Accepted manuscript. Final published version may differ:
Alina Medeiros, Adrian Buttazzoni, Stephanie E. Coen, Andrew F. Clark, Katherine Wilson, Jason Gilliland,
Review of gender, socioeconomic status, and ethnic background considerations reported in active school travel intervention studies,
Journal of Transport & Health, Volume 21, 2021, https://doi.org/10.1016/j.jth.2021.101035.

1.0 Introduction

Active school travel (AST) is defined as any form of human-powered travel to and from school, such as walking and cycling. AST has been shown to have positive effects on the health of school-age children (ages 5 to 19 years), including higher daily physical activity and cardiovascular fitness [1]. AST is also associated with several cognitive benefits such as improved mental health [2] and for communities as it can lead to reduced vehicular traffic, increased pedestrian safety around schools, and improved air quality [3,4].

Despite the many positive benefits, research suggests that within recent decades fewer children are engaging in active modes of travel and instead are being passively transported to/from school in personal vehicles [5–10]. There have been many interventions developed and implemented to try to reverse decreases in AST, but recent research shows only modest success at increasing rates of AST across populations [11,12]. The lack of significant behaviour changes may be due to an absence of consideration for specific mediating factors, such as variables specific to the child, their family, and/or the community that influence the relationship of the AST intervention and behaviour change [13]. As a result, interventions may not be addressing populations in the community that are least likely to use AST and therefore are not demonstrating large successes. There are gaps in participation along the lines of gender, socioeconomic status (SES), and ethnic background (i.e., minoritized populations on the basis of race/ethnicity, language and migrant status [14–16]).

Disparities in AST participation rates exist by gender, with reviews noting associations between gender and AST. In these reviews, boys are noted as having higher rates of AST than girls [17,18], which mirrors the wider gender gap in physical activity participation among youth

[19]. Differences in parental perceptions regarding independent mobility based on a child's gender contribute to differences in rates of AST [20,21]. Stemming from gendered assumptions of feminine vulnerability, girls are often granted less independent mobility compared to boys due to parenting practices that are 'protective' of daughters [22]. For example, parental perceptions of traffic safety were a more significant predictor of girls' independent mobility than boys and girls were less likely than boys to use AST if parents reported that there were busy roads to cross on the route in Australia [23] and Belgium [20]. Parental perceptions, relative to their child's, have a greater influence on AST behaviours, which suggests parental perceptions contribute to gender-based differences in AST [24].

Rates of AST vary among different neighbourhood SES levels. Reports from multiple studies consistently illustrate trends suggesting that as SES decreases, children are more likely to engage in AST [18,25]. Seemingly higher participation in low SES neighbourhoods may be driven by disadvantages in material circumstances such as less access to a personal vehicle [18]. For lower SES neighbourhoods, equity disparities stem not from participation, but from an over-abundance of negative outcomes associated with AST. Research has shown that higher SES neighbourhoods have higher quality pedestrian infrastructure, such as pedestrian and biking facilities [26] and maintenance [27]. Whereas children in low SES communities often have greater risk exposure due higher crime rates and traffic dangers on their route to school [26,27]. These conditions are of significant concern as pedestrian motor vehicle collisions have higher frequency and mortality in low SES communities [28]. Thus, participation rates alone do not tell the whole story about inequities by SES; these rates need to be understood in the social and material context of local areas.

Ethnic background is another factor related to children's AST behaviour. In the United States, Hispanic and African American children are more likely to participate in AST than their white counterparts [18,25,29]. Conversely, Asian children are the least likely to use AST in North America [18]. Being of immigrant background is associated with increased AST in New Zealand [25]. In the United Kingdom, South Asian children are more likely to be driven to school compared to white European and African-Caribbean children [30]. Research suggests that these differences in AST participation among ethnicities partially stem from cultural differences in parenting styles. For example, compared to North American parents, Chinese parents are less likely to grant children independent mobility [31,32]. AST rates by ethnic background also vary among geographical locations as ethnic background intersects with other factors such as SES to shape children's and parents' norms and perceptions surrounding AST [18]. In combination with differing rates of AST, these complex relationships and differences among norms and perceptions highlight the need for equity considerations within AST interventions. It is necessary to study the role of cultural context in the design and evaluation of AST interventions to ensure that they are able to effectively reach minoritized populations [33,34].

Challenges to equitable AST participation related to gender, SES, and ethnic background are important to consider. To decrease the gaps in AST participation and to ensure that children can safely engage in and benefit from AST, interventions need to address these equity concerns. Inequality refers to an uneven distribution, but not all inequalities are inequitable per se. Inequities refer to those inequalities that derive from relative social privilege [35]. Inequities can occur as a result of an intervention when one group benefits more than another [36,37]. These differential effects in intervention success increase inequities when the groups that benefit most

are those that already more advantaged. Physical activity literature suggests that inequities can be produced throughout the intervention process as a result of differential access to resources [38], intervention efficacy [39], and uptake [40]. Interventions can work to reduce inequities by providing targeted supports and/or reducing specific barriers experienced by disadvantaged groups [36,37].

To address inequities in AST, interventions should address the barriers faced by particular sub-groups of children to provide greater opportunities and potential benefits for those of disadvantaged groups [37]. In a review of North American AST interventions, equity-based approaches were the least often reported intervention strategy [41]. Despite equity objectives noted in program development or funding, this was not necessarily followed through in the reporting of peer-reviewed publications. Peer-reviewed literature is used to inform public health practice [42]. Without specific considerations of equity made within these peer-reviewed publications, there is little foundation for practitioners to build upon in order to develop equitable practices and/or policies.

It is currently unknown how equity considerations are being acknowledged and included in the design and/or evaluation of AST interventions to improve outcomes for disadvantaged groups, as identified by gender, SES, and ethnic background. To better understand how studies of AST interventions are considering equity for school-age children (ages 5 to 19 years), this paper presents a systematic review identifying how equity is considered in studies of AST interventions around the world. To address this purpose, two key research questions will be answered:

(1) How have studies of AST interventions considered or framed multiple equity factors, namely those related to gender, socioeconomic status (SES), and ethnic background (i.e., minoritized populations on the basis of race/ethnicity, language and migrant status [14–16]) , in the design and evaluation of AST interventions?

(2) To what extent do studies of AST interventions report equity considerations in their analyses, outcomes, programming, and discussions?

2.0 Methods

2.1 Search Strategy

The methodology used for this systematic review paper is available on PROSPERO (ID: [WITHHELD FOR BLINDING]). This systematic review builds upon a previous systematic review by Buttazzoni and colleagues [43], which focused on AST Interventions in North America. The following search terms used by Buttazzoni and colleagues were re-applied; however, to broaden this paper we removed the focus on North America and included publications up to and including December 2019. We based our search strategy on important relevant concepts and included their synonyms and applied truncation when necessary. The following search strategy was applied: *(active* or *walk* or *bike* or *cycl*)* and *(transport** or *travel* or *commut** or *journey* or *route* or *trip*) and *school** and (*intervention* or *program** or *project* or *initiative* or *promot**). Six electronic databases were used in the search: BIOSIS Previews, GeoBase, SCOPUS, PubMed, SPORTDiscus, and Web of Science.

2.2 Eligibility Criteria

Articles were eligible to be included in this study if they met six eligibility criteria: (1) conducted an evaluation of an AST intervention; (2) contained a description of the intervention

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design, methodology, implementation, and results of the AST intervention; (3) contained a quantitative outcome; (4) reported a primary outcome related to AST (e.g., aims related to AST engagement, skills, or knowledge); (5) were written in English; and (6) were published after January 2010. AST interventions were defined as one or more deliberate actions implemented to address outcomes related to AST (e.g., modifications to the built environment, school-wide events promoting walking, cycling/pedestrian training programs).

2.3 Study Selection & Review Process

The study selection and review process that was completed for this paper is illustrated in Figure 1. The initial database search displayed 15,182 articles, with 265 articles found in BIOSIS Previews, 8,176 in PubMed, 1,437 in SCOPUS, 531 in SPORTDiscus, 1,191 in Web of Science, and 3,582 in GeoBase. After title screening, 1,349 articles were retained from which 448 duplicate articles removed. Abstract screening excluded an additional 667 papers. That left 234 eligible articles for full-text assessment. The full-text assessment removed an additional 170 papers that did not match the eligibility criteria, leaving 63 papers eligible for inclusion. Searching reference lists found an additional six articles, which results in 69 papers included in the final synthesis.

[Insert Figure 1 here]

2.4 Data Extraction

Data was extracted using a tool adapted from Welch et al. to focus on the equity factors assessed in this paper, including gender, SES, and ethnic background [44]. The definition of the key equity factors are as follows:

- Gender refers to the socially constructed attributes of girls, women, boys, men, and gender-diverse people. Sex refers to the biological characteristics of humans and animals [45]. The literature often uses sex and gender interchangeably, therefore mentions of either were included. Since we are discussing health related behaviour within the social context, gender is the most appropriate term for our purpose in this paper.
- SES indicates economic and social status. Measures of SES include education, employment and income [46]. References to any measure of SES or to SES broadly were included.
- Ethnic background for the purposes of this paper is defined as populations minoritized on the basis of race/ethnicity, language and/or migrant status [14–16].

The adapted extraction tool is provided in Appendix 1. The final adaptation of the tool was developed through piloting its application across a sample of reviews. Data that was extracted includes background information about the study, such as study design, region, sample, and theoretical background, as well as mentions of each equity factor in the title/abstract, introduction, methods, results, and discussion. Mentions included brief acknowledgements of the equity factor, to more extensive considerations and explicit efforts to address the factor within the intervention. All 69 papers underwent data extraction by the primary reviewer. One-third of the papers were randomly selected and completed independently by a second reviewer. These were compared to the extractions of the primary reviewer to ensure consensus between reviewers. If there were any differences in information extracted, both sets of information were included.

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2.5 Quality assessment

Quality assessments were conducted for study design and implementation using the NIH Quality Assessment Tool for Before-After (Pre-Post) Studies With No Control Group [47]. This tool was used to assess multiple dimensions of methodological quality consistently across all studies. The NIH Quality Assessment Tool for Before-After (Pre-Post) Studies With No Control Group [47] includes 12 questions relating to key criteria such as: statement of the study question/objective, description of eligibility/selection criteria, representativeness of study population, efficient sample size, consistency of intervention delivery, validity of outcome measures, blinding of participants, accounting for loss to follow-up, and statistical/analytical methods. All articles were assessed independently by two reviewers. The percentage of initial agreement was >80%. Where there were disagreements between assessments, both reviewers discussed reasons for their ratings until a mutually agreed-upon decision was reached. There were no cases where a third reviewer was required to settle disagreements. Studies were rated according to three distinct grades: good, fair, and poor. Those rated as "good" have a low risk of methodological bias. A "fair" rating indicates that the study may be susceptible to some methodological bias. Studies that were rated "poor" have a significant risk of methodological bias and findings should be interpreted with caution.

[Insert Table 1 here]

3.0 Findings

3.1 Overall findings

A total of 69 papers, reporting on 64 distinct interventions, were included in the final analysis (Table 2). The majority of these papers (n=44, 64%) focused on elementary school-age

children (5-14 years old), occurred in North America (n=31, 45%), and did not report a theoretical framework (n=46, 67%). Pertaining to methodological quality, 14 (20%) studies were rated as good and having a low risk of bias, 51 (74%) were fair and may be susceptible to some bias, and 4 (6%) were poor and were interpreted with caution. Cycle training and education programs were frequently reported (13 papers, 19%) and these included interventions that aimed to increase children's cycling-related knowledge, confidence and/or behaviours. A total of 14 (20%) papers focused on Safe Routes to School or School Travel Planning interventions, which are school-specific multicomponent interventions with the goal of increasing rates of AST. Both utilize a framework of "E's" referring to an integrated approach including education, encouragement, enforcement, engineering, and evaluation components within the intervention [117,118]. In 2019, the Safe Routes to School Partnership added equity as the sixth "E" to their framework, however, it was included after the majority of the papers in this review were published [118]. Another prominent intervention strategy – the focus of 5 (7%) studies – was the walking school bus which involves an adult chaperone walking along a set route picking up or dropping off children at set stops along the way.

Among all studies, there were no trends in which intervention types considered equity most often or produced the most equitable outcomes (Table 3). Gender and SES were mentioned either in brief or as an extensive consideration more so than the other equity factors (Table 4). Ethnic background was mentioned least often. Of these mentions, most occurred in the methods, often as a variable controlled for, or as a description of the study sample.

[Insert Tables 2 and 3 here]

3.2 Gender

Gender was mentioned in the majority of papers reviewed (n=54, 78%), ranging from a brief acknowledgement of gender-based differences in AST to gender considerations within intervention design and evaluation. Of these papers, 51 collected gender information. Gender was most often collected using self-report methods (n=24) [48,56,64,71,75,76,79–82,85,87,90,91,95,96,102,105,108,110,114–116,119]. It is important to note that, when reporting genders, all articles categorized children as either male or female or boy or girl. No papers accounted for gender diversity (e.g., non-binary, Two Spirit, gender fluid identities). As a result, there was no data from this review to report on for children who do not identify as a boy or a girl.

Fifteen papers reported intervention effects between genders [51–55,64,76,78,82,97,99,100,106,108,115], while 11 papers reported no significant differences [48,58,61,62,67,81,84,85,88,95,107]. Information regarding gender was collected and/or controlled for in 25 papers, however, these papers did not go on to consider gender as a variable of analysis [50,56,57,59,60,66,69,71,72,74,75,79,80,87,90–92,96,102,103,105,110,113,114,116].

Of the papers that found gender differences, the majority (n=11/15) stated that boys increased their AST more than girls as a result of the intervention [52–54,64,76,78,82,97,99,108,115]. An intervention promoting helmet use found differential impacts with greater increases in boys' helmet use than girls', noting that rates of helmet use were similar after the intervention [100]. Despite finding no gender differences, a study of 1600 children and parents in Australia suggested that such differences were most likely present in other variables, such as cycling to school being dominated by boys when considering mode of travel [85]. For

example, the authors of this study note that despite literature to support gendered norms in mode of travel to school, these differences may not have been fully captured in their analysis [85].

In an examination of a cycle training intervention among 7- to 15-year-olds in the United States, it was found that girls were more likely to ride their bike with their parents, and had a higher likelihood of an accident at baseline [81]. Knowledge tests used to evaluate the program showed increases in scores [81], however they were not disaggregated by gender, hindering further analysis of trends between genders. Research on a walking school bus intervention in New Zealand reported differential impacts; boys were perceived by parents and guardians as less likely to follow the rules and more likely to "lack common sense"; conversely, girls were seen as more compliant participants [55]. Differing effects on boys' and girls' AST behaviours were also noted in school policies. Girls were more likely to engage in AST if their school was part of a health-promoting network that focused on broader aspects of health such as individual lifestyle habits and behaviours, society, and the environment [76,120]. Boys were more likely to use AST if their school informed parents about the importance of physical activity [76]. In a study based on 210 children in Spain, intervention components specifically targeting girls, such as encouraging them to voice their opinions and giving them opportunities to choose activities, were included. Despite these strategies, a larger effect was still reported for boys than girls [108].

3.3 Socioeconomic Status

Only 50 (72%) of the papers mentioned SES and 42 of these collected SES data. These studies considered SES at the level of the neighbourhood, school, and/or household. The most common method of operationalizing SES was the percentage of the school population eligible for free and/or reduced lunch programs (n=14) [51,66,68,70,77,78,93–95,97–99,105,109],

followed by parental SES as measured using either the highest level of parent education, income, and/or employment status (n=11) [57,61,62,64,67,80,86,107,108,111,113]. Twenty-four papers reported SES at some level, but did not consider SES as an independent variable in models [51,52,54,57,66,68,74,77,78,80,81,87,95–99,105,107,111,113–116]. Only five reported significant differences in AST interventions in relation to SES [48,55,70,88,93]; whereas, 13 papers reported no significant differences according to SES [53,61,62,64,67,73,85,86,89,94,106,108,109].

Multiple studies found that lower SES children had the highest rates of AST participation at baseline [73,88,93,111]. There were mixed results as to how SES was associated with AST following an intervention among papers that reported differential impacts. Relative to low SES groups, it was reported by one paper examining School Travel Planning Interventions that middle SES populations were most likely to change their behaviour towards AST [88]. Other studies noted that high SES populations were most likely to use e-bikes [48], and that schools with higher SES populations were more likely to adopt and sustain a walking school bus program [55]. A study conducted in the United States with 165 fourth grade children found that compared to very low SES, low SES groups had greater knowledge related to AST following an educational intervention [70].

Schools with primarily low SES populations faced the greatest challenges related to AST compared to other strata of SES. Low SES schools tended to lack volunteer participation for AST programs, hindering their implementation [55,63]. A lack of resources such as bicycles, scooters, and/or safety equipment was also cited as a barrier to AST faced by children in low SES communities. To overcome these concerns, studies by Huang [78], Lachapelle [81], and

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Mendoza [97] and their respective associates provided bicycles and equipment to their sample populations. No outcomes were reported from this strategy as it was simply noted as a method to overcome intervention barriers and potential confounding with income [78,81,97].

3.4 Ethnic Background

Aspects of ethnic background were mentioned in 32 (46%) of the papers, 26 of which collected such information. Child ethnic background was most often operationalized using family reports (n=10) and/or school composition data (n=9) asking specifically about ethnicity or race [51,53,61,67,78,86,90,91,93–95,97,98,105,107,109]. Three papers used data on first language – family, school, or census reported – to account for ethnic background [66,106,111], while measures of acculturation and parents' country of birth were used by one paper and two papers respectively [99,102,106].

Of the 32 papers, 15 papers collected information related to ethnicity and/or controlled for it in their analysis, however, they did not analyse it as an independent variable [51,54,61,66–68,74,77,80,90,91,95,98,105,111]. Seven studies found that ethnicity was not significant in predicting AST behaviors [78,93,94,102,106,107,109]. Four papers found differences in AST participation across groups [53,86,97,99].

Although Lucken and colleagues reported no differences in AST perceptions as a result of an informational intervention for parents in the United States, they found differential impacts among ethnic backgrounds, noting that minoritized populations were less likely to use AST [86]. These findings were confirmed by other studies from the United States which found that white children were most likely to bicycle to/from school [53], whereas Asian children were significantly less likely [97]. One paper on a walking school bus intervention noted differential

impacts related to child and parent acculturation and AST participation among Latino populations in Texas, USA [99]. Minoritized populations that had adopted attitudes, values, and behaviors of the dominant culture were more likely to participate in the walking school bus program and change their behaviors towards AST [99,121]. Loo and colleagues examined a cycle training program in Hong Kong and reported differing effects; Chinese parents exhibited protective behaviours more often than Western parents [31,84]. They suggested that the cycle training program was important to address cultural differences in parenting styles, as it could help to address some parental concerns by improving the cycling ability and safety of children [84,122].

4.0 Discussion

The purpose of this paper was to examine how equity factors, including gender, neighbourhood SES, and ethnic background (i.e., minoritized populations on the basis of race/ethnicity, language and migrant status [14–16]), are considered in the design and evaluation of AST interventions and to what extent published evaluations of AST interventions report equity considerations in their analyses and outcomes, programming, and discussions. Equity considerations include actions to reduce unjust inequalities in AST participation among subgroups of children. Equity considerations are important to ensure that all students can safely participate in and benefit from AST. Considering differing subgroups of children can strengthen intervention outcomes by influencing children not reached by current intervention strategies.

Consistent with existing literature [123,124], despite collecting demographic information at baseline, papers often controlled for equity parameters rather than addressing them in their intervention design or evaluation. Gender and SES were the equity variables most often

304 considered in the papers reviewed, while ethnic background was the least often included. Most
305 interventions took place within a school setting and gender was often evenly distributed, whereas
306 other variables tended to be unbalanced within the population. Such demographic distributions
307 typically enabled gender to be analyzed, but potentially hindered other equity analyses due to a
308 lack of adequate sample size for sub-group analysis [124]. Many studies were able to consider
309 dimensions of SES as reliable proxy measures, such as proportion of students eligible for free
310 and reduced lunch and highest level of education parents have completed, which are less
311 obtrusive than asking for information on household income [125]**.** The lack of diversity in ethnic
312 background may be a result of studies having been undertaken in homogenous communities or
313 difficulties in recruiting participants from groups who do not speak the dominant language of the
314 region [126].

315 The large differences among intervention types, study methods, and conceptualization of
316 SES [127] and ethnic background [128] used in the articles complicated evaluation and
317 comparisons. In terms of the design of AST interventions, equity was often overlooked or not
318 reported within the published article. Lack of consideration of equity factors within intervention
319 design may unintentionally increase inequities [129]. Furthermore, many papers did not conduct
320 a sub-group analysis or report intervention effectiveness for population sub-groups. The lack of
321 equity considerations in the evaluation of AST interventions further hindered our ability to
322 examine the effects of AST interventions on equity.

323 Considering intervention design broadly, all the AST interventions considered in this
324 review were implemented at the community level with the community (e.g. school, municipality)
325 as the intervention setting and population-level change as the outcome [130]. This design is

emphasized by Rose's "population strategy" in which the goal of the intervention is to shift the entire group to a more satisfactory level of activity [129,131]. This strategy is favourable in physical activity interventions as it enables action towards ensuring that the entire population is meeting recommended levels [35]. Using multiple targeted components within one broad intervention is also suggested to target a wider range of behavioural influences and improve intervention effectiveness [132]. This intervention design considers and acts towards addressing the multi-faceted and complex causes of unfavourable health behaviours [35]. Broad critiques of health interventions implemented at the community level, note their lack of consideration for equity factors [129], as demonstrated by the results of this review.

To overcome such criticisms and consistent with existing recommendations for equity in physical activity interventions [35,124,129], specific initiatives should be implemented within the broader community intervention targeting disadvantaged groups. Physical activity research suggests that tailoring intervention methods to target specific groups has positive results on reducing inequities in physical activity participation [133,134]. It is recommended that practitioners consider the intersectional influence of gender, SES, and ethnic background to address the needs of the most disadvantaged sub-groups of children in AST interventions. By doing so, interventions may provide them with greater benefits, address AST participation equitably, and increase overall AST participation rates at the community level.

It is important to identify that gender, SES, and ethnic background intersect within the lives of children and create different barriers and facilitators of AST among all children, further supporting tailored approaches. Of the papers that reported challenges in intervention implementation or differential results among subgroups of children, two areas are highlighted for

consideration when developing targeted intervention components: norms and community capacity.

Specifically addressing gender, norms hindering girls' physical activity and mobility should be considered. Sevil and colleagues attempted to target girls in a multicomponent intervention by considering girls opinions and preferences and enabling them to choose activities. Despite these actions, results still demonstrated a larger effect size for boys [108]. The methods used in the intervention may not have addressed barriers to participation such as stereotypes of physical activity being a masculine endeavour [135,136]. Other results were consistent with this notion as they show some success at addressing gender inequity by promoting AST in alignment with overall health, including but not limited to physical activity [76]. Moving beyond physical activity may have overcome such norms held by children and parents, and thus increased the likeliness of girls using AST.

Regarding gendered patterns of helmet-use, for example, it was noted that boys were less likely to use a helmet than girls prior to a helmet use policy being enacted, but boys and girls had similar rates after the policy, correcting the disparity [119]. Research suggests that parental norms were more protective of girls [22], girls lacked experience and competence riding a bicycle [81], and that parents enforced stronger helmet rules for children that are less experienced cyclists [137]. Consequently, parents' helmet rules may have been stronger for girls than boys. Furthermore, risk taking behaviours associated with boys may have contributed to boy's lack of helmet use [138]. This is significant because it illustrates how other gendered health inequities can be entangled with participation in AST and revealed when equity factors are considered; that is, while the helmet-use intervention did not further increase girls' helmet-use, it

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was successful in increasing safe cycling practices amongst boys. There was thus an intermediate equitable outcome achieved in terms of reducing boys' risk-taking behaviours.

Coinciding with these changes, secondary intervention components addressing community capacity, both from a knowledge and material standpoint, for AST should be included in interventions. Interventions should include education for children to ensure that they are able to safely navigate their environments [139]. Literature has also noted that in low SES communities specifically, children may face barriers related to a lack of bicycle ownership or equipment that is not in working order [81]. To address barriers related to a lack of material resources, such as these, interventions should provide objects, such as bicycles and helmets, to children [81].

Recommendations from this review include addressing equity in the development and design of the intervention. Practitioners should consider the norms and capacity within the population in order to better frame the goals of AST programs and tailor intervention components to the needs of the community. For instance, practitioners should incorporate school-specific assessments of existing as well as lacking resources (e.g., cycling infrastructure, education programs) during the pre-implementation phase. Conversely, schools that already have high rates of AST, such as those in low SES communities, may benefit more from practitioners conducting neighbourhood evaluations of environmental risk exposure to ensure the safety of paths commonly used for AST. Policy makers providing funding and resources to AST interventions should consider equity within the intervention as well as among interventions. Understanding that increasing rates of AST does not apply to all communities, it is important that outcomes of AST interventions not just focus on increasing rates of AST but also consider

increasing the quality/safety of AST (e.g. safety). Both policy makers and practitioners should consider utilizing frameworks such as the Health Equity Framework [140] and Equity Focused Health Impact Assessment [141] to guide their work and ensure that programs and policies are equitable among all children.

For researchers, including and reporting behaviour change theory [142] within the intervention development and research methodology are important ways to bridge understanding of AST behaviour and guide interventions targeting inequities. While many of the interventions reported on were likely guided by a theoretical framework, only 23 articles (33%) reported their theoretical framework. By reporting the theory utilized for intervention development and research methodology, these articles provided a foundation for their work and enable others to understand the epistemological viewpoint of the researchers [143]. Understanding the theoretical framework enables researchers/practitioners to understand the considerations made within the intervention and tailor those considerations to meet the needs of those most disadvantaged and vulnerable in their community.

More studies are needed to determine effective intervention strategies targeting minoritized ethnic communities in the context of various countries. Engaging such children through participatory research is important to understand how equity factors intersect to influence perceptions and engagement with AST. Among all equity factors, evaluation methods should include sub-group analyses to explore differences in intervention effectiveness among groups. Sex- and Gender-Based Analysis can also help to address inequities based on sex and gender within the community and develop research that is representative of the experiences of population sub-groups [144,145]. To ensure that equity factors are being considered throughout

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the research process, broader frameworks, such as PROGRESS [146], PROGRESS Plus [147], or tools such as the one used in this review [44], can be used.

4.1 Strengths and Limitations

To the authors' knowledge, this is the first systematic review to focus on the inclusion of equity in AST studies. This review highlights which equity characteristics are lacking in current evaluations and can be better incorporated in the analysis of future research. Additionally, this paper uses a specifically designed equity tool for health that was used for data extraction. Limitations of this paper stem from the exclusion of literature that was not peer-reviewed. Interventions may have considered equity further upstream in their development process and these considerations may not have been captured in the published paper either due to restrictions associated with word count or authors' decisions. We originally planned to evaluate an additional equity characteristic, specifically place-based equity concerns, however, we could not find a suitable operationalization of the concept as it relates to AST interventions. Despite this methodological limitation, we would still encourage future AST intervention scholarship to consider how social and physical environments may be influential variables affecting the implementation, framing, and success of developed and evaluated programs. Exclusion of non-English language papers and qualitative outcomes, which may have provided relevant results and/or greater comprehension into the equity of AST interventions, are further limits of this study. All the findings reported are unlikely to be causational but rather correlational due to the nature of the studies. The variety of different reported outcomes and measures used in the included studies do not allow for the review to include a meta-analysis of the effectiveness of the

equity features of interventions. Finally, the review cannot account for the cross-cultural variance that likely accompanies the priority of the various equity characteristics in different countries.

5.0 Conclusions

Many studies of AST interventions did not report equity considerations made within the intervention design or evaluation. As peer-reviewed literature is used to inform public health programs and policies, it is recommended that studies report any and all equity considerations made. Future research should also consider reviews of grey literature or other non-peer-reviewed materials. Evaluations of AST interventions should include sub-group analyses and equity frameworks to determine the effectiveness of the intervention at increasing rates of AST equitably within the population.

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Journal of Transport & Health, Volume 21, 2021, https://doi.org/10.1016/j.jth.2021.101035.

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