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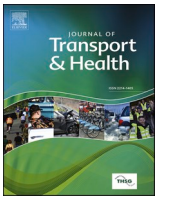

Socio-environmental factors associated with shifts in children's travel mode between 6 and 8 years

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ABSTRACT

Introduction: Active school travel (AST) is an important contributor to child health, yet levels are low and declining in Aotearoa New Zealand. There is a paucity of research exploring change in AST over the earliest school years, a key life stage for setting AST habits for lifelong health gain. We aimed to measure transport mode shifts between 6 and 8 years of age, and identify factors associated with mode shifts.

Methods: We used data from the 6 and 8 year waves of the Growing Up in New Zealand Study, including 642 participants with AST measures at both times. Parents/caregivers were asked about their child's usual transport mode to/from school, perceptions about distance to school, school community cohesion, perceptions of their child at school, and a range of sociodemographic factors. At 8 years, children also self-reported perceptions of peer relationships and school. Factors associated with shifts from active to passive, and passive to active modes from 6 to 8 years were explored using stepwise logistic regression with backwards selection.

Results: AST was low at both time points (37% at 6 years, 34% at 8 years). Overall, 12% moved from active to passive modes and 9% moved from passive to active modes. Higher odds of shifting to active travel modes at 8 years were found for boys, living closer to school, parent-reported importance of living close to school, and child-reported peer relationships/liking school at 8 years. Only one factor was associated with changing to passive modes; for each one unit increase in school community cohesion at 6 years, the odds of changing to passive modes versus remaining with active modes was 15%.

Conclusion: Findings from this study highlight an urgent need for policy and practice to enable and encourage active travel modes for young children and their families.

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1. Background

1.1. Active school travel benefits and prevalence

The benefits of active school travel (AST; i.e., getting to and/or from school using active modes such as walking or biking) for child and environmental health are well established (Faulkner et al., 2009; Larouche et al., 2014; Lee et al., 2008; Saunders et al., 2013; Schoeppe et al., 2013). Yet, the 2022 Global Matrix 4.0 of physical activity report card grades showed low levels of AST across the 57 participating countries (Aubert et al., 2022). Aotearoa New Zealand (NZ) had a D grade for AST, with only five countries reporting lower grades. Overall, less than a third of children and young people used AST in the NZ report card (Wilson et al., 2023). This was a reduction from the previous report card (Smith et al., 2018), and was in keeping with an overall decline in AST over time in NZ (Smith et al., 2019b). The 2022 NZ report card also highlighted a lower rate of AST for younger children in school years 0–6 (approximately 5–10 years old; 29.9%), compared with children in school years 7–10 (approximately 11–14 years; 33.9%) (Wilson et al., 2023).

1.2. The importance of understanding AST in early school years

Evidence suggests activity behaviours track throughout the lifespan (Telama et al., 2005, 2014), AST tracks in younger years (Carver et al., 2011), and persistent AST from childhood is associated with health-promoting physical activity into adulthood (Yang et al., 2014). Importantly, sharp declines in AST from childhood to adolescence and continuing into adulthood have been observed (Yang et al., 2014), so understanding and laying a strong foundation of AST early in life is imperative. Habit formation is an essential component to supporting lifelong health behaviours (Fiorella, 2020) and habit strength significantly augments the impact of planned behaviours on AST intention and behaviours (Murtagh et al., 2012). Instilling a habit of AST from school inception is thus optimal compared to the comparatively greater effort required to facilitate shifts to AST later in life.

The transition to school is a time of particular importance, considered as a "critical period" (Entwisle and Alexander, 1989). In particular, the first year of school involves children transitioning from identities of "home child" to "school child" (Entwisle and Alexander, 1993). Shifting from home life to life in educational settings require significant shifts in child development alongside socialisation to the school setting and school-related behaviours for both children and parents/caregivers (Fabian and Dunlop, 2002; Peak, 1992). Considerable cognitive development also occurs in the earliest years of school, where children progress from preoperational to operational modes of thought (Entwisle and Alexander, 1989), increasing their capability for getting about actively.

It is possible that meaningful shifts in transport mode to school occur between this initial transition to school period and subsequent years - as children and their families become accustomed to the school setting and their new identities, and as parent/caregiver confidence in their child's ability to get about actively increases. Indeed, parental licence for independent mobility (e.g., walking or wheeling without adult supervision) increases with age, aligning with increased parent perception of their child's capability to get about safely (Shaw et al., 2015).

Overall, it is clear that interventions to support AST in the early school years have considerable potential for supporting children's current and future wellbeing, however a majority of AST research focuses on AST behaviours in older children. Developing and maintaining AST is important, and it is plausible that the likelihood of AST increases with age in the early school years. However, it is not known whether AST or passive travel modes persist in the earliest years of school, or if meaningful mode shifts occur in either direction. Knowledge is needed to understand whether shifts occur and the directions of these shifts (and factors associated with them), to inform interventions for schools, families, and practitioners (e.g., schools and transport agencies facilitating school travel planning as part of school transition programmes with families). In particular, identifying and understanding factors related to shifts from active to passive travel modes over this early life phase would highlight areas for urgent attention.

1.3. Understanding factors associated with AST

A substantial body of evaluations of school-based interventions to increase AST exists (Jones et al., 2019; Larouche et al., 2018; Schönbach et al., 2020; Villa-González et al., 2018). While evidence to inform these and future interventions is largely cross-sectional and heterogeneous, consistent findings have been observed for the pervasive role of distance to school on children's AST and the importance of safety, walkability, and active travel infrastructure (Aranda-Balboa et al., 2020; Ikeda et al., 2018b; Rothman et al., 2018; Smith et al., 2017). Localised physical interventions that are fit for the community and its environment are necessary (Rothman et al., 2021), but do not completely explain AST, and a more comprehensive and nuanced understanding of factors of importance is needed.

The social environment has also received attention, with the potentially important roles of socio-relational aspects such as social cohesion, social connectivity, social interactions, and social support highlighted for children's AST (Aranda-Balboa et al., 2020; Ikeda et al., 2018a). Although focused on independent mobility rather than school travel specifically, in their systematic review, Marzi et al. (2018) determined that the social environment appeared to be more important than the physical environment in explaining children's independent mobility. Factors included parent perceptions about safety of the neighbourhood for children and in general, sense of community, fear of crime and strangers, neighbourhood friendliness, informal social control (i.e., residents look out for children), presence of other children in area, presence of others walking, and social support from adults and children. In addition, parent confidence in their child's abilities, and children having friends were key factors of importance. In their recent study, Kunaratnam et al. (2022) determined area-level social factors (material deprivation - proportion of population with low incomes, no high school diploma, lone parent families, receiving income from government, unemployed, living in housing needing major repairs; and ethnic

composition – proportion of recent immigrants and visible minorities, and a composite score of these) appeared to have stronger associations with children's AST in less walkable environments compared with more walkable environments. While social determinants of health such as material deprivation have been widely explored as associates or used as control variables in studies examining AST, less is known regarding socio-relational aspects of AST. Additionally, for the most part, socio-relational factors have been measured from the perspective of parents, with little focus on children's perspectives. NZ research has demonstrated children are able to articulate their needs, perspectives, and preferences in relation to health behaviours, health-promoting environments, and AST (Egli et al., 2020a, 2020b; Williams et al., 2022). In this research, children are situated as competent social actors (Prout and James, 2015), capable of sharing insights of relevance and importance in relation to the study aim.

1.4. Evidence gaps and research aim

For the most part, NZ research has focused on children's AST in later childhood (e.g., 8–13 years), rather than younger childhood (e.g., Ikeda et al. (2019); Hasanzadeh et al. (2022); Oliver et al. (2015)), resulting in a lack of age-specific insights for younger children. There is a paucity of research exploring change in AST over the earliest school years in NZ and internationally (Rothman et al., 2018; Smith et al., 2017). Moreover, while considerable evidence exists for the importance of built environment factors associated with AST, less is known regarding socio-relational factors of importance – despite increasing evidence suggesting these factors may play an important role in AST promotion. There is a paucity of literature to understand children's perspectives in this context. We have previously explored socio-environmental factors associated with AST in a large sample of young children participating in the Growing Up in New Zealand study (GUiNZ) at ages 6 and 8 years (Smith et al., 2024). Parent/caregiver perceived distance to school and reported importance of living close to school were significantly related to AST at both time points. At 8 years only, children of Pacific ethnicities were significantly less likely to get to school actively compared with their non-Pacific peers. These cross-sectional analyses identified factors of importance for AST at each age, but it remained unclear whether travel modes changed over this period and if so, what factors were related to shifts from passive to active modes in this young age group, or vice-versa. In the current research, we aimed to contribute to these clear and important research gaps, by asking the questions: (1) do children maintain active or passive modes of travel to school from 6 to 8 years of age, (2) are there positive (i.e., from passive to active modes) or negative (i.e., from active to passive modes) shifts in travel mode to school from 6 to 8 years of age, and (3) what socio-demographic, environmental, and child and parent reported socio-relational factors are associated with positive or negative shifts in travel mode to school from 6 to 8 years of age.

2. Methods

2.1. Protocol

Data for this study were drawn from the longitudinal GUiNZ cohort study, the full methods of which are detailed elsewhere (Morton et al., 2012). The first wave of the study was with pregnant mothers of 6846 children and their partners, who were living in the Tāmaki Makaurau/Auckland and Waikato Regions of NZ. Children were born between March 2009 and May 2010. Birth parameters for the GUiNZ child cohort aligned to contemporary births nationwide (Morton et al., 2015). The current examination drew from the 6 year (school years 1–2) and 8 year (school years 3–4) waves of the study, and the original maternal questionnaire (for sociodemographic items not captured elsewhere). The Ministry of Health Ethics Committee provided ethical approval to conduct the study (#NTY 08/06/055). This study was a secondary analysis of the GUiNZ study, and analyses were limited to available measures. Of note, the authors did not have access to data on household geography meaning we were unable to generate objective environmental measures specifically for this study.

Eligibility criteria for analysis were: had child ID number; mother was usually residing in NZ; child was usually residing in NZ; child attended school in NZ; usual travel mode to school was reported at both 6 and 8 years; child ethnicity was reported; and at the 8 year wave, the child had not moved house or attended any other school since the 6 year wave (in order to achieve a longitudinal dataset and retain environmental perceptions from the 6 year study wave).

2.2. Measures

2.2.1. Change in usual travel mode to/from school

Parents/caregivers were asked "What forms of transport do you mostly use to get your Growing Up in New Zealand study child/children to and from school?" Travel mode was classified as a binary variable: active (bicycle, scooter, walk) or passive (car, school bus, public transport, taxi). Four categories were then calculated to describe shifts between the 6 and 8 year survey waves: passive to active, passive to passive, active to passive, and active to active. While public transport use is associated with increased physical activity in adults (Rissel et al., 2012), public transport use in NZ children is low (Ministry of Transport, 2014), and a particular focus of this examination was on active modes for the entirety of the school trip. Therefore, for the purposes of this research, public transport was classified as a passive travel mode.

2.2.2. Explanatory variables

Sociodemographic factors. Mothers provided their child's sex (treated as a binary outcome: boy, girl) at the 6 year survey. Children reported their ethnicity (choosing one ethnicity only) at the 8 years survey, which was classified here as Māori, Pacific, Asian, NZ

European, or 'other' ethnicities. Each ethnicity was treated as a binary indicator in analyses, with the reference group being NZ European. Mothers also reported on their highest qualification (no secondary school qualification, secondary school/NCEA 1–4, Diploma/Trade certification/NCEA 5–6, Bachelor's degree, higher degree) in the original maternal survey. Maternal education was treated as a categorical variable, and responses 'no secondary school qualification and secondary school/NCEA 1–4 were combined due to small numbers.

Area/environmental factors. New Zealand Index of Deprivation 2013 (NZDep2013) is a measure of area-level deprivation on a scale of 1 (least deprived) to 10 (most deprived). NZDep2013 was calculated using census data at the meshblock scale (smallest geographical unit) (Atkinson et al., 2014) and was treated as a continuous measure in the analyses. At 6 years, parents were asked to respond to two statements: "The school is easy to access" and "We live within the school zone" using a 5-point Likert scale (1 = not at all important to 5 = very important). The sum of these two items was calculated and treated as a continuous variable (i.e., "Importance of living close to school"). In this survey wave, parents were also asked "Approximately how far away is your child/children's school from your home?". Responses were categorised as "less than 1 km", "1–5 km" or "greater than 5 km". For the current analyses, the latter categories were combined to "at least 1 km" due to small numbers in the "greater than 5 km" category.

Child perceptions. At 8 years only, children were asked to respond to two statements using a 5-point Likert scale (1 = I don't agree, 5 = totally agree): "My friends are usually nice to me" and "I have enough friends," and two statements using a 4-point Likert scale (0 = never, 3 = almost always) "I look forward to school" and "I like school". Likert scores were summed and this was treated as a continuous variable in analyses, with a higher score indicating more positive self-reported peer relationships.

Parent/caregiver perceptions of their child's independence, happiness, and relationships at school. At 6 years, this was measured using three statements: "I think that my child/children are happy in their school," "I think that my child/children can mix with other children well at school," and "I think that my child/children is independent enough to cope with school." Responses were on a 5-point Likert scale, ranging from strongly disagree (1) to strongly agree (5). Scores for these three items were summed and treated as a continuous variable. At 8 years parents were asked to respond to three statements about their child at school: "My child has good friends at school," "The children seem happy," and "All the child's needs are met". Responses to these items were binary (0 = no, 1 = yes), and the sum of these scores was calculated and treated as a continuous variable.

Parent/caregiver involvement with school. At 6 years, parents/caregivers were asked to indicate whether they had been involved in a range of activities at school. These were classified as: "Gone to a community or school event in the past month"; "Regular supervising, e.g., walking school bus, road patrol, parent help" or "Other" (any other school involvement that was not specifically related to AST). Response options were binary (0 = no, 1 = yes); the sum of scores was calculated and treated as a binary variable (no parents responded yes to more than one item). At 8 years this was measured with the summed scores of three items: "The school keeps me informed about my child's learning," "There is good parental input into the school," and "The school seeks parental input." Again, responses were binary and the summed score was calculated and treated as a binary variable (no parents responded yes to more than one item).

School community cohesion. At 6 years, parents/caregivers were asked to indicate the importance of four statements: "The school

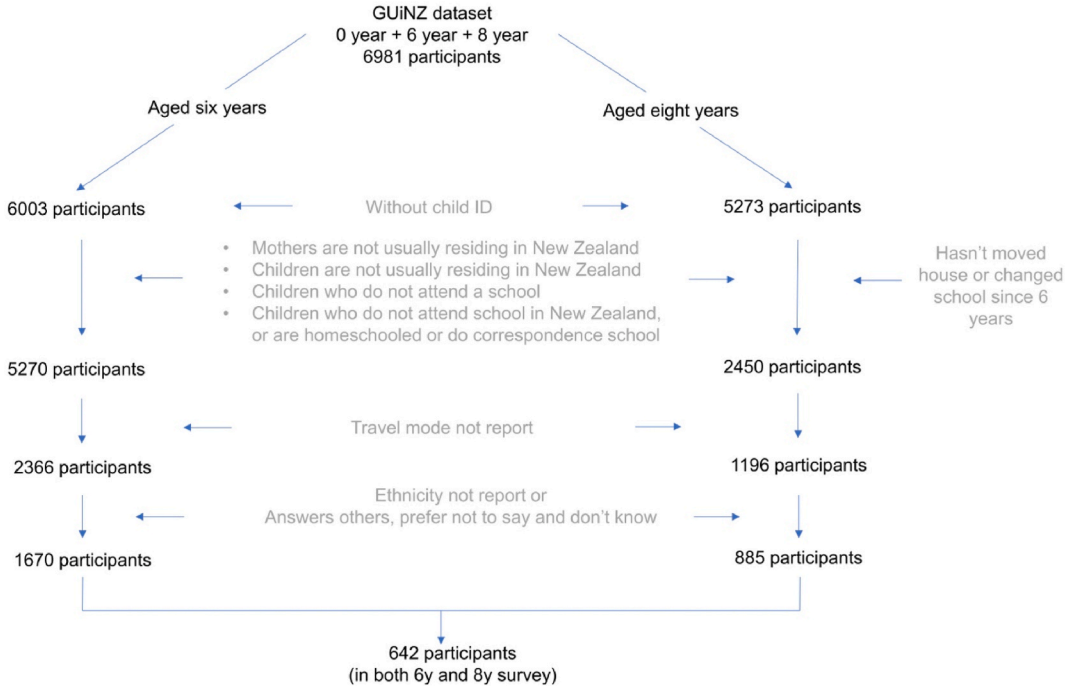

Fig. 1. Flow chart of participants included in analyses.

Table 1
Observed variables and their descriptive statistics for participants included at both 6 year and 8 year study waves of the Growing Up in New Zealand Study.

Variables	Description	Categories	% or mean ± SD
Active school travel variables			
Usual mode of travel to/from school (6 years)	Usual mode of travel to/from school	Passive travel (car, public transport, school bus)	402 (62.6%)
		Active travel (walk, bike, scooter)	240 (37.4%)
Usual mode of travel to/from school (8 years)	Usual mode of travel to/from school	Passive travel (car, public transport, school bus)	421 (65.6%)
		Active travel (walk, bike, scooter)	221 (34.4%)
Mode shift from 6 to 8 years	Individual changes (or not) in mode between 6 and 8 years	Active to Active (no change)	162 (25.2%)
		Active to Passive (negative change)	78 (12.1%)
		Passive to Passive (no change)	343 (53.4%)
		Passive to Active (positive change)	59 (9.2%)
Independent variables			
Sex	Sex of child	Girl	292 (45.5%)
		Boy	350 (54.5%)
Ethnicity	Parent-prioritised ethnicity	New Zealand European	461 (71.8%)
		Māori	87 (13.6%)
		Pacific	45 (7.0%)
		Asian	27 (4.2%)
		Other + MELAA + New Zealander	22 (3.4%)
Neighbourhood Deprivation	NZDep2013 Index of Deprivation	1 (least deprived)	96 (15.0%)
		2	91 (14.2%)
		3	85 (13.2%)
		4	75 (11.7%)
		5	66 (10.3%)
		6	57 (8.9%)
		7	49 (7.6%)
		8	51 (7.9%)
		9	36 (5.6%)
		10 (most deprived)	36 (5.6%)
Importance of living close to school	Summed score of two items		8.34 ± 1.65
	1. Importance of "The school is easy to access"	Not at all important	<10[a]
		Not important	15 (2.3%)
		Neither important nor unimportant	46 (7.2%)
		Important	255 (39.7%)
		Very Important	320 (49.8%)
	2. Importance of "We live within the school zone"	Not at all important	24 (3.7%)
		Not important	47 (7.3%)
		Neither important nor unimportant	114 (17.8%)
		Important	187 (29.1%)
		Very Important	270 (42.1%)
Perceived proximity to school	How far away is your child's school from your home?	Less than 1 km	284 (44.2%)
		Equal to or greater than 1 km	358 (55.8%)
Parent/caregiver perceptions of child's independence, happiness, relationships (6 years)	Summed score of three items		13.26 ± 1.81
	1. I think that my child/children are happy in their school	Strongly disagree	<10[a]
		Disagree	<10[a]
		Neither agree nor disagree	18 (2.8%)
		Agree	278 (43.3%)
		Strongly agree	336 (52.3%)

(*continued on next page*)

Table 1 (*continued*)

Variables	Description	Categories	% or mean ± SD
	2. I think that my child/children can mix with other children well at school	Strongly disagree	10 (1.6%)
		Disagree	<10[a]
		Neither agree nor disagree	30 (4.7%)
		Agree	299 (46.6%)
		Strongly agree	298 (46.4%)
	3. I think that my child/children is independent enough to cope with school	Strongly disagree	<10[a]
		Disagree	<10[a]
		Neither agree nor disagree	16 (2.5%)
		Agree	283 (44.1%)
		Strongly agree	334 (52.0%)
Parent/caregiver involvement with school (6 years)	Summed score of three items		1.99 ± 0.69
	1. Gone to a community or school event in past month	Not in past month	140 (21.8%)
		In past month	502 (78.2%)
	2. Regular supervising e.g. walking school bus, road patrol, parent help	No	469 (73.1%)
		Yes	173 (26.9%)
	3. School involvement (other non-AST forms of involvement)	No	37 (5.8%)
		Yes	605 (94.2%)
School community cohesion (6 years)	Summed score of four items		16.86 ± 1.95
	1. Importance of "The school fosters a strong parent, family, or community involvement"	Not at all important	<10[a]
		Not important	<10[a]
		Neither important nor unimportant	49 (7.6%)
		Important	324 (50.5%)
		Very Important	260 (40.5%)
	2. Importance of "It is the same school as attended by family/friends/other known children"	Not at all important	34 (5.3%)
		Not important	78 (12.1%)
		Neither important nor unimportant	167 (26.0%)
		Important	199 (31.0%)
		Very Important	164 (25.5%)
	3. I feel welcome to visit my child/children's school	Strongly disagree	<10[a]
		Disagree	12 (1.9%)
		Neither agree nor disagree	18 (2.8%)
		Agree	230 (35.8%)
		Strongly agree	374 (58.3%)
	4. I think that my child/children feel/'s like they belong in their school	Strongly disagree	<10[a]
		Disagree	<10[a]
		Neither agree nor disagree	10 (1.6%)
		Agree	270 (42.1%)
		Strongly agree	351 (54.7%)
School community cohesion (8 years)			
	1. I feel welcome at school	No	632 (98.4%)
		Yes	10 (1.6%)
	2. am able to visit my child's classroom	No	>630[a]
		Yes	<10[a]
	3. There is a board of trustees that represents our community	No	>630[a]
		Yes	<10[a]
Child-reported peer relationships (measured at 8y)	Summed score of four items		12.84 ± 2.37
	1. My friends are usually nice to me	I do not agree	<10[a]

(*continued on next page*)

Table 1 (*continued*)

Variables	Description	Categories	% or mean ± SD
		Agree a little bit	66 (10.3%)
		Agree somewhat	71 (11.1%)
		Agree a lot	214 (33.3%)
		Totally agree	286 (44.5%)
	2. I have enough friends	I do not agree	17 (2.6%)
		Agree a little bit	41 (6.4%)
		Agree somewhat	42 (6.5%)
		Agree a lot	133 (20.7%)
		Totally agree	409 (63.7%)
	3. I look forward to school	Never	23 (3.6%)
		Sometime	176 (27.4%)
		Often	165 (25.7%)
		Almost always	278 (43.3%)
	4. I like school	Never	14 (2.2%)
		Sometime	117 (18.2%)
		Often	185 (28.8%)
		Almost always	326 (50.8%)
Parent/caregiver perceptions of child's independence, happiness, relationships (8 years)	Summed score of the following three responses		
	1. My child has good friends at school	No	567 (88.3%)
		Yes	75 (11.7%)
	2.The children seem happy	No	522 (81.3%)
		Yes	120 (18.7%)
	3. All the child's needs are met	No	>630[a]
		Yes	<10[a]
Parent/caregiver involvement with school (8 years)	1. They keep me informed about my child's learning	No	569 (88.6%)
		Yes	73 (11.4%)
	2. There is good parental input into the school	No	>630[a]
		Yes	<10[a]
	3. The school seeks parental input	No	>630[a]
		Yes	<10[a]
Maternal education	The highest qualification of the child's mother	No secondary school qualification or Secondary school/NCEA 1-4	113 (17.6%)
		Diploma/Trade certification/NCEA 5-6	116 (25.9%)
		Bachelor's degree	194 (30.2%)
		Higher degree	169 (26.3%)

[a] Due to cell sizes being smaller than 10, precise values and percentages are not presented here in accordance with GUiNZ data use protocols.

fosters a strong parent, family, or community involvement," "It is the same school as attended by family/friends/other known children," Responses were on a 5-point Likert scale (1 = not at all important, 5 = very important). In addition, parents/caregivers were asked to respond to two statements: "I think that my child/children feel/'s like they belong in their school," and "I think that my child/children are happy in their school." Response options were also on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). Scores for all four items were summed and treated as a continuous variable. At 8 years, three statements were presented with binary response options (0 = no, 1 = yes): "I feel welcome at school," "I am able to visit my child's classroom," and "There is a board of trustees that represents our community." Scores were summed and treated as a continuous variable.

2.3. Data analysis

Descriptive statistics for participant characteristics and study variables at each survey wave were presented. Unadjusted logistic regression models were used to identify factors associated with travel mode change in either direction. Stepwise logistic regression was then used with backwards selection, whereby the full model was first fitted including all explanatory variables (as listed above). The least significant term was then removed from the model in a stepwise fashion, until all variables in the model were related to the outcome at a significance level of $p < 0.1$. This process was repeated for participants who changed from usually travelling using passive travel modes to active travel modes between the two time points, and for those who changed from active to passive travel modes between the survey waves, resulting in two separate logistic regression models. Independent regression models were considered the most useful and clear approach to identify factors associated with positive or negative shifts in school travel mode.

3. Results

A PRISMA diagram for the number of participants included and excluded from the study is provided in Fig. 1. Descriptive statistics for each variable assessed are provided in Table 1. In total, 642 children were included in the analyses for this study. Rates of AST at each time point were similar (37% at 6 years, 34% at 8 years); girls had higher AST at 6 years than boys (40% versus 35%), but rates were similar between girls and boys at 8 years (35% versus 34%, respectively). Travel mode predominantly remained constant over time. Overall, 79% had no change in travel mode; just over 25% continued getting to school actively and just over 53% continued to use passive travel modes. However, there were observable shifts across time, with 78 participants (12%) moving from active to passive modes and 59 (9%) moving from passive to active modes from 6 to 8 years.

Results from unadjusted logistic regression models are available on request; variables significantly related to change from passive to active were importance of living close to school and perceived proximity to school (both $p < 0.001$) and child-reported peer relationships ($p = 0.03$). No factors were significantly associated with change from active to passive travel modes in the unadjusted models.

Table 2 presents the final model and odds ratios for changing to active school travel modes at 8 years (versus continuing to get to school passively), for the 402 participants who usually used passive modes to travel to school at 6 years. Taking all other factors in the model into account, boys had almost twice the odds of changing from passive travel at 6 years to active travel modes at 8 years. Compared with children whose parents perceived their school to be 1 km or less from home, those whose parents perceived their school to be more than 1 km from home had 71% lower odds of shifting to active travel modes rather than remaining using passive travel modes at 8 years. For every one unit increase in parent-reported importance of living close to school, children had 38% higher odds of shifting to active travel modes versus continuing to travel to school using passive modes. The odds of changing to AST rather than remaining using passive travel modes were 20% higher with every one unit increase in child-reported peer relationships at 8 years. There was a suggestion of lower odds of changing to active travel modes for parents/caregivers reporting some school involvement at 8 years (albeit $p = 0.057$, and the confidence interval was wide).

Table 3 presents the final model and odds ratios for changing to passive school travel modes at 8 years (versus continuing to get to school actively), for the 240 participants who usually got to school using active travel modes at 6 years. The odds of changing to passive modes (versus remaining with active modes) was 15% lower (OR 0.85) with every one unit increase in school community cohesion. Although not significant at $p < 0.05$, there was also a suggestion of increased odds of changing to passive modes (versus continuing to get to school actively) for every one unit increase in parents positive perceptions of their child's happiness and relationships at school.

4. Discussion

In this research we aimed to understand whether shifts in usual school transport mode (from passive to active, or vice-versa) occur between 6 and 8 years of age in a diverse group of young children, who had not moved from their home or school between 6 and 8 years. A secondary aim was to identify factors associated with a change over time, either from passive to active modes, or from active to

Table 2
Final model for odds ratios for changing to active school travel modes at 8 years (versus continuing to get to school using passive travel modes).

Independent variable	Categories/comparison or units	OR (95%CI)	p-value
Sex	Males versus females	1.98 (1.06, 3.70)	0.033
Importance of living close to school	Continuous *Mean ± SD: 8.3 ± 1.7* *Range: 2-10*	1.38 (1.11, 1.72)	0.004
Parent perceived proximity to school	≥1 km vs < 1 km	0.29 (0.15, 0.51)	<0.001
Child-reported peer relationships at 8 years	Continuous *Mean ± SD: 12.8 ± 2.4* *Range: 3-15*	1.20 (1.04, 1.38)	0.012
Parent/caregiver involvement with school at 8 years	1 (any one of three items agreed with) versus 0 (no agreement with 3 items asked)	0.30 (0.09, 1.03)	0.057

Note: This model was generated for n = 402 participants who usually used passive modes to travel to school at 6 years (all variables $p < 0.10$).

Table 3
Final model for odds ratios for changing to passive school travel modes at 8 years (versus continuing to get to school actively).

Independent variable	Categories/comparison or units	OR (95%CI)	p-value
Parent/caregiver perceptions of child's independence, happiness, relationships (6 years)	Continuous *Mean ± SD: 13.3 ± 1.8* *Range: 3-13*	1.21 (0.99, 1.48)	0.064
School community cohesion at 6 years	Continuous *Mean ± SD: 16.9 ± 1.9* *Range: 10-20*	0.85 (0.72, 0.99)	0.046

Note this model was generated for n = 240 participants who usually used active modes to travel to school at 6 years (all variables $p < 0.10$).

passive modes. We present novel findings with regard to: (1) children shifting their travel mode in both directions during the earliest years of school, (2) identification of socio-relational factors related to travel mode shift, and (3) highlighting the importance of child-reported friendships in supporting AST. This research is important for a number of reasons. First, our focus on changes in the earliest school years (where little evidence exists) provides new evidence on negative changes and the need for early intervention. Habit formation is an integral facilitator of health-promoting behaviours throughout the lifespan, and activity behaviours track from childhood into later life. The finding that 12% of children changed from active to passive modes at such a young age (despite not moving home or school) is new and highlights an urgent need for interventions to mitigate such shifts, and to support a return to active modes as early as possible. We also present new findings on potential areas for intervention to minimise shifts to passive modes in the early years (i.e., supporting school community cohesion and child happiness, independence, and relationships at school, from school inception). Our research also provides important prompts for improving research in the future, including the need to measure changes to passive as well as active modes over time, and highlighting the value of capturing socio-relational aspects of AST and children's perceptions of these, neither of which are commonplace in the literature. We discuss the study findings and their novelty and implications in more detail below.

Overall, we found low rates of AST at both time points - 37% at 6 years, and 34% at 8 years. This was slightly higher than recent national data on children's AST whereby 31% of children and young people got to school actively (Wilson et al., 2023). Of note, the national study also highlighted younger children in early school years had lower rates of AST than those in later childhood (i.e., 30% in school years 0–6 and 34% in years 7–10). It is possible the higher rate in the current study is reflective of a bias towards active school travel, noting that a considerable portion of respondents (n = 3284, 56.79% at 6 years, n = 2828, 57.48% at 8 years) did not answer the question about usual travel mode, and thus were excluded from analyses.

Nearly 80% of children used the same travel mode at 6 and 8 years of age and over half (53%) of children maintained passive modes to school over time. It is worth recalling that only participants who had not moved home or school between these two times were included in these analyses. This finding highlights the urgent need for interventions to overcome the persistent use of passive travel modes to school, and to establish new AST habits in these early years for current and future health. Given the significant role of the built environment in supporting active travel modes (Aranda-Balboa et al., 2020; Ikeda et al., 2018b; Rothman et al., 2018; Smith et al., 2017), it is possible that this finding is reflective of the unchanging physical environments of these children around their homes and schools, and along their school routes. Considering also the evidence for tracking of activity behaviours over time (Telama et al., 2005), it is possible these trends will continue for these children without a significant shift in how active travel modes are prioritised and supported for children, including the development of supportive physical infrastructure.

A novel aspect of this research was the exploration of factors associated with shifts from passive modes to active modes, and from active to passive modes. Considering the overall rates of AST at 6 and 8 years in this study, it could have been assumed that travel modes remain relatively constant within individuals – that is around a third of children used AST at 6 years, and continued to do so at 8 years. Our approach highlighted that while the rates at the group level were indeed consistent over time, there were observable shifts occurring at the individual level, with some shifting to active modes, and others to passive modes, in essence, cancelling each other out at the group level. Our findings show that considering AST only as the outcome of interest has the potential to dilute the ability to understand changes in travel modes over time (and factors related to these changes), and missing key insights needed to inform efficacious AST interventions. There is a clear need to continue to identify and understand shifts to passive modes in future research. It is possible the findings presented here are a function of the younger age of children in this study, who are just entering their school years (Rothman et al., 2018). Parents may be less likely to allow children in this younger age group to school independently (Hillman et al., 1990), or to simply get around their neighbourhood actively until they are perceived as being old enough (Smith et al., 2019a), ultimately limiting opportunities for AST in early school years. It is likely that a significant age-related shift may occur at later time points (e.g., at the 10 year wave of GUiNZ). Longitudinal work with additional time points is required to explore these patterns in more detail.

Both distance to school variables were significantly associated with the odds of shifting from a passive travel mode to AST in the expected directions. This contributes new knowledge to the substantive body of literature on the importance of proximity to school for AST (Aranda-Balboa et al., 2020; Ikeda et al., 2018b; Rothman et al., 2018; Smith et al., 2022), by highlighting the important role of distance to school on supporting positive shifts to AST in the earliest school years. There are a range of opportunities to reduce the impact of living further from school. Partnering with communities including using local carparks for park and walk/ride interventions can enable AST for portions of the school journey (Smith et al., 2020). Developing schools as community hubs can benefit children and communities alike, through supporting AST and social connections for all (Ergler and Smith, 2023). Where new neighbourhood

developments occur, it is essential that school location is carefully planned to ensure equitable access to school. Conversely, school closures and the wide reaching impacts of these closures must be considered and mitigated (Kearns et al., 2009; Witten et al., 2003). Inequities in living further from schools likely exist – for example, those living in remote areas; families wishing to prioritise te reo Māori language immersion education (i.e. Kura Kaupapa Maori or Ngā Kura a Iwi) for their children may have to travel further (Mihaere et al., 2024); and families who require specialist schools for disabled children. Regarding the latter, here we also highlight disabled children's rights to able to attend their local school (rather than being relegated to specialist schools), and the considerable benefits of this for the child and their wider community (IHC New Zealand, n.d.). This research did not allow for exploration of factors of importance for disabled children; future research in this topic is warranted (Ross and Buliung, 2018). Implementing school zoning (i.e., limiting enrolments to students residing in the local school neighbourhood) can reduce distances travelled by students. Where school zones are large, or in the case of specialist schools, provision of school bus services can provide students with a safe means to commute to school. While not facilitating AST for the complete journey, evidence with adult populations suggests public transport use is significantly associated with increased physical activity (Rissel et al., 2012). It is noteworthy that in NZ, the Ministry of Education only funds free school bus services where 'suitable' public transport (based on distance, timing, and need for changing services) is not available (Ministry of Education, 2022) – meaning that bus services are not provided for all schools. For younger children, even if 'suitable' public transport exists, parents may be reluctant to send their child on any form of public transport due to safety concerns, whereas a dedicated school bus could be perceived to be safer. The cost of public transport is an additional barrier, and to be eligible for school transport assistance, students in school years 1–8 must live at least 3.2 km from the school (far exceeding a walkable distance) and be enrolled at the closest school. In mid 2023 free public transport for children was mandated (New Zealand Government, 2023). However, five months later NZ had a shift in government which has subsequently overturnined directives for programmes to support people to walk, cycle, and use public transport, including the removal of free public transport for children (Martin, 2023; Hu, 2024). Finally, considering threshold distances are larger for biking than walking (D'Haese et al., 2011), and rates of biking in NZ children are extremely low (Te Manatū Waka Ministry of Transport, 2020) (including this study where the prevalence of "biking or scootering" was 5% at 6 years and 7% at 8 years), interventions to support biking to school are imperative. The provision of safe biking infrastructure is essential – for example, bike lanes that are separate from other modes, wide enough to ride comfortably, have no hazards present and a clear line of sight, and that are connected and integrated with the wider transport system including safe places to cross roads (Rothman et al., 2021; Smith et al., 2019a; Swain et al., 2023). School-level supports such as provision of bike storage, rules and regulations around biking and uniforms, cycle skills training, ensuring equitable access to bikes, and running cycle trains could also support uptake of biking to school (Hawley et al., 2018; O'Fallon, 2008; Sersli et al., 2019).

Boys were almost twice as likely as girls to shift to AST at 8 years. It is worth noting that a lower proportion of boys got to school actively at 6 years compared with girls, and this difference was negligible at 8 years. Sex was not significantly related to change to AST in the unadjusted analysis ($p = 0.19$). Inequities in AST for girls are consistently observed in later childhood and into adulthood (Goel et al., 2022). It is possible that parents allow their boys to transition to having greater autonomy and parental licence for independent mobility at an earlier age than for girls, which could be linked to parents' perceptions of their child's ability to navigate their environments safely, or other safety concerns. It also unclear at what age independent mobility licences (including getting to school independently) are granted for NZ children and whether this even occurs in the earliest years of school, but there is some evidence for independent mobility licences being granted at 8 years of age (Lin et al., 2017; Smith et al., 2019a). A majority of international literature on independent mobility has focused on children aged 7 years and older (Shaw et al., 2015). Children in Finland (Shaw et al., 2015), Japan (Drianda and Kinoshita, 2011), and Tanzania (Malone and Rudner, 2011) demonstrate high levels of independent mobility from 7 years of age, and evidence of independent mobility licences being granted at 8 years has been shown for children in Portugal (Cordovil et al., 2015). Importantly, seminal work by Hillman and Adams (1992) and later supported by Malone and Rudner (2011) highlight that age is not necessarily the key driver for independent mobility, rather "the concepts of age and mobility are constructed through their production and reproduction through everyday dynamic life experiences" (Malone and Rudner, 2011). The dataset used in the current study did not allow for exploration of these factors – future studies exploring socio-cultural and environmental factors associated with young children's independent mobility are warranted.

Child-reported peer relationships at 8 years were associated with significantly greater odds of shifting to active travel modes from 6 to 8 years. To our knowledge, this is the first time this relationship has been examined. As this variable was only assessed at 8 years, we are unable to determine whether child relationships were constant over time and/or impacted AST - it may be that friendships are developed through getting to school actively together, or that having friends living nearby allows for greater AST (Silva et al., 2014; Timperio et al., 2006). The collection of child perceptions is a useful contribution to the literature, particularly considering differences in perceptions around AST exist between children and parents (Aranda-Balboa et al., 2021). This novel finding highlights the potential role of social support and peer relationships on AST, and the utility of assessing this factor from children's perspectives in future research. For example, the assessment of peers using AST, accompaniment on the trip to school, and perceptions of the journey itself could be useful.

Twelve percent of participants shifted from usually travelling to/from school using active modes to passive modes at 8 years. The scale of the shift to passive modes was somewhat unexpected, and initial reflections were that perhaps this was a shift to public transport, which was treated as a passive mode. However, our retrospective analyses revealed that none of these children shifted to public transport at 8 years. Only one variable was significantly associated with lower odds of shifting from active to passive modes. For every one unit increase in school community cohesion at 6 years, the odds of changing to passive modes (versus remaining with active modes) were 15% lower. This variable captured parent perceptions about the school fostering involvement, other family/friends attending the school, and a sense that their child was happy and felt that they belonged at the school. Earlier research has demonstrated the important role of neighbourhood or community social cohesion and connections in supporting children's AST and independent

mobility (Ikeda et al., 2019; Lin et al., 2017). This research provides new evidence for the importance of social cohesion at the school community level, and its association with travel mode change over time. While the same items were not assessed at 8 years, this finding provides some indication that having established connections and cohesion in the early years of school might help children to maintain AST behaviours over time. Interventions to support children's social relationships during the transition to school may be beneficial. Future research would benefit from exploring social cohesion in more detail, including how to support increases in social cohesion.

4.1. Strengths and limitations

This study involved secondary data analysis from the GUiNZ study, a longitudinal survey of factors across six wellbeing domains. While the study provides comprehensive information on key child wellbeing factors, it was not designed to understand school travel in detail and potential factors of relevance have changed over survey waves, and we did not have access to geographical information of participants. Accordingly, we were not able to explore shifts in key social factors over time (as measures differed across waves), or consider other known factors of importance for AST, in particular safety (Ikeda et al., 2021) and objective measures of the physical environment (Aranda-Balboa et al., 2020; Ikeda et al., 2018b; Rothman et al., 2018; Smith et al., 2017). While the study was not focused on independent mobility, the measure of accompaniment as an indicator of peer or parent/caregiver support would have been useful. Stratified analyses by distance to school (i.e., those living within a walkable distance vs. those who do not) were not deemed appropriate for this dataset. Previous evidence from NZ has shown striking differences by objectively-assessed distance to school, with a third reduction in AST for those living 1.3–2.3 km from school, and almost no participants living beyond 2.3 km using AST (Ikeda et al., 2018b); findings from another study with 8–14 year olds suggested 1.4 km as a useful threshold (Duncan et al., 2016). The GUiNZ study response options for perceived distance to school were limited to living <1 km from school, 1–5 km from school, or >5 km from school, providing insufficient specificity and sensitivity for stratified analyses. The addition of objective built environment measurements over multiple timepoints (ideally measuring routes travelled) would be worthwhile in future studies.

Although the GUiNZ participant numbers at each survey wave exceeded 6000, it is important to note the current analyses were limited to those who responded to the school travel mode item, and who hadn't moved from their home or school between the 6 and 8 year survey waves. This approach was important to allow us to remove the potential impact of changing environments, however it does mean our findings must be treated with caution and are not generalisable to the wider population.

In this study, we drew from the work of Medeiros et al. (2021) and in Ross and Buliung (2018), in particular recognising the need to address equity in AST studies, including reporting equity considerations. We have highlighted sex inequities in shifting to AST from 6 to 8 years, and reflected on children's rights and possible inequities in supports for AST and implications for disabled children and Māori children (Indigenous children of NZ). Other equity factors (e.g., migrant status (Kunaratnam et al., 2022)) were not able to be explored, but are worthy of examination in future studies, alongside more detailed examination across ethnicity, sex and gender, and disability.

5. Conclusion

Our study findings highlight the urgent need for interventions to generate a step change in AST for young children in NZ, ensuring both boys and girls are supported to shift to AST, and mitigating challenges for children living further away from school. While this study did not measure built environments around homes, schools, or routes, the persistently low rates of AST in the context of consistent home and school environments signal that optimal infrastructure to enable young children to get to and from school actively may also be lacking.

Institutional review

The study was conducted according to the guidelines of the Declaration of Helsinki, and was approved by the Ministry of Health Ethics Committee (NTY 08/06/055).

Informed consent

Informed consent was obtained from all participants involved in the study.

Data availability statement

Growing Up in New Zealand data access is controlled by a Data Access Protocol. Data requests are reviewed by a Data Access Committee. Full details on data access are available at https://www.growingup.co.nz/using-data.

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CRediT authorship contribution statement

Melody Smith: Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Visualization, Writing – original draft. **Alana Cavadino:** Formal analysis, Funding acquisition, Writing – review & editing. **Yijun Zhang:** Funding acquisition, Writing – review & editing, Formal analysis. **Hayley McGlashan Fainu:** Funding acquisition, Writing – review & editing. **Jinfeng Zhao:** Funding acquisition, Writing – review & editing. **Susan Morton:** Data curation, Funding acquisition, Methodology, Writing – review & editing. **Debbie Hopkins:** Funding acquisition, Writing – review & editing. **Harriette Carr:** Funding acquisition, Writing – review & editing. **Terryann C. Clark:** Funding acquisition, Writing – review & editing.

Declaration of Competing interest

None.

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