independent mobility may contribute to behaviour change	
D'Haese, S. (2011)	Flanders, Belgium The objective of the study was to determine feasible distances for walking and cycling to school (criterion distances) in Belgian children. For children living within these criterion distances from school, the correlation between parental perceptions of the environment, the number of motorized vehicles per family and the commuting mode (active/passive) to school was investigated	44 schools and 996 parents of 11-12-year-old students attending those schools (one parent per children).	Quasi experimental design. The data collection phase lasted 7months. Data was collected through interviews addressed to parents. Criterion distances were set at the distance in which at least 85% of the active commuters lived. After the determination of these criterion distances, multilevel analyses were conducted to determine correlates of active commuting to school within these distances. Almost sixty percent (59.3%) of the total sample commuted actively to school. Criterion distances were set at 1.5 kilometres for walking and 3.0 kilometres for cycling. In the range of 2.01 - 2.50 kilometres household distance from school, the number of passive commuters exceeded the number of active commuters. For children who were living less than 3.0 kilometres away from school, only perceived accessibility by the parents was positively associated with active commuting to school. Within the group of active commuters, a longer distance to school was associated with more cycling to school compared to walking to school. Household distance from school is an important correlate of transport mode to school in children. Interventions to promote active commuting in 11-12-year-old should be focusing on children who are living within the criterion distance of 3.0 kilometres from school by improving the accessibility on route from children's home to school	T7.2
Easton, S. (2014)	Sheffield UK The aim of this paper is to specifically consider the interaction of the following effects in explaining the travel mode of choice for secondary school children in Sheffield, UK: • Neighbourhood-level factors, which include characteristics of the urban form and structure, may have a range of direct and indirect effects on travel behaviour • School level factors, most notably variations in the 'performance' of schools and the socioeconomic composition of their pupil intake, may influence school and residential location choices	26,709 students (age 11-16) linked to 100 different neighbourhoods and attending one of 27 different state secondary schools in Sheffield.	Quasi experimental design. As for the results, the main factors affecting the children travel mode between home and schools resulted the following: Route distance from home to school: that was found to be by far the strongest predictor of motorised travel. The main distance for active travel (walk, bike) was of 1,5 km up to more than 3 km. Gender: boys walk or bike more than girls. Age: older high school pupils were less likely, on average, to walk to school compared to 11-12 year but when they walk, they travel longer distances. Ethnic group: the ethnic groups for which data were available were found to have travelled significantly further to school than white British pupils in Sheffield in 2009-10	T7.2

	• Individual-level characteristics, such as age, have a relationship to the extent to which children will countenance or be empowered to choose active forms of travel		Urban form variables (probably valid only for the Sheffield or UK roads): The only urban form variable which was found to be significant was the density of cul-de-sacs (no-through roads). Analysis showed that taking account of distance to school, pupils who lived closer to school in areas of high cul-de-sac density, were more likely to engage in active commuting The findings in this paper suggest that the predictors of active school commuting are complex and conditioned by neighbourhood- and school-level factors as well as individual or household characteristics. Initiatives promoting active commuting through, for example, transport and urban design improvements will have only limited effect if societal and socio-spatial structures oblige some groups of pupils to commute long distances-yet this is the corollary of policies promoting school choice.	
Fyhri, A. and Hjorthol, R. (2008)	Norway The purpose of this paper was to establish a measure of independent mobility (not only home-school travels) in a nationwide sample of Norwegian children, and to examine a range of background variables previously shown to have an influence on mode choice for children's school or leisure transport, and to investigate their relative contributions by use of a structural equation model	The empirical analysis of this article is based on two data sources; the Norwegian national Travel Survey (NTS) of 2005 and an additional survey of the physical environment and activities of children. The respondents of this survey were parents with children in the age group 6-12 years: 1282 respondents recruited from the NTS 2005	Data collected from the NTS 2005 and merged with a survey carried out with a quasi-experimental approach. The results of the analysis carried out show that distance to school and child age is the most influential variables: one kilometre decrease in distance equals approximately a one-year increase in age in terms of effect size on the independent mobility index. Another important factor is traffic safety, but any measure aimed at increasing walking and cycling via improved traffic safety will only be effective if parents' experience of traffic safety is improved. Thus, any physical measures improving traffic safety need to be supplemented by information or campaigns in order to be effective for increased independent mobility. As for the leisure activities, even though there is a relatively large potential for walking or cycling, the most typical mode of travel to leisure activities is by car. Public transport is hardly ever used for getting to these activities. Between 16 percent (other organizations) and 30 percent (youth club) of trips are on foot. This is low compared to the corresponding proportion walking to school, which is about 45 percent for the same age group. The use of bicycle is also lower for travel to and from other activities than to and from school	T7.2
McMillan (2005)	US The purpose of this study was to evaluate the relationship between urban form and child trip to school and, in particular, the parent perception on neighbourhood safety and traffic speed. This was carried out trough objective measurement of proportion of street segments with a complete sidewalk system.	1,128, 8-11-year-old children	Cross sectional, observational cohort study Children are more likely to walk or cycle to school when distance to school < 1 mile, neighbourhood had mixed land use & greater amount of windows faced street. Less likely when traffic speeds > 30 mph and unsafe	T7.2
Nelson, N. et al. (2008)	Ireland The purpose of this study is to identify if distance is a barrier to active commuting among adolescents, and if there is a criterion distance	4,013 adolescents (mean age 16) of which one third walked or cycled to school.	Quasi-experimental study A higher proportion of males than females commuted actively (41.0 vs. 33.8%, $\chi 2$ (1) = 22.21, $p < 0.001$, $r = -0.074$). Adolescents living in more densely populated areas had greater odds of active commuting than those	T7.2

	above which adolescents choose not to walk or cycle.		in the most sparsely populated areas. In each density category, active commuters travelled shorter distances to school. After controlling for gender and population density, a 1-mile increase in distance decreased the odds of active commuting by 71%. The majority of walkers lived within 1.5 miles and cyclists within 2.5 miles. Over 90% of adolescents who perceived distance as a barrier to active commuting lived further than 2.5 miles from school. According to this study, population density and gender are important walkability factor: distance travelled to school increased as population density decreased and the odds of active commuting are 66% greater among males. In addition, new previously unconsidered reasons emerged. Lack of time, intrinsic factors such as laziness and tiredness, and convenience were more important than weather, traffic related danger or heavy bags.	
Van Dick, D. (2009)	Izgem (Belgium) The objective of this study was to investigate whether adolescents living in a high-walkable town centre are more physically active than those living in a less-walkable suburb	120 adolescents (age 12-18 years), 60 per neighbourhood	Quasi-experimental/cross sectional study, In contrast with the expectations, adolescents living in the less-walkable suburb reported 220 min/week more cycling for transport than those living in the high-walkable town centre. A trend towards significance was found for mean step counts/day with 1371 more steps/day for suburban adolescents. Travel time to school was 7.4 min less for urban adolescents. In contrast with previous results in adults, lower walkability and larger distance to school was associated with more physical activity in Belgian adolescents. Therefore, physical environmental interventions designed for adults, focusing on increases in connectivity, residential density and connectivity, might not be effective for Belgian adolescents	T7.2
Ahlport K. et al (2007)	North Carolina (USA) The purpose of this article is to describe the barriers to and facilitators of walking and biking to school as reported by parents and children who live within a 1.5-mile radius of their school. Qualitative paper.	Thirty-seven parents and 37 children participated in 12 focus groups (6 parent groups and 6 student groups). On average, children who participated in the focus groups were 10 years of age.	Separate semi-structured focus group guides were developed for the parent and student AT (Active Travellers) and NAT (Non-Active Travellers) groups. The focus group guides and protocols were developed consistent with recommended focus group methodology. The main result of this article is a detailed and commented list of barriers and facilitators of active school travel identified by participants. In order of importance the main perceived barriers concerned: safety barriers, physical environment, school polices and rules. The principal finding of this study is that a supportive physical environment (including sidewalks and safe pathways/routes to school) is a necessary but insufficient condition to encourage active travel to school. Fear of child abduction was the number one barrier identified by parents and children, but many other factors, including the flexibility of parent work schedules, parent motivation, and the physical load students must carry to and from school, also influence parents' decisions about whether or not children walk or bicycle to school.	T7.2

Chillon, P. et al (2014)	Five USA regions: Alaska and Northwest, California, Southcentral, Southeast, and Northeast. Analysis of the data collected by the National Evaluation of *Walk to School Project*, a nationwide study of the Walk to School (WTS) program and its impact in the US.	1,216 student and 1,219 parents. 18 elementary schools of which were 14 intervention schools and 4 control ones.	Measures included monthly child report of mode of school travel during the previous week (n = 10,809) and perceived barriers and social norms around active school travel by parents (n = 1,007) and children (n = 1,219). Generalized linear mixed models (GLMM) with log-link functions were used to assess bivariate and multivariate associations between hypothesized correlates and frequency of active school travel, assuming random school effect and controlling for the distance to school. The final model showed that the most relevant significant predictors of active school travel were parent's perceived barriers, specifically child resistance (Estimate = −0.438, $p < 0.0001$) and safety and weather (Estimate = −0.0245, $p < 0.001$), as well as the school's percentage of Hispanic students (Estimate = 0.0059, $p < 0.001$), after adjusting for distance and including time within school cluster as a random effect. In particular the following factors were related to children active school travel: i) percentage of students living within a 1-mile radius, ii) percentage of students who are African American or Hispanic, iii) walk/bikeability, iv) parent's perceived barrier factors (safety and weather), v) suitability of the route, vi no walking companion and vii) children's resistance.	T7.2
Graziose, M. (2012)	New York City (USA) The paper examined the association between built environment characteristics in the school neighbourhood (park access, public transportation density, total crime, and walkability) and self-reported PA behaviour and related theory-based psychosocial factors in a sample of urban fifth-grade public school students in NYC.	20 schools, mainly in low-resources neighbourhood. 1,241 students (10-13 years) completed the questionnaire and 1,165 completed anthropometric measurement. At the end 952 students with both anthropometric and questionnaire were included in the analysis.	Quasi-experimental study Baseline data from the Food, Health and Choices obesity prevention trial were used to create multilevel linear models of the relationship between the analysed students' physical activity and related psychosocial factors and characteristics of the built environment of the school's neighbourhood (park access, public transportation density, total crime, and walkability), controlling for age and body mass index z scores. 4 built environment characteristics (park access, public transportation density, total crime, and walkability) for the analysed 20 school neighbourhoods and for the population of NYC elementary school (n = 728) for comparison. The study results demonstrated that total crime can be inversely associated with boys' light physical activity duration and behavioural intention for physical activity. Boys' habit strength for physical activity was positively associated with public transportation density and negatively associated with total crime. Girls' frequency of light physical activity was positively associated with park access. Built environment characteristics explained 97% of the between-school variation in girls' self-efficacy in walking for exercise.	T7.2
Henne, H. et al. (2014)	King county and San Diego County, California (USA) The objective of the study was to identify non-distance factors related to children's active transport (AT) to school, including parental, home, and environment characteristics.	123 Children aged 6-11 and their parents (only children living less than 20-minute walk from school were included)	Quasi-experimental study (no figures on the results provided) In the quantitative analyses, factors significantly associated with child AT were identified. Older child age, parental use of AT to any location and specifically to work, and a parent without a driver's license were positively related to child AT. Whereas, a parent with a rule regarding staying close to	T7.2

	Understanding the factors related to children's AT to school, beyond distance to school, could inform interventions to increase AT and children's overall physical activity.		or within sight of the house/parent, and the number of hours parents work per week were negatively related to child AT. It is worth noting that the study reported that factors not associated with child AT were the number of siblings, parental report of vigorous exercise, household income, and neighbourhood walkability (this suggests that parental perceptions and attitudes about active commuting may be more influential than the built environment factors).	
Lee, C. et al. (2013)	Austin, Texas (USA) The purpose of this study was to examine attitudinal and environmental correlates of walking to the elementary school, controlling for distance	22 public Elementary schools and 601 child pairs (case, walkers, and control, driven, subjects) with matched home locations and different school travel modes (walking vs. private automobile) were examined,	Quasi-experimental study The distance between home and school was the control variable in this study. About half of the matched pairs (51.1 %) lived in the same location (e.g., same apartment or duplex), and the rest lived within 200 ft (61.0 m) of each other. The mean distance to school was exactly the same between walkers and drivers (0.491 miles or 791.2 m). The main independent variables are environmental perceptions about (a) walkability, (b) safety concerns, and (c) parental attitudes and preferences Other (confounding) variables as children's age, race, gender, grade, body mass index (BMI) percentile, and special lunch qualification, and parents' education levels, number of siblings, number of cars and drivers' licenses, years lived in the current residence, and reasons for choosing the current neighbourhood. Despite the same/similar objectively measured distance and home location, perceptions of distance, sidewalk and traffic conditions, park presence, and convenience of walking differed between walkers and automobile users. Parental attitudes and children's preferences were associated with the odds of walking. Safety concerns (traffic danger, stranger danger, and getting lost) were higher among drivers. In conclusions to promote walking to school, route/street improvements appear promising, but parallel educational and promotional efforts may be needed to address perceptual and attitudinal barriers	T7.2
Napier, M. et al. (2010)	Utah (USA) In this study the roles of community design and parent and child perceptions of walkability to school are tested for associations with walking in three communities: a walkable new urbanist community, a mixed community (standard suburban community where the walk to school traversed part of the new urbanist community), and less walkable standard suburban community. Perceived environmental barriers to walking to school are measured and compared for fifth graders (n¼ 193) and their parents (n¼ 177).	Participants were from three distinct groups: walkable, mixed and less walkable communities). 2 elementary schools and 11 fifth grade classes were selected for a total of 177 parents and 193 children	Quasi-experimental study Walkable and mixed community students walked to school more frequently than those from the less walkable community. In addition, students living further away walked less frequently. For the perceived barriers, both parent and child perceptions of more barriers relate to less walking. The control variable of parents' preferences for their children to walk to school is strongly correlated with students' frequencies of walking, but correlations with other independent variables reduced this variable to insignificance in the multivariate equation. A re-computation of walking rates in the current study for only those students living within a mile of school (part of the CDC goal) shows that 88% of walkable community, 78% of mixed community and 45% of less walkable community student respondents walk to school. Even for student respondents who live in a standard suburban community, if their route to	T7.2

			school traverses a walkable community, they also walk to school at relatively high rates. These results demonstrate that multiple supports for and barriers to walking are important, including: walkable community design, short vs. long physical distances, and child and parental perceptions of barriers to walking to school.	
Seraj, S, L. et al. (2012)	Southern California: Los Angeles, Riverside, Orange Counties. (USA) This paper aims to shed light on parental attitudes and perceptions towards bicycling and walking as modes of transportation for children's school travel. The paper provides a comprehensive examination of the factors that shape parental attitudes and perceptions towards these modes by simultaneously considering five different attitudinal variables in a joint model system.	The study used the sample of the Southern California portion of the 2009 National Household Travel Survey (NHTS). This included 1,000 respondents, all parents of elementary school aged children (only one parent per child).	Quasi-experimental study Through the use of a multivariate ordered response model (a model structure that allows different attitudes to be correlated), the current study analyses five different parental attitudes towards their children walking and bicycling to school, based on data drawn from the California add-on sample of the 2009 National Household Travel Survey. The five attitudinal measures were related to crime, weather, volume of traffic, speed of traffic, and distance to school. It is found that school accessibility, work patterns, current mode use in the household, and sociodemographic characteristics shape parental attitudes towards children walking and bicycling to school. The study findings eventually provide insights on policies, strategies, and campaigns that may help shift parental attitudes to be more favourable towards their children walking and bicycling to school. Neighbourhood/district design, school awareness programs, dedicated active travel initiatives, incentive-based programs (prices) are the main practices suggested by the paper to foster children walking and cycling to school.	T7.2
Giles-Corti, B. et al. (2010)	Perth, Australia The objective of this study was to examine the impact of neighbourhood walkability (based on street connectivity and traffic exposure) within2 km of public primary schools on children regularly walking to school. To this end a school-specific walkability index (named Pedshed) was developed for all government primary schools in Perth.	25 schools and 90 children (5-7 years)/school.	Quasi-experimental study Pedshed index (a ratio of the pedestrian network area to the maximum possible area within a defined distance based on Euclidian (i.e., 'as the crow flies') distance) was used to assess the connectivity of the walkable catchment area within 2 km of the school. A Pedshed ratio ≥ 0.6 is assumed to be a good target for a walkable catchment and was, therefore, considered the optimum minimum Pedshed against which the study compared the schools. In Perth (238 schools) approximately one-half (51%) of the schools had a Pedshed score below the 0.6 target for a walkable catchment. Associating the walking to school (6 trips/week) and the walkability index sub-components: street connectivity (measured by Pedsheds) and exposure to traffic, it resulted that the interaction between the Pedsheds and traffic volume is highly significant. Compared with children attending schools located in areas with low connectivity (i.e., low Pedshed) and high traffic exposure, the odds of walking to school were three times higher in children attending schools located in high walkable areas The final result was that regularly walking to school was higher in children attending schools in high walkable neighbourhoods (i.e., high street connectivity and low traffic volume) and less likely in neighbourhoods with high connectivity but high traffic volume. Connected street networks provide direct routes to school but when designed for heavy traffic, the potential for children to walk to school is reduced. This highlights the importance of	T7.2

			carefully considering school siting and, particularly, street design in school neighbourhoods.	
Ikeda, E. et al. (2018)	New Zealand This systematic review and meta-analysis examined the associations between active travel to school and the neighbourhood-built environment in children and youth by systematically identifying and collating data from New Zealand studies	Data from five studies involving 2844 children and youth aged 6–19 years were included in the meta-analysis.	Meta-analysis Data on participant demographics and school characteristics were obtained from each analysed study, and built environment features within 400 m and 1 km buffers around home were calculated in a consistent manner using geographic information systems. Active travel to school was positively associated with intersection density (1 km buffer) and negatively associated with school socioeconomic status, dwelling density (1 km buffer), and distance to school, including age, sex, ethnicity and number of siblings as fixed effects in the final model. The findings of this meta-analysis can be used to guide and support the development of policies on school location and catchment, and pedestrian and cycling infrastructure for children and youth to actively and safely travel to school.	
Timperio, A.et al. (2006)	Melbourne, Australia The purpose of this study was to examine personal, family, social, and environmental correlates of active commuting to school among children.	235 children aged 5 to 6 years and 677 children aged 10 to 12 years from 19 elementary schools.	Cross-sectional study. Self-administered questionnaires were completed by parents, and the older children. The shortest possible routes to school were examined using a geographic information system. Among both age groups, negative correlates of active commuting to school included parental perception of few other children in the neighbourhood and no lights or crossings for their child to use, and an objectively assessed busy road barrier en route to school. In younger children, an objectively assessed steep incline en route to school was negatively associated with walking or cycling to school. Good connectivity en route to school was negatively associated with walking or cycling to school among older children. Among both age groups, children were more likely to actively commute to school if their route was <800 meters.	
Larouche, et al. (2015)	12 country sites: Australia (Adelaide), Brazil (São Paulo), Canada (Ottawa), China (Tianjin), Colombia (Bogota), Finland (Helsinki, Espoo and Vantaa), India (Bangalore), Kenya (Nairobi), Portugal (Porto), South Africa (Cape Town), the United Kingdom (Bath and North East Somerset) and the United States (Baton Rouge). The study had two primary objectives. The first aim was to describe school travel behaviour in a large sample of 9–11-year olds from the above outlined countries who participated in the International Study of Childhood Obesity, Lifestyle and the Environment (ISCOLE). Of particular interest, the ISCOLE was conducted using standardized methods in geographically, economically and culturally diverse country	6,555 children (53,8% girls) in 12 sites across the word.	Quasi-experimental study The interviewed children reported their main travel mode to school and the duration of their school trip. Potential individual and neighbourhood correlates of AST were assessed with a parent questionnaire adapted from previously validated instruments. Multilevel generalized linear mixed models (GLMM) were used to examine the associations between individual and neighbourhood variables and the odds of engaging in AST while controlling for the child's school. Site moderated the relationship of seven of these variables with AST; therefore, the analyses were stratified by site. RESULTS: The prevalence of AST varied from 5.2 to 79.4% across sites and the school-level intra-class correlation ranged from 0.00 to 0.56. For each site, the final GLMM included a different set of correlates of AST. Longer trip duration (that is, $\geqslant$ 16 min versus $\leqslant$ 15 min) was associated with lower odds of AST in eight sites. Other individual and neighbourhood factors were associated with AST in three sites or less.	T7.2

	sites. The second, objective consisted in the investigation of the individual and environmental correlates of AST among those participants using multilevel models.		More in particular, despite the high variance of answers from the 12 sites, (for instance, the prevalence of AST was almost 20 times higher in Finland compared to India) it was found that travel time was the most consistent correlate of AST. Specifically, children reporting trips of 16 min or more were less likely to engage in AST in 8 out of 12 sites. Moreover, in the entire sample, the association between travel time and travel mode was moderated by country-site, suggesting that the 'acceptable' duration of an active trip varies across country sites. The heterogeneity in the correlates of AST across countries may be partly attributable to the diversity of the country sites. It has been suggested that the lack of motorized alternatives could explain the relatively high prevalence of AST in low- and middle-income countries. Nevertheless, the study found a negative relationship between motorized vehicle ownership and AST only in China, Portugal and South Africa. Furthermore, despite a high country-level rate of motorized vehicle ownership, Finland had the largest prevalence of AST. The high prevalence of AST in Finland has been attributed to a combination of factors including favourable social norm, supportive policies and high-quality walking and cycling infrastructure. In contrast, a 'culture of convenience', wherein the socially acceptable distance for walking to/from school is thought to be less than 1.6 km may partly explain the low prevalence of AST among Canadian children. The final recommendation emerging from this study is that policy-makers, urban/transport planners and public health workers should not assume that built environment interventions that are effective in one setting (or in one population) will necessarily work elsewhere.	

Appendix 2: Brief description of the main policies and good practices

Picture courtesy of Millie Rooney

Source: Osborne, P. (2008), Safe Routes to Schools and School Travel Plans: An Overview

Note: the following policies and good practices are listed according to Table 2

Walking School Bus (http://www.walkingschoolbus.org/)

A walking school bus is a group of children walking to school with one or more adults. It can be as informal as two families taking turns walking their children to school to as structured as a route with meeting points, a timetable and a regularly rotated schedule of trained volunteers.

A variation on the walking school bus is the bicycle train, in which adults supervise children riding their bikes to school. The flexibility of the walking school bus makes it appealing to communities of all sizes with varying needs.

The organization of each walking school bus is up to the participants of each bus. What's important is to simply start moving and help our children discover that their journey to school can start with their own feet.

Safe Routes to School program

Safe Routes to School (SRTS, https://www.cdc.gov/policy/hst/hi5/saferoutes/index.html) Safe route to school is an important and well financed initiative that is part of the "Fixing America's Surface Transportation (FAST) Act" of 2015 issued by the U.S. Department of Transportation. The program can be implemented at the state, community, or local school district level and implies gathering and collaborating diverse competences and actors coming from the educational, transportation, public safety and city planning fields.

SRTS encourages increased student physical activity through safe and active transport to and from school. SRTS promotes walking, bicycling, or other forms of active transportation among students and their families. SRTS can include educating the community and improving the built environment to ensure safe places for children and adolescents to walk and bike to and from school. Key elements of SRTS include:

- City planning and engineering approaches to transportation that address built environment needs and ensure safe conditions for walking and biking
- Tools, guides, and resources to encourage participation in safe and active transport
- Educational activities for students, parents, and community members about rules of the road and traffic safety
- Enforcement approaches to encourage safety and reduce unsafe behaviours among drivers, bicyclists, and pedestrians
- Evaluation activities to monitor and measure the impact of these programs. (see also the School Travel Plan program)

SRTS can be implemented at the state, community, or local school district level. Depending on existing infrastructure, SRTS may require that education, transportation, public safety, and city planning agencies coordinate their efforts. The Safe Routes to School National Partnership has produced State Report Cards detailing efforts nationwide. Program implementation that emphasizes partnerships has the ability to not only engage schools and communities but create a cultural shift. Specifically, involvement of various stakeholders can help with multilevel planning and coordination of resources, which can help to reduce the burden on schools and their staff.

Ride2School Program (https://sport.vic.gov.au/our-work/participation/ride2school-program)

The Ride2School Program encourages children to be more active by riding their bikes, walking, scooting or skating to school, and complements the Government's commitment to promoting cycling as a sustainable and active transport option.

Ride2School is delivered by "Bicycle Network" in partnership with local schools and councils.

One component of the program is the annual Ride2School Day. This national event is Australia's largest celebration of riding, walking, skating and scooting to school.

Ride2School Day was held on Friday 22 March 2018 in Victoria with the participation of about 1,000 schools and 390,000 students.

Another benefit of the Ride2School program is the annual grants for schools registered in the program. Schools can apply for grants up to the value of $5,000 which can be used on bike parking, Active Paths, a fleet of bikes for the school, financial contributions to a new bike shed and more.

Safe Walking and Biking to School (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1447987/)

The Safe Routes to School Program in Marin County, California, is working to promote walking and biking to school. Using a multipronged approach, the program identifies and creates safe routes to schools and invites communitywide involvement. By its second year, the program was serving 4665 students in 15 schools.

The program has only 4 paid staff. One of the 2 founding members is the program director, and the other works several hours a week supervising and promoting the program. A full-time educator is employed to develop the program's school curriculum and oversee classroom education. A traffic engineer assists in identifying and creating safe routes for participating students. A private consulting firm, hired during the second year, oversees and evaluates the program. The Marin County Safe Routes to School Program relies heavily on parent, teacher, and community volunteers to carry out its broad range of activities. The program requires each school to identify a volunteer team leader prior to enrolling.

School Travel Plan (http://www.saferoutesnj.org/resources/stp/)

And

School Travel Planning

These are both initiatives carried out in the frame of the SRTS program. The plan "maps out" how to improve pedestrian and bicycle travel to and from school to increase the number of students who walk and bike to school and to improve safety. A School Travel Plan identifies the following:

- Where students currently walk and bike
- Where students would walk and bike if they could
- What changes need to be made so that students can and will walk and bike to school

The School Travel Plan will identify short term solutions for immediate action and implementation as well as long term ones that may require further planning

Beat the Street

Beat the Street is a 12-month community-wide programme which improves the health and wellbeing of entire towns and cities by getting people of all ages moving. It is evidence-based and leads to long term behaviour change by creating a social norm around walking and cycling.

Beat the Street was created by Intelligent Health, a company dedicated to building active communities in the UK and worldwide. The programme adopts a community approach to behaviour change that is split into 3 phases: anticipation, experience and legacy.

Dr William Bird, CEO and founder of Intelligent Health who developed Beat the Street, said: *"If we want to improve the health and wellbeing of the country we need to be ambitious, provide a clear narrative to get people active and support them on their journey. Physical activity has more health benefits than any other single intervention and is the means to a healthy community."*

The main Beat the Street experience lasts for up to 2 months and transforms a town into a giant playground. Participants can pick up a Beat the Street card which contains radio-frequency identification (RFID) technology and tap them against sensors called 'Beat Boxes' located on lamp posts across the area. Players receive points for each box they tap and can even create or join teams which can receive prizes for tapping the most boxes; this motivates entire schools, community groups and businesses into becoming more active.

Once the game is complete, Beat the Street creates a legacy of physical activity; using the power and popularity of the game, Beat the Street will signpost people to events and activities in their area as well as working with local stakeholders to continue to build active communities.

Walk to School Research program (https://www.health.nsw.gov.au/research/Pages/2004-walk-to-school.aspx)

The Central Sydney Walk to School Research Program 2005-2007 was conducted in response to the ongoing decline in the percentage of school children aged 10-12 who walk to and from school, and because of the significant health, social and environmental benefits that result from reduced car use and increased walking. The program was a cluster randomised controlled trial which developed, implemented and evaluated a multi-component intervention to increase the number of upper primary school children who walked all or some of the way to and from school. The project was funded by the Health Promotion Demonstration Research Grants Scheme.

Gold Medal School Program

Utah's Gold Medal Schools program supports the adoption of school policies that provide opportunities for nutritious food choices and regular physical activity. The effectiveness of Gold Medal Schools was evaluated via anthropometric measurements and dietary and physical activity surveys.

Walk safely to school days (http://paf.org.au/programs/walk-safely-to-school-day/)

Walk Safely to School Day (WSTSD) is an annual, national event when all primary school children are encouraged to walk and commute safely to school. It is a community event seeking to promote road safety, health, public transport and the environment.

WSTSD promotes the important message that active kids are healthy kids. The event encourages parents, carers and their children to build regular walking to and from school into their daily routine. Children need a minimum of 60 minutes exercise per day. Encouraging less driving and more walking aims to decrease dangerous vehicle congestion around schools and reduce carbon emissions from idling cars. Lastly, it is just a nice way to be part of your community. The last WSTSD was the 17 of May 2019.

Nevada Moves Day (http://southtahoenow.com/story/03/07/2019/10th-annual-nevada-moves-day-march-20)

During Nevada Moves Day and every day, drivers should watch for children walking and bicycling to school and be mindful of reduced speeds and varying school start times in school zones. Motorists should also only pass bicyclists when it is safe - with at least three feet of space between the bicycle and vehicle - and never overtake a vehicle that has stopped for pedestrians. Pedestrians and bicyclists should only cross streets when safe, and look both ways before and while crossing.

"This is an opportunity for children to learn about pedestrian and bicycling safety as they make their way to school," Bicycle and Pedestrian Program Manager Jamie Borino explained. "Walking or biking to school reduces school zone traffic that results from children being driven to school. We hope to bring a safe environment to school zones and reduce traffic congestion…"

The last Nevada Moves Day took place on March 20 2019.

Bikeability (http://bikeabilitytrust.org/)

Bikeability is a UK government's cycle education programme and it is based on the government's National Standard for cycle and instructor training. It prepares people (and children) to cycle everywhere cycling is permitted, and contributes to delivering the transport, environmental, health and economic benefits that more people cycling promises.

Bikeability is a progressive programme in which trainees first master cycle handling skills in traffic-free environments (Level 1), then develop the skills and confidence to cycle on local roads and simple junctions (Level 2), before tackling often busier, multi-lane roads and complex junctions (Level 3). Additional 'Bikeability Plus' modules aim to increase the take up of Bikeability training in schools and its impact on children's cycling.

Camino Escolar (School Road Program) http://www.dgt.es/es/seguridad-vial/educacion-vial/recursos-didacticos/infancia/proyectos-de-camino-escolar.shtml (in Spanish)

The school road program is an initiative launched by the Spanish transport ministry whose objective is to promote and facilitate children to go to school on foot and independently, that is, without being accompanied by adults on a safe route.

The program purpose is to guarantee that schoolchildren make the way to school on foot and in an autonomous way. This supposes that the children of the neighbourhood have the possibility of socializing and of assuming levels of autonomy in a crucial period of their formation as responsible persons.