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# Effects of a Danish multicomponent physical activity intervention on active school transport

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ABSTRACT

*Introduction:* Walking and bicycling to school yields great potential in increasing the physical activity levels of adolescents, but to date very few intervention studies have been evaluated. The aim of this study was to evaluate the effect of a multicomponent school-based physical activity intervention on adolescent active school transport (AST) and three intermediate outcomes: perceived school route safety, parent support and attitude towards bicycling.

*Methods:* In total, 1014 adolescents at 14 schools filled in a transport diary at baseline and at a two-year follow-up and were included in the primary outcome analysis. Mean age at baseline was 12.6 years (range: 11.0–14.4 years). Seven of the schools were randomized to the intervention which was designed to change the organizational and structural environment at the schools, thereby increasing non-curricular physical activity i.e. recess activity, active transport and after-school fitness program. Transport mode to school was assessed through a 5-day transportation diary.

*Results:* The proportion of active transport was high at baseline (86.0%) and was maintained at the two-year follow-up (87.0%). There was no difference in active travel between the intervention and the comparison schools after the intervention, but more students perceived parental encouragement and had a positive attitude towards bicycling at the intervention schools. This difference was however only borderline significant.

*Conclusion:* The prevalence of AST was high at both baseline and follow-up, but no difference between the intervention and comparison schools was detected. Future intervention research should ensure a high degree of involvement of students, teachers and parents, focus merely on AST and take advantage of already planned physical environment changes in well-designed natural experiments.



## 1. Introduction

The health benefits of walking and bicycling for transport are widely accepted and scientifically supported (Bauman et al., 2011; Davison et al., 2008), and active school transport (AST), defined as physical active commuting to and from school, has been proposed as a way to decrease obesity rates among children and adolescents (Faulkner et al., 2009; Lubans et al., 2011). Several other benefits associated with AST have also been reported e.g. independent mobility and cognitive functions (Martínez-Gómez et al., 2011; Mitra, 2013). If the proposed tracking of active transport to adulthood is strong (Tudor-Locke et al., 2001; Wong et al., 2011), the benefits for society will be magnified in terms of decreasing the negative side effects of automobile transport e.g. greenhouse-gas emission and congestion, while at the same time contributing to more lively neighborhoods (Gehl, 2010; Woodcock et al., 2009).

In a review of interventions promoting AST, 14 studies were included and only one of those was targeted students older than 12 years (Chillon et al., 2011). Due to a large variation in intervention programs, the review categorized the initiatives according to the Active Living by Design (ALbD) 5P model: preparation, promotion, programs, policy and physical projects (Bors et al., 2009). The ALbD model builds on an ecological framework (Sallis et al., 1998) and suggests that initiatives are most successful if all 5Ps are incorporated, i.e. that changes to policy and the physical environment occur together with more traditional information and education initiatives (promotion and

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programs), and that these initiatives are supported by collaborating partnerships from various fields (preparation phase) (Bors et al., 2009). However only two studies incorporated all 5P's, and four other studies incorporated changes to the physical environment or to the school policy. The remaining eight studies used preparation, programs and promotion initiatives. Most studies reported an increase in AST, but in general the effect sizes were small, and due to large variation no clear recommendations could be made to increase the effectiveness of future interventions. Therefore, the review emphasized the need for high-quality evaluations of AST interventions, and especially interventions targeting adolescents. Future studies were furthermore encouraged to evaluate proposed intermediate outcomes based on theoretical frameworks of behavioral change (Chillon et al., 2011). One potential intermediate outcome could be the perception of route safety, which is a shared element of most presented frameworks (McMillan, 2005; Ogilvie et al., 2011; Panter et al., 2008). It includes both the objective traffic route safety and the abilities and perceptions of the individual. Another important intermediate outcome is the encouragement or support from parents, which also has been incorporated in two relevant frameworks for AST (McMillan, 2005; Panter et al., 2008). In the framework by Panter et al. (2008) it is described as a decision-making process in which both parents and the child have influence on the final choice. The attitude towards active transport could also be affected by an intervention, and is also interconnected to other factors. Panter et al. (2008) hypothesized that a positive attitude towards AST will prompt a more positive perception of the route safety, but one could also propose that the relationship is reciprocal i.e. that a safe route will cause a positive attitude towards AST and active transport in general (Sirard and Slater, 2008).

AST is very common in Denmark and a representative study from 1998 to 2000 showed that approximately 60% of children aged 11–15 years cycled and 20% walked to school. The high levels of AST has been ascribed to a long lasting effort to develop and maintain safe route to school, active transport education at the schools, and systematic promotion by lobby organizations (Jensen, 2008). A typical Danish public school has 300–500 students from 6 to 16 years, and half of them has less than 1.5 km to school (Jensen, 2008). Even though there are good conditions for AST in Denmark, the romantic presentation of a country where even most 5-year olds children cycle to school is overstated (Fotel and Thyra, 2004). The prevalence of children walking and cycling to school have decreased the last 30 years, as in the rest of the world, but among 11–15 year olds it is still considerable higher than in most other countries (Fyhri et al., 2011).

The primary objective of the current study is to evaluate whether the multicomponent intervention was effective in increasing or preventing a decrease in AST. In addition we investigate intervention effect on perceived route safety, parental encouragement and student attitude towards bicycling. Finally, we investigate if gender, baseline AST, perceived environment, distance to school, parental encouragement and objective walkability of the school site moderate the intervention effect.

## 2. Material and methods

### 2.1. Design and study population

The study is based on data from the multicomponent intervention *SPACE—for physical activity*. The intervention is a comprehensive school-based intervention to improve non-curricular PA through changes of the physical and organizational environment supported by educational activities. It has a cluster randomized controlled design, and is described in detail elsewhere (Toftager et al., 2011). After an open invitation 21 schools in the Region of Southern Denmark enrolled in 2009, and to improve the homogeneity between the intervention and control group the schools were analyzed and matched pairwise according to eight variables i.e. Euclidean distance from residence to school for 5th and 6th graders; area household income; area education level; area ethnicity distribution; school district urbanity; condition and characteristics of school outdoor areas; school health policy; and active transport in the local area. The seven most identical pairs of schools were then randomized one by one to the comparison or intervention group (Toftager et al., 2011).

Baseline measurements with questionnaires and diaries were obtained in spring 2010 from the 5th and 6th grade in all 14 schools, with follow-up measurements at almost the same week in 2012 in the 7th and 8th grade (Fig. 1). The transport diary and web-based questionnaire were pilot-tested prior to the main data collection including cognitive interview validation (Collins, 2003; Toftager et al., 2011). Data collection was conducted in pairs (one intervention school and one comparison school at the same time) to minimize the influence of season and weather conditions. Parents and students received written information about the study, and were informed that participation was voluntary. We used a passive informed consent procedure, where students were included unless the parents withdrew consent. This procedure has been found to be ethically appropriate in low-risk research in adolescents (Santelli et al., 2003). The Danish National Committee on Health Research Ethics reviewed the study protocol and concluded that formal approval was not required. The study is registered and listed in the Danish Data Protection Agency (reference number: 2009-41-3628) and registered in the Current Controlled Trials (ISRCTN79122411).

### 2.2. Intervention

The intervention package comprised 11 components targeting non-curricular PA, i.e. recess PA, after-school fitness program and active transport. Schools and municipalities were requested and supported to implement all 11 components, but there were no defined criteria to exclude schools with incomplete implementation. A detailed description of the intervention components was delivered to all participating schools, with the possibility for smaller individual adjustments and tailoring to the local context. All 11 components and details of implementation are described in detail elsewhere (Toftager et al., 2011). However, the components targeting active transport are elaborated in the following.

Four components were directly targeting active transport, and could be divided into policy, programs and physical initiative according to the ALbD model (Bors et al., 2009). The implementation of the interventions began simultaneously in autumn 2010. The *policy initiative* consisted of formulating and implementing a school PA policy, including active travel to school, which was implemented at all intervention schools. Examples of the content of the PA policy targeting AST were: (1) encouraging parents to minimize school transport by car, practice active transport to school and be active transport role models; (2) endorse traffic education initiatives for all age groups at the school and use active travel in educational settings; (3) goal setting for active transport and a declaration of intent to work with municipalities and other stakeholders to improve the safety of the environment for AST.

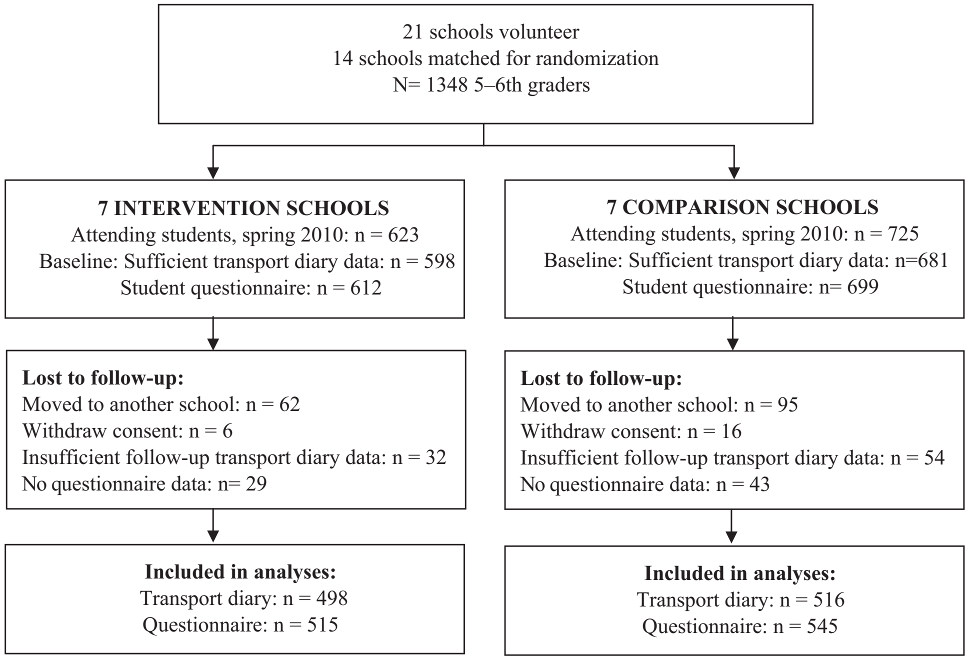


**Fig. 1.** Flow of participants from baseline to follow-up measurements.

The *program initiatives* included two components, which were educating and training students in safe cycling; and establishing a school traffic patrol, with older students helping younger students to cross the streets near the school. All participating schools had cyclist education already running, as was the school traffic patrol at four intervention schools and five comparison schools. For the three intervention schools without traffic patrol, there were no appropriate crossings in close proximity to the school, which made the component less relevant to implement.

The *physical initiative* comprised physical changes to improve safety for active transport. The improvement of the cycling infrastructure was met in two schools, but lack of financial support precluded implementation at the remaining five schools. The physical improvements at the two schools were: a short cycle path near the school separating cyclists from cars, speed humps, a new parking area further away from school and 30 cycles to use for educational purposes.

One more P for *preparation* could be added, since the intervention was supported by a cross-disciplinary network consisting of teachers, school leaders, municipality consultants and the research team coordinated by a project manager from the Region of Southern Denmark. Altogether the initiatives should both enhance safety en route to school, improve the cycling abilities of the students, and raise the awareness of the benefits of AST in both students and parents.

## 3. Calculation

### 3.1. Primary outcome

The variables used in the analyses are presented in Table 1. AST was assessed using 5-day active commuting diaries, which were filled in for the previous day at the first lesson the next morning. Transport mode for each trip to or from school was dichotomized to active transport all way (*bicycling, walking, skating*) or passive transport (*driving by bus, train or car*). The primary outcome was binomial and defined as $x$ active trips out of $n$ reported trips (max. possible trips $n=10$). To be included in the analyses a student should have reported at least 4 trips at both baseline and follow-up.

### 3.2. Intermediate outcomes and effect modifiers

The exact wording of the question and response options of the three intermediate outcomes are presented in Table 1. The question about route safety was specific to bicycling, so students who never cycled (10.6%) did not answer that question. Following effect modifiers were tested: gender, perceived route safety, parental encouragement, baseline AST status, distance to school and school walkability. In short, the school walkability consists of three objectively measured urban form characteristics: road connectivity, vehicular traffic exposure and residential density. The 14 schools were divided into low, medium and high walkability according to the summed index (Christiansen et al., 2014). Baseline AST status was binary and defined as positive if all trips at baseline were active. Distance to school was measured on the pedestrian enhanced network (GIS) and dichotomized to living within 2 km from school or not. Gender and age were obtained through school records (Table 1).

### 3.3. Statistical analysis

The statistical analyses were based on the intention-to-treat principle and results are reported at the level of the individual student. The effect of the intervention was evaluated using multilevel logistic regression, which accounted for the clustering of observations within schools.

**Table 1**
Overview of variables, questions and response coding used in analyses.

| Variable | Question | Response coding | Role in analyses | Data source[a] |
|---|---|---|---|---|
| AST | How did you come to and from school yesterday? | 0: 'Car','bus or train'<br>1: 'Bicycle', 'walked, 'roller-skates, skateboard or the like'. | Primary outcome | TD |
| Perceived route safety | How would you describe your cycle route to or from school? | 0: 'Very unsafe' or 'unsafe'<br>1: 'Very safe' or 'safe' | Intermediate outcome and moderator | WQ |
| Parental encouragement | My parents encourage me to cycle | 0: 'Completely disagree', 'disagree' or 'neither/nor' | Intermediate outcome and moderator | WQ |
| Attitude toward bicycling | I enjoy bicycling | 1: 'Completely agree' or 'agree' | Intermediate outcome | WQ |
| School walkability | NA | 0: Low walkability<br>1: Medium or high walkability | Moderator | GIS |
| Baseline AST status | How did you come to and from school yesterday? | 0: Not all trips active<br>1: All trips active | Moderator | TD |
| Distance to school | NA | 0: $\geq 2$ km<br>1: $<2$ km | Moderator & confounder | GIS |
| Gender | NA | 0: Boys<br>1: Girls | Moderator & confounder | SR |
| Age | NA | 11.0–14.4 Years | Confounder | SR |
| Proportion of AST at baseline | How did you come to and from school yesterday? | Active trips/all trips (0.0–1.0) | Confounder | TD |

[a] TD=Transportation diary, WQ=web-based questionnaire, SR=school records, GIS=geographic information system.

The number of active trips out of all reported trips at follow-up was specified as the binomial outcome in the primary effect analysis, and intervention versus comparison as the independent variable. Analyses were adjusted for differences in age, gender, distance to school, and proportion of active transport at baseline (number of active trips divided by number of all reported trips at baseline). The effect of the intervention on the three intermediate outcomes was assessed similarly but without the binomial option. To interpret the variation between the 14 schools an intraclass correlation coefficient (ICC) was calculated as $ICC=\sigma_2^2/\sigma_1^2+\sigma_2^2$, where $\sigma_2^2$ is the variance between schools (second-level variance) and $\sigma_1^2$ is the variance between individuals approximated as $\sigma_1^2=\pi^2/3$ (Goldstein et al., 2002). Effect modification was explored by adding one interaction term at a time in the multilevel model. Likelihood-ratio tests were performed to determine whether the inclusion of the interactions significantly improved the prediction of the likelihood of AST (Cervero, 2002; McMillan, 2007). Analyses were performed using STATA version 12 and a 5% significance level.

## 4. Results

### 4.1. Study participation

Fig. 1 shows the flow of participants in the study. At baseline 1348 students were enrolled at the 14 schools and 1311 filled in the web-based questionnaire and 1279 students filled in the transport diary for at least four trips. At follow-up 157 students had moved to another school, 22 students had withdrawn consent and additionally 86 students did not fill in the transport diary for at least four trips. Thus, 1014 students had at least four reported trips at both baseline and follow-up and were included in the primary analysis of AST based on the transport diary (response rate of 75.2%). The average number of reported trips was 9.4 at baseline and 9.0 at follow-up, and 81% of the included students had eight or more trips reported at both time points. In total 1060 students filled in the questionnaire at baseline and follow-up and were included in the analyses of the intermediate outcomes (response rate of 78.6%).

Comparisons of the students with sufficient transport diary data ($n=1014$) with the students who were lost to follow-up ($n=265$) showed that the lost-to-follow-up group was 0.2 years older ($p<0.001$), but otherwise no differences regarding gender, distance to school or AST at baseline were detected (data not shown).

### 4.2. Characteristics of study participants at baseline

Characteristics of the participating students at baseline in the intervention and comparison groups are presented in Table 2, followed by the distribution of reported trips. Age and gender were similarly distributed in the two groups, as was the proportion of overweight students. Approximately three out of four students were living within 2 km of school, nearly half perceived parental encouragement for cycling to school, and more than nine out of ten enjoyed cycling with only minor differences between the groups. In total, 88.8% of the students at the intervention schools perceived their route to school as safe or very safe compared to 83.8% in the comparison schools.

The distribution of trips showed some differences between the groups. The overall proportion of active trips was high for both groups, but higher at the intervention schools (88.4%) compared to the comparison schools (83.7%). The proportion of trips by foot was higher at the comparison school (15.5% vs. 11.1%), but the proportion of trips by bicycle was considerably lower (68.2% vs. 77.3%).

### 4.3. Change in AST and intermediate outcomes

The changes in AST, perceived route safety, parental encouragement and attitude towards bicycling are presented in Table 3. Both the intervention and comparison group increased the proportion of active trips by approximately one percentage point (%p), with no significant difference between groups (OR: 1.27 95% CI 0.81–1.99). There was some variations among schools, as nine schools remained

**Table 2**
Baseline characteristics and distribution of trips in the SPACE Study by intervention status if sufficient transport diary data at baseline.

| | *n* | Intervention | *n* | Comparison |
|---|---|---|---|---|
| Girls (%) | 598 | 49.0 | 681 | 48.2 |
| Age, mean years (sd) | 598 | 12.6 (0.63) | 681 | 12.6 (0.63) |
| Overweight or obese[a] (%) | 581 | 14.1 | 644 | 13.8 |
| School within 2 km from home[b] (%) | 598 | 78.4 | 681 | 76.5 |
| Perceived safe route to school (%) | 569 | 88.8 | 630 | 83.8 |
| Parents encourage cycling to school (%) | 594 | 48.6 | 667 | 47.5 |
| Positive attitude towards bicycling (%) | 594 | 92.9 | 667 | 93.6 |
| Reported trips, mean (sd) | 598 | 9.3 | 681 | 9.3 |
| Distribution of trips by intervention group | | | | |
| Trips by foot (%) | 5591 | 11.1 | 6304 | 15.5 |
| Trips by bicycle (%) | 5591 | 77.3 | 6304 | 68.2 |
| Trips by car (%) | 5591 | 7.5 | 6304 | 8.7 |
| Trips by bus or train (%) | 5591 | 4.1 | 6304 | 7.6 |

[a] Overweight defined according to the International Obesity Task Force gender-age cut-offs.
[b] Network distance from home to school.

**Table 3**
Differences between intervention and comparison groups at follow-up two years later.

| | Intervention | | | Comparison | | | OR[a] | | |
|---|---|---|---|---|---|---|---|---|---|
| | *n* | *Baseline % (95% CI)* | *Follow-up % (95% CI)* | *n* | *Baseline % (95% CI)* | *Follow-up % (95% CI)* | *OR (95% CI)* | *P* | *ICC* |
| Active trips to school | 498 | 87.8 (85.5; 90.1) | 88.8 (86.7; 91.0) | 516 | 84.3 (81.8; 86.9) | 85.3 (82.8; 87.9) | 1.27 (0.81; 1.99) | 0.30 | 0.05 |
| Perceived safe route to school[b] | 454 | 93.4 (91.1; 95.7) | 90.5 (87.8; 93.2) | 461 | 87.2 (84.1–90.3) | 88.9 (86.1; 91.8) | 0.87 (0.50; 1.51) | 0.63 | 0.04 |
| Parents encourage cycling to school | 515 | 47.8 (43.4; 52.1) | 55.7 (51.4; 60.0) | 545 | 47.5 (43.3; 51.7) | 50.8 (46.6; 55.0) | 1.26 (0.92; 1.73) | 0.15 | 0.01 |
| Attitude towards bicycling | 515 | 93.0 (90.8; 95.2) | 88.9 (86.2; 91.7) | 545 | 92.8 (90.8; 95.0) | 84.6 (81.5; 87.6) | 1.50 (0.90; 2.50) | 0.12 | 0.03 |

[a] Adjusted for age, gender, distance to school and baseline value.
[b] The lower number of included adolescents is caused by missing response from non-cyclist.

near baseline level; three schools increased AST by 2.4%p, 7.0%p and 10.6%p, while two schools decreased the level of AST by 4.0%p and 8.8%p. At the four schools with the lowest walkability index the average proportion of AST increased from 76.9% to 81.4% on average, while it remained unchanged at 88.9% at the ten schools with medium or high walkability (data not shown).

The proportion of students feeling safe or very safe en route to school decreased from 93.4% to 90.5% in the intervention group and increased in the comparison group from 87.2% to 88.9%, but this difference was insignificant (OR 0.87 95% CI 0.50–1.51). For the last two intermediate outcome variables the results indicated a change in the desired direction, although non-significant. A total of 55.7% of the students perceived encouragement for bicycling in the intervention group at follow-up compared with 50.8% in the comparison group (OR: 1.26 95% CI 0.92–1.73, $p$-value = 0.15) and 88.9% in the intervention group compared to 84.6% in the comparison group had a positive attitude towards bicycling at follow-up (OR 1.50 95% CI 0.90–2.50, $p$-value = 0.12).

### 4.4. Change in AST by subgroups

Subgroup analysis was conducted for the following groups: perceived route safety (safe vs. unsafe), parental encouragement (encourage cycling vs. not encourage cycling), gender (girls vs. boys), distance to school ($<2$ km vs. $\geq 2$ km), school walkability (low walkability vs. medium and high walkability) and baseline AST status (all active trips vs. not all active trips). Only the perceived route safety interaction showed a significant improvement when added to the model. The students reporting an unsafe route to school at baseline were more likely to use AST at follow-up in the intervention group compared to the students with an unsafe route in the comparison group (OR 2.69 95% CI 1.20–6.07), whereas there were no differences between the students reporting a safe route to school at baseline. The proportion of active trips for the students with a perceived safe route was close to 90% for both intervention and comparison group at both time points, whereas the students with a perceived unsafe route to school AST increased from 56.0% to 61.0% in the comparison group and from 70.1% to 78.9% in the intervention group. The proportion of AST also increased more for students living further than 2 km away (54.0% to 62.5%) as presented in Fig. 2. Furthermore, there were also detected a small increase for students who were attending a school with a low walkability index (76.9% to 81.4%), not perceiving encouragement from parents (84.8% to 86.2%) and for boys (85.1% to 87.4%), whereas their counterparts remained unchanged. These increases were similar for both the comparison and intervention group, thus no significant intervention modifications had occurred. At baseline 69.8% of the students used AST on *all trips*, and this group had a proportion of AST at follow-up on 95.4%. The students, who used mixed transport mode at baseline, increased their proportion of active trips from 53.7% to 67.9% (data not shown).

## 5. Discussion

### 5.1. Main findings

The objective of the study was to (1) evaluate the overall intervention effect on AST, (2) evaluate the intervention effect on three intermediate outcomes, and (3) investigate potential effect moderators. The level of AST was high at baseline in all schools and had

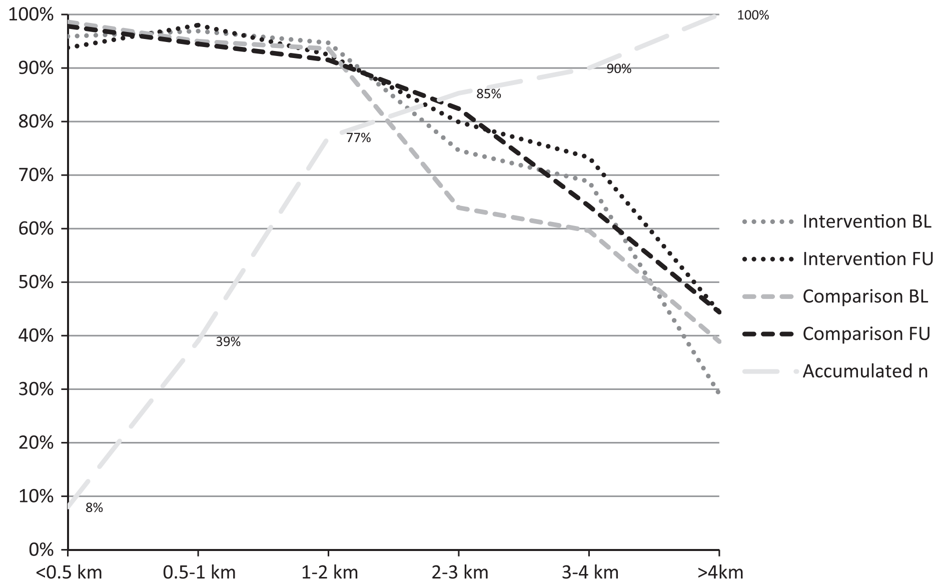


**Fig. 2.** Proportion of AST by six distance intervals for the intervention and comparison group at baseline (BL) and follow-up (FU). 'Accumulated n': Accumulated proportion of students at distance intervals. ($n=1014$).

increased marginally at the two-year follow up with no difference between groups. There was no group difference in perceived safety en route to school, however, parental encouragement and positive attitude towards bicycling was higher at the intervention schools although not significant. Subgroup analyses showed that students in the intervention group with a perceived unsafe route to school increased their proportion of AST significantly more than their counterparts at the comparison schools.

### 5.2. *Reasons for lack of effect*

The reasons for not finding an effect on AST caused by the current intervention could be ascribed to a combination of design, implementation feasibility and the venue of the intervention. Regarding the design the review by Chillon et al. (2011) suggest that interventions focusing solely on AST might be more effective than those with a broad focus on PA in several arenas, and that effective interventions are able to achieve a high level of involvement of both school employees and parents. The current intervention had a broad focus on non-curricular PA and did not systematically involve parents. Regarding the implementation feasibility the lack of effect could also be explained by the fact that only two out of the seven intervention schools changed their physical environment. Post hoc analysis of AST of the two schools with environment changes did not, however, indicate a higher impact. Finally, the venue of the interventions could also explain the lack of effect, as AST was very high at baseline and two of the intervention components targeting AST were already implemented at both intervention and comparison schools. The proportion of passive trips was14.1% at baseline, and of those 26.9% were shorter than 2 km. Thus only 3.8% of all trips were passive trips within 2 km, which would be easier to convert to active trips. The ICC of AST was 9.8% at baseline decreasing to 7.6% at follow-up, indicating that the difference between the 14 schools decreased, which was confirmed as the schools with lowest baseline AST improved the most, irrespective of whether the school belonged to the intervention or the comparison group. This could imply that factors at the school level, such as the physical environment, are more important in the younger years, and supports the theory that children are building their independent mobility through a maturations process including skill acquisition related to the environment and social interaction with friends (Kullman, 2010). Longitudinal research has however also found a more varying picture, as there was observed both increase and decrease in AST at the school level after a two-year follow-up (Wen et al., 2008).

### 5.3. *Positive trends in potential intermediate outcomes*

The positive trend in parental encouragement and attitude towards bicycling must be acknowledged, as an increase in these two factors can influence the tracking of active transport behavior from youth to adulthood. The results were not significant, but the confidence intervals indicate a minor effect of the intervention (Hackshaw and Kirkwood, 2011). This minor effect could be attributed to the increased awareness of the benefits of PA and AST through both the intervention project itself and the implementation of the school PA policy. The subgroup analyses of six potential moderators showed that the intervention had an effect on the group of students with a perceived unsafe route to school at baseline. This effect can partly be explained by the fact that more students in the intervention group with an unsafe route at baseline changed perception of their route to safe at follow-up. At the same time, though, the overall prevalence of students with a perceived safe route to school decreased slightly from 93.4% to 90.5% in the intervention group, meaning that more students with a perceived safe route at baseline changed their perception to unsafe. The proportion of students feeling safe en route to school was however still much higher than found in an Australian study, were less than half indicated safe route (Trapp et al., 2012). Living further than 2 km away, having a perceived unsafe route to school, not having encouraging parents and attending a school with a low walkability index was associated with a lower proportion of AST but also a larger increase in AST from baseline to follow-up. This supports the before mentioned effect of the maturation process on the perception of an acceptable AST environment.

### 5.4. Strengths and limitations

This effect evaluation of a multicomponent intervention to improve AST demonstrates a strong and comprehensive design according to a previous published intervention evaluation quality assessment instrument (Thomas et al., 2004). It is considered as a strength that baseline participation rate was well above 80%, and follow-rate was very close to 80%. It was a randomized controlled design, and analyses were adjusted for gender, age, and distance to school, which are the most relevant confounders. Analyses of both intermediate outcomes and effect moderators inspired from published frameworks were conducted. The diary method to assess travel behavior has previously been used to validate traditional recall questionnaire items (Cerin et al., 2012), and by analyzing the binomial outcome (active or passive trips out of total possible trips) the sensitivity and precision of the data were preserved. Validity of all items in the questionnaire and transport diary were assessed using cognitive interviews in a pilot study with similar age groups prior to the main data collection (Collins, 2003; Toftager et al., 2011). Furthermore, the high completion rate of the transport diaries supports this method as a feasible way of collecting reliable data while retaining diversity of travel behavior.

There are several limitations of the study. First of all, it is possible that the diary method may have caused a reactive effect and contributed to the very high level of AST in both groups. Furthermore, self-report measures are always associated with uncertainty. In this study it is especially applicable for the intermediate outcomes, and future studies should refine methods to better assess intermediate outcomes of AST interventions. Second, schools had to enlist for participation in the study, and the majority of students at the schools should live within 2 km from school and be of Danish ethnicity, for which reason the participation schools are not representative of the population of all Danish schools and thus the external validity of the study is reduced. Third, a limitation is the complexity of the intervention and the heterogeneity in implementation, which increases the difficulties in setting a definite conclusion. As for previous comprehensive studies, it was challenging to implement all components of the intervention, especially the environmental improvements (Bors et al., 2009). Two other components were already implemented at both intervention and comparison schools, and the implemented components were not assessed for quality or for perceived impact on the students or parents.

## 6. Conclusions

This study is one of the first intervention studies to investigate the effect of a whole-school approach to AST in European older children. There was no detectable intervention effect on AST, but there was an indication of an effect on parental encouragement and student attitude towards bicycling. In light of the implementation, these results are reasonable, as the active ingredient almost entirely consisted of increased awareness of the benefits of PA and AST caused by the project itself and the movement policy. In 5th and 6th grade the AST was already high in most schools, and this was maintained at the two-year follow-up. This argues for a potential ceiling effect.

Future intervention studies could replicate the four components of this study, in schools with a lower initial AST and fewer implemented AST initiatives. Further actions for involving teachers, students and parents in the movement policy formulation and implementation should be taken, and including *promotion* on a regular basis in the community, so all five Ps (preparation, promotion, programs, policy and physical projects) from the ALbD model are implemented. Physical projects improving the environment for AST demand a high degree of political involvement and support, and such projects take a long time from proposal to implementation. Therefore, well-planned natural experiments focusing on AST supported by engagement of local authorities can form the basis for solid knowledge of promoting active transportation for the generations to come.

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