ACTIVE TRAVEL STUDIES

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RESEARCH ARTICLE

Active Travel in Rural New Zealand: A Study of Rural Adolescents' Perceptions of Walking and Cycling to School

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Background: Understanding students' perceptions of walking and cycling to school informs active travel interventions and policy. However, perceptions of students in rural settings are unknown, yet they are important predictors of active travel use. This study examined perceptions of walking and cycling to school among adolescents ineligible for school transport financial assistance (living ≤4.8 km of school) in rural New Zealand.

Methods: Adolescents (n = 62; 53.2% female; 15.6 ± 1.5 years; five schools) residing and attending a secondary school in a rural setting (population < 1,000) completed an online survey about their perceptions of walking and cycling to school (attitudes, subjective norms, perceived behavioural control/intention). Home-to-school distance was calculated using a geographic information system's shortest network path analysis.

Results: Overall, 73% walked and 11% cycled to school. Compared to cycling, adolescents reported a greater desire (57% vs 26%) and intention (74% vs 13%) to walk to school and perceived more support from friends (37% vs 30%), parents (81% vs 40%), and schools (61% vs 34%) (all $p < 0.001$). Adolescents also reported better physical infrastructure (presence/availability of footpaths vs cycle lanes) for walking versus cycling to school (86% vs 36%, $p < 0.001$). Over 95% perceived both walking and cycling to school as safe.

Conclusions: Compared to cycling, walking to school was a more common and preferred transport mode with greater perceived social support and physical infrastructure. The findings suggest that supportive social and built environments appear to encourage walking to school in rural areas. Mode-specific approaches may be required to encourage cycling to school for rural adolescents.

Keywords: active transport; rural; adolescents; walking; cycling; perceptions

1. Introduction

Walking and cycling to school are the two most common modes of active transport to and from school (ATS). They are convenient and environmentally friendly ways to foster daily physical activity among adolescents (Aubert et al., 2018; Guthold et al.; 2020; Khan et al., 2020) while also providing a range of health, personal, and social benefits (Kek et al., 2019; Mandic, Hopkins et al., 2017; Carver et al., 2005). In New Zealand, fewer than 50% of adolescents use ATS (Smith et al., 2018), with walking being more popular than cycling to school (Mandic, Hopkins et al., 2017). Walking to school is also more popular in other countries, including Canada (59% vs 3%) (Larsen et al., 2009), China (40% vs 16%) (Sun, Liu and Tao, 2015), Great Britain (40% vs 16%) (Department for Transport, 2017), Ireland (18% vs 2%) (Murtagh, Dempster and Murphy, 2016), Spain (46% vs 2%) (Chillón et al., 2013), and Switzerland (34% vs 10%) (Bringolf-Isler et al., 2008). However, in some countries, such as Denmark (Cooper et al., 2006), Germany (Reimers et al., 2013), and the Netherlands (Bere et al., 2008), cycling to school is more popular than walking among adolescents at least in part due to a complex mix of socio-historical and cultural factors, ongoing investment in cycling-friendly infrastructure, and supportive policies (Pucher and Buehler, 2008).

In general, most studies have examined walking and cycling to school combined under the term "active transport" (Martin, Lee and Lowry, 2007; Babey et al., 2009; Evenson et al., 2006; Robertson-Wilson, Leatherdale and Wong, 2008) or focused on walking only (Mitra and Buliung, 2015) or cycling only (de Bruijn et al., 2005). However, walking and cycling are distinct modes of transport with distinct characteristics. For example, mode-specific enablers and barriers have been identified by both New Zealand adolescents (Mandic, Hopkins et al., 2017; Mandic et al., 2022) and their parents (Mandic et al., 2020), suggesting the importance of examining these two modes of ATS separately. In these New Zealand studies, both parents and adolescents perceived cycling as less safe with less social support and more environmental barriers than walking to school.

Further, most studies examining adolescents' school travel have been conducted in main urban centres (Martin, Lee and Lowry, 2007; Mitra, Buliung and Roorda, 2010; Jones and Sliwa, 2016; Easton and Ferrari, 2015; Babey et al., 2009; Chillón et al., 2013), with few studies focusing on rural areas (Bungum et al., 2008; Sjolie and Thuen, 2002). As these geographic settings have distinct social, cultural, economic, and built environment contexts, the rates of adolescents' walking and cycling to school as well as enablers of and barriers to their use are likely to differ in rural and urban areas. Typically, a higher prevalence of ATS is observed among adolescents in urban versus rural areas (Pabayo and Gauvin, 2008; Babey et al., 2009; Yang, Diez Roux and Bingham, 2011; Potoglou and Arslangulova, 2017; Sjolie and Thuen, 2002; Robertson-Wilson, Leatherdale and Wong, 2008; Fulton et al., 2005). This observation may at least in part be attributed to longer distances to school travelled by rural adolescents. In contrast, a New Zealand study reported a higher prevalence of ATS among adolescents in rural versus urban areas (Mandic et al., 2015).

Distance from home to school is the strongest predictor of ATS in adolescents (Ikeda et al., 2018; Mandic et al., 2015; De Meester et al., 2013). Threshold distances for adolescents walking to school range from 1.4 km to 3.0 km (Bere et al., 2008; Pocock et al., 2018; Nelson et al., 2008, Chillón et al., 2015), whereas reasonable cycling distances range from 3.0 km to 8.0 km (D'Haese et al., 2011; Nelson et al., 2008; Bere et al., 2008; Van Dyck et al., 2010), with large variability between countries. In addition, parental (Mandic et al., 2020) and adolescents' (Mandic et al., 2022) perceptions and rates of walking and cycling to school change with increasing home-to-school distance. Thus, efforts to promote ATS will most likely only be effective among adolescents living within a *reasonable* walking and/or cycling distance from their school. Therefore, studies examining adolescents' perceptions of walking and/or cycling to school should be conducted in adolescents for whom using ATS is potentially feasible.

In New Zealand, adolescents living within 4.8 km of their closest school are ineligible for school transport financial assistance (Ministry of Education, no date); consequently, they rely on walking, cycling, private vehicle transport, or public transport for their school travel. Although fare-based public buses are available in the main urban centres and some medium-sized urban areas, limited public transport provision is characteristic of rural areas internationally, including in New Zealand (Nutley, 2003; Nutley, 1996).

To address the paucity of rural transport knowledge, rural-specific transport habits and perceptions need to be investigated to develop appropriate place-based interventions and policies to promote ATS and ultimately increase adolescents' physical activity. Research questions for this study were guided by socio-ecological frameworks of travel behaviour (Panter, 2008; Sallis, 2006) and the theory of planned behaviour (Ajzen, 2002). Socio-ecological frameworks of travel behaviour suggest that a wide range of individual, social, environmental, and policy factors influence how adolescents travel to school (Panter et al., 2010; Davison and Lawson, 2006; Pont et al., 2009). In addition, the theory of planned behaviour (Ajzen, 2002) illustrates the role of individual beliefs and perceptions. Briefly, this theory posits that the intention to use ATS, as a direct antecedent of the behaviour itself, can be predicted based on attitudes towards walking and cycling, subjective norms, and perceived behavioural control. Therefore, this study compared the perceptions of walking and cycling to school among adolescents attending a secondary school within 4.8 km (3.0 mi) of their home in rural settings in the Otago region of New Zealand.

2. Materials and methods

2.1. Setting

Currently, there is no internationally agreed upon definition of "rural" areas in New Zealand (Statistics New Zealand, no date). In the present study, "rural settings" were settlements/areas with populations of less than 1,000 residents, as defined by the New Zealand government (Statistics New Zealand, no date; Statistics New Zealand, 2020). The Built Environment and Active Transport to School (BEATS) Rural Study was conducted between February and September 2018 in the Otago region, New Zealand (White et al., 2021). Aside from the city of Dunedin, the region is made up of rural settlements and small urban (1,000–9,999 residents) and medium urban (10,000–29,999 residents) areas (Statistics New Zealand, 2020; Statistics New Zealand, 2018; Statistics New Zealand, 2019). Data were analysed for adolescents living in rural settlements who attended a secondary school in a rural area.

2.2. Participants

Adolescents (13 to 18 years of age; school years 9 to 13) from 11 out of 15 secondary schools outside of Dunedin city participated in this study. Years 9 to 13 are the last five years of school in New Zealand. This study focused on adolescents, as lower rates of ATS have been

observed among adolescents versus children, at least partly due to increasing distance from home to secondary versus primary school (Pabayo and Gauvin, 2008; Bringolf-Isler et al., 2008). Adolescents provided written consent before participating; parental consent was not required. Survey and anthropometry data were collected using BEATS Study research methodology (Mandic, Williams et al., 2016; White et al., 2021) during one 50- to 60-minute school period under research staff supervision. This study protocol was approved by the University of Otago Human Ethics Committee (Ref. 17/178). Among 1,015 adolescents who participated, 961 had complete written consent forms and valid survey data, of whom 62 lived in rural settlements/areas in the Otago region and attended one of the five schools there (**Figure 1**). Inclusion criteria of home-to-school distance of up to 4.8 km was chosen because in the Otago region of New Zealand, rural high school students living within 4.8 km of school did not have any other obvious available mode of transport to school (e.g., public bus, subsidised school bus) and therefore needed to choose between ATS or being driven by a parent/self-driving.

2.3. Student survey measures

The structure of the BEATS survey was underpinned by socio-ecological models of physical activity and active transport (Panter et al., 2010; Spence and Lee, 2003) and the theory of planned behaviour (Ajzen, 2002). In the BEATS Rural Study, participants completed an

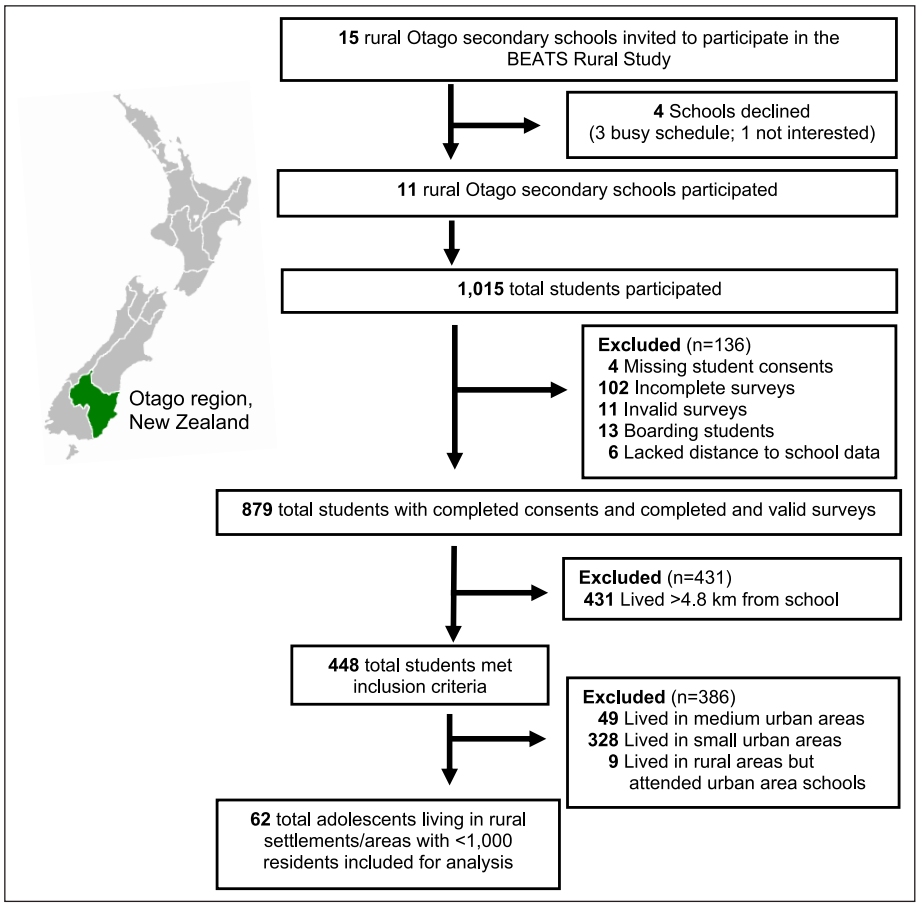

Figure 1: Flowchart of participant selection for data analysis.

online questionnaire that included items related to adolescents' sociodemographic characteristics, transport to school habits, attitudes towards and perceptions of walking and cycling to school, and enablers of cycling to school. The items analysed for this article have been previously published (Mandic, Hopkins et al., 2017; Mandic et al., 2022) and are briefly summarised in the following.

2.3.1. Sociodemographic characteristics and distance to school

Adolescents self-reported their date of birth, gender, ethnicity, school year, home address, and family ownership of vehicles and bicycles. Home addresses were used to determine an index of neighbourhood deprivation and reported in quintiles (1 = least deprived to 5 = most deprived) as a proxy for neighbourhood socioeconomic status (Atkinson, Salmond and Crampton, 2014). Distance to school was determined using geographic information systems (GIS) analysis using the shortest network from home to school (Mandic, Williams et al., 2016). Home address was also used to categorise adolescents' home locations, respectively, into one of the six urban and rural categories defined by Statistics New Zealand (Statistics New Zealand, 2018).

2.3.2. Travel to school

Adolescents reported the frequency of use of different modes of transport to school (i.e., car passenger, car driver, walking, cycling) using response categories "never", "rarely", "sometimes", "most of the time", and "all of the time", as previously described (Mandic, Hopkins et al., 2017). Transport modes used "most of the time" and "all of the time" were used to categorise adolescents as using ATS, motorised transport only, or mixed modes (Mandic, Hopkins et al., 2017).

2.3.3 Beliefs about walking and cycling to school

All questions related to adolescents' perceptions of walking and cycling to school were worded to ask about travel *to* school only to avoid the repetitiveness of the questions as well as to acknowledge that adolescents do not necessarily travel directly home from school but may travel to other destinations (such as to sport practices or visiting friends) which may have effects on their transport mode. As previously described (Mandic, Hopkins et al., 2017), adolescents' attitudes towards walking and cycling to school were assessed by means of bipolar (−3 to +3) semantic differential scales, with response options framed by the adjectives "dull"–"interesting", "unpleasant"–"pleasant", and "boring"–"stimulating" for experiential beliefs and "unhealthy"–"healthy", "bad"–"good", and "useless"–"useful" for instrumental beliefs. Consistent with previous analyses (Mandic, Hopkins et al., 2017), scores on individual items from each scale were averaged to create a composite score for *experiential beliefs* and *instrumental beliefs*, respectively. Subjective and perceived norms were assessed by adolescents' perceptions of peer and parental support and role modelling and school support for walking and cycling using a seven-point Likert scale. Perceived behavioural control was evaluated by means of items assessing adolescents' perceived confidence and behavioural control to use ATS, and intention was assessed with items reflecting desire and intention to walk and cycle to school using a seven-point Likert scale. In addition to experiential and instrumental composite scores, a *self-efficacy* composite score was created as the average score of ability/capability/confidence items for cycling to school. A detailed description of how composite indicators were constructed has been published elsewhere (Mandic et al., 2022).

2.3.4. Personal motivations for and barriers to walking and cycling to school

Personal motivations (getting exercise, socialising with friends), personal barriers (time required, prior planning, amount to carry, after-school schedule, sweating, feeling tired, lack

of interest), environmental barriers (distance, lack of footpaths/cycle paths, weather), and safety beliefs were assessed separately for walking and cycling. Responses were measured using a four-point Likert scale (1 = strongly disagree to 4 = strongly agree). Scores for personal barrier items were averaged to generate a *personal barriers* composite score for walking and cycling.

2.3.5 Perceptions of potential enablers of cycling to school

Adolescents reported their perceptions of potential enablers of cycling to school, such as reduced traffic speed and cycle-friendly school uniforms. Additional items assessed adolescents' opinions about cycling in general, including enjoyment of recreational cycling, frequency of cycling with friends/parents, and perceived benefits of cycle skills training. Responses were measured using a four-point Likert scale (1 = strongly disagree to 4 = strongly agree).

2.4 Data analysis

Demographic characteristics were analysed using descriptive statistics. Response collected on a four-point Likert scale were recoded into two-category variables for analysis: [1] and [2] = "disagree"; [3] and [4] = "agree" response. Responses collected on a seven-point Likert scale were recoded into three-category variables for analysis: [1], [2], and [3] = "disagree"; [4] = "neutral"; [5], [6], and [7] = "agree" response. Categorical variables relating to beliefs about, motivations for and barriers to walking and cycling to school were compared using McNemar's test and are reported as frequencies [n (%)]. Continuous variables (composite scores for experiential beliefs, instrumental beliefs, personal barriers, and number of friends who walked/cycled to school) for walking versus cycling to school were compared using paired t-tests and are reported as means ± standard deviation (SD). Data assumptions of normality for continuous variables were checked and showed skewness values between −2 and +2 and kurtosis between −7 and +7, with the exception of distance to school. Cronbach's alpha internal consistency reliability coefficients were calculated for *experiential beliefs:* $\alpha = 0.84$ [walking], 0.95 [cycling]; *instrumental beliefs*: $\alpha = 0.82$ [walking], 0.86 [cycling]); and *self-efficacy for cycling*: $\alpha = 0.89$; and *personal barriers*: $\alpha = 0.80$ [walking], 0.82 [cycling]. Data were analysed using IBM SPSS Statistics Software (version 24.0). Statistical significance is indicated by a p-value of <0.001 to account for multiple statistical tests.

3. Results

3.1. Sociodemographic characteristics

Among 62 rural adolescents who lived ≤4.8 km from school (age: 15.6 ± 1.5 years; 53.2% female; 75.4% New Zealand European, 14.8% Māori (Indigenous people of New Zealand), 10% other ethnic groups), the median distance from home to school was 0.7 km (0.4 mi) (interquartile range: 0.5 km (0.3 mi)). Overall, 96.8% of adolescents had at least one bicycle, and all adolescents had at least one vehicle at home (**Table 1**).

3.2. Travel to school habits

ATS was the most frequent mode of travel to school (74.2%), followed by motorised transport (17.7%) and mixed modes (8.1%) (**Table 1**). Overall, usual transport to school modes were 72.6% on foot, 11.3% by bicycle, 12.9% driven by others, 6.5% driving self, 6.5% by car and on foot, and 4.8% other modes or combinations (**Table 1**).

Table 1: Adolescents' sociodemographic and school travel characteristics.

	Total (n = 62)
Age (years) (mean ± SD)	15.6 ± 1.5
Gender [n (%)]	
Girls	33 (53.2)
Boys	29 (46.8)
Ethnicity [n (%)]	
New Zealand European	46 (75.4)
Māori	9 (14.8)
Pacific	2 (3.3)
Asian	0 (0)
Other	4 (6.6)
Neighbourhood-level deprivation [n(%)]	
1 (least deprived)	0 (0)
2	20 (32.3)
3	20 (32.3)
4	22 (35.5)
5 (most deprived)	0 (0)
Distance to school (km) [median (interquartile range)]	0.7 (0.5)
Household vehicles [n (%)]	
None	0 (0)
One	14 (22.6)
Two or more	48 (77.4)
Average (mean ± SD)	2.4 ± 1.0
Household bicycles to get to school [n (%)]	
None	2 (3.2)
One	20 (32.3)
Two or more	40 (64.5)
Average (mean ± SD)	2.3 ± 1.3
Transport to school [n (%)]	
Active transport	46 (74.2)
Motorised transport	11 (17.7)
Combination of active and motorised transport	5 (8.1)
Usual transport modes to school [n (%)]	
On foot^	45 (72.6)
By car (driven by others)	8 (12.9)
By bike^	7 (11.3)
By car (driving myself)	4 (6.5)
By car and on foot	4 (6.5)
Other modes or combinations	3 (4.8)

SD = standard deviation; n = number.
^Some of the active transport users combined walking and cycling.

3.3. Attitudes, perceived norms, and perceived behavioural control and intention

No differences were observed in experiential or instrumental beliefs by mode of transport (experiential beliefs score: walking: 4.9 ± 1.2, cycling: 4.8 ± 1.4, p = 0.361; instrumental beliefs score: walking, 5.9 ± 1.1, cycling: 5.5 ± 1.2, p = 0.014). However, more adolescents perceived that walking to school received greater peer, parental, and school support, with greater peer and parental role modelling than for cycling (**Table 2**). Adolescents reported a greater number of friends who always or sometimes walk rather than cycle to school (2.2 ± 1.4 vs 0.6 ± 1.0, p < 0.001). Over two-thirds of adolescents reported having complete control in the decision to walk or cycle to school (p = 0.498) (**Table 2**). Similarly, more adolescents expressed having the desire and intention to walk to school compared with cycling (**Table 2**). The self-efficacy composite score for cycling was 5.1 ± 1.3 (out of 7).

3.4. Personal motivations and barriers

While the majority of respondents perceived both walking and cycling to school to be great forms of exercise, a larger proportion favoured walking compared to cycling (**Table 3**). They also perceived that walking to school provided a better opportunity to socialise with friends (**Table 3**). In addition, adolescents perceived better physical infrastructure support for walking versus cycling to school, such as availability and quality of footpaths versus cycle lanes (**Table 3**). Most adolescents perceived both walking and cycling to school as safe. No significant difference was observed in adolescents' perceptions of logistics-related barriers nor personal barriers for walking versus for cycling to school (composite score; walking: 1.7 ± 0.6, cycling: 1.8 ± 0.7, p = 0.165).

3.5. Potential enablers of cycling to school

Overall, 41.0% of adolescents thought that cycle skills training would help them to feel safer when cycling in traffic, but only 27.9% would take such training at their school if it was available. With respect to cycling in general, 60.7% of the adolescents enjoyed cycling for recreation, 19.7% often cycled with their friends, and 18.0% often cycled with their parents. Rural adolescents reported that cycle-friendly uniforms (39.3%), having a school locker (34.4%), being able to cycle without a helmet (32.8%), safer bicycle storage (29.5%), and slower traffic on the roads (21.3%) would encourage them to cycle to school more frequently.

4. Discussion

The key findings are that the adolescents in rural settlements living within 4.8 km of school in Otago, New Zealand, (1) more frequently walked to school than cycled; (2) reported greater peer, parental, and school support for walking versus cycling to school; (3) perceived better physical infrastructure for walking compared to cycling to school; and (4) expressed greater desire and intention to walk than cycle to school. In contrast, their perceptions of safety, distance to school, and trip duration were not significantly different for walking versus cycling to school. This is one of the first studies to compare perceptions of walking versus cycling to school exclusively among rural adolescents. The findings illustrate differences in prevalence of and preferences for walking versus cycling to school as well as mode-specific barriers among adolescents living in rural New Zealand.

These findings extend the existing evidence from urban centres of New Zealand and other countries demonstrating that, compared to cycling, walking is more common, more favourable, and a better supported mode of transport to school among rural New Zealand adolescents who are ineligible for the subsidised school bus. In this sample of adolescents living within 4.8 km from their school, approximately three-quarters used ATS regularly (74%), with the rates of walking to school being significantly higher than the rates of cycling (73% vs

Table 2: Adolescents' beliefs about walking and cycling to school.

	Walking to school (n = 62)			Cycling to school (n = 62)			P-value
	Agree n (%)	Neutral n (%)	Disagree n (%)	Agree n (%)	Neutral n (%)	Disagree n (%)	
Attitudes (mean ± SD)							
Experiential beliefs (interesting, pleasant, stimulating)	4.9 ± 1.2			4.8 ± 1.4			0.361
Instrumental beliefs (healthy, good, useful)	5.9 ± 1.1			5.5 ± 1.2			0.014
Subjective/perceived norm [n (%)]							
My friends think I should walk/cycle to school.[a]	23 (37.1)	11 (17.7)	4 (6.5)	19 (30.6)	30 (48.4)	13 (21.0)	<0.001
No other students walk/cycle to school.[b]	7 (11.3)		54 (87.1)	22 (35.5)		40 (64.5)	0.001
It is not considered cool to walk/cycle to school.[b]	7 (11.3)		55 (88.7)	10 (16.1)		52 (83.9)	0.581
My parents or guardians think I should walk/cycle to school.[a]	50 (80.6)	8 (12.9)	4 (6.5)	25 (40.3)	25 (40.3)	12 (19.4)	<0.001
One or both of my parents or guardians walk/cycle frequently.[a]	23 (37.1)	11 (17.7)	28 (45.2)	13 (21.0)	4 (6.5)	45 (72.6)	0.002
My school encourages me to walk/cycle to school.[b]	38 (61.3)		24 (38.7)	21 (33.9)		41 (66.1)	<0.001
Perceived behavioural control [n (%)]							
I am confident I could walk/cycle to school.[a]	57 (91.9)	2 (3.2)	3 (4.8)	52 (83.9)	7 (11.3)	3 (4.8)	0.249
I see myself as being capable of riding a bicycle to school.[a]				47 (75.8)	8 (12.9)	7 (11.3)	
I believe that I have the ability to ride a bicycle to school.[a]				53 (85.5)	6 (9.7)	3 (4.8)	
I have complete control over whether or not I walk/cycle to school.[a]	42 (67.7)	11 (17.7)	9 (14.5)	46 (74.2)	11 (17.7)	5 (8.1)	0.498
Behavioural intentions [n (%)]							
I want to regularly walk/cycle to school.[a]	35 (56.5)	16 (25.8)	11 (17.7)	16 (25.8)	4 (6.5)	42 (67.7)	<0.001
I intend to walk/cycle to school frequently.[a]	46 (74.2)	6 (9.7)	10 (16.1)	8 (12.9)	3 (4.8)	51 (82.3)	<0.001
Self-efficacy for cycling (mean ± SD)						5.1 ± 1.3	N/A

SD = standard deviation.

[a] Data collected using a 7-point Likert scale (1 = Strongly disagree to 7 = Strongly agree). Data recoded as 1, 2, 3 = disagree, 4 = neutral and 5, 6, 7 = agree to create categorical variables.

[b] Data collected on a 4-point Likert scale (1 = strongly disagree to 4 = strongly agree). Data recoded as 1, 2 = disagree and 3, 4 = agree to create categorical variables.

Table 3: Personal motivations and barriers, environmental barriers, and safety perceptions of walking and cycling to school.

	Walking to school (n = 62)		Cycling to school (n = 62)		P-value
	Agree n (%)	Disagree n (%)	Agree n (%)	Disagree n (%)	
Personal motivations					
Walking/cycling to school is a great way to get some exercise.	61 (98.4)	1 (1.6)	51 (82.3)	11 (17.7)	0.002
I can chat to my friends on my walk/cycle to school.	38 (61.3)	24 (38.7)	17 (27.4)	45 (72.6)	<0.001
Logistic-related barriers					
Walking/cycling to school takes too much time.	13 (21.0)	49 (79.0)	7 (11.3)	55 (88.7)	0.180
It involves too much planning ahead to walk/cycle to school.	5 (8.1)	57 (91.9)	8 (12.9)	54 (87.1)	0.453
I get too hot and sweaty walk/cycling to school.	7 (11.3)	55 (88.7)	14 (22.6)	48 (77.4)	0.092
I have too much stuff to carry to walk/cycle to school.	13 (21.0)	49 (79.0)	25 (40.3)	37 (59.7)	0.004
It is not convenient for me to walk/cycle to school because of my after-school schedule.	14 (22.6)	48 (77.4)	13 (21.0)	49 (79.0)	0.999
I often feel too tired to walk/cycle to school.	17 (27.4)	45 (72.6)	16 (25.8)	46 (74.2)	0.999
I often cannot be bothered to walk/cycle to school.	22 (35.5)	40 (64.5)	25 (40.3)	37 (59.7)	0.629
Environmental barriers					
It is too far to walk/cycle to school.	7 (11.3)	55 (88.7)	0 (0)	62 (100.0)	N/A
There are no footpaths/cycle paths along the way.	9 (14.5)	53 (85.5)	40 (64.5)	22 (35.5)	<0.001
The weather is too cold and wet to walk/cycle to school in the winter.	24 (38.7)	38 (61.3)	17 (27.4)	45 (72.6)	0.065
Safety perceptions					
It is unsafe to walk/cycle to school.	0 (0)	62 (100.0)	3 (4.8)	59 (95.2)	N/A
My parents think it is not safe to walk/cycle to school.	2 (3.2)	60 (96.8)	2 (3.2)	60 (96.8)	0.999

Data collected on a 4-point Likert scale (1 = strongly disagree to 4 = strongly agree). Data recoded as 1, 2 = disagree and 3, 4 = agree to create categorical variables.

11%). These data are not directly comparable to findings from previous studies conducted in similar populations due to the lack of an internationally accepted definition of "rural" areas (Statistics New Zealand, no date), and in this study, only those living within 4.8 km from their school were included. It is also possible that the very short distance to school in our study sample (median distance: 700 m) may also have had an influence on mode choice for school travel for rural adolescents. For example, for such a short journey, getting the bicycle out, cycling to school, and locking it up at school may take more time than the time required to walk to school. However, although our inclusion criteria resulted in a relatively small sample size and very short median distance to school, the higher prevalence of walking versus cycling to school is similar to findings from other studies conducted in rural adolescents (Bungum et al., 2008; Nelson et al., 2008) as well as urban adolescents in many countries (Timperio et al., 2006; Sun, Liu and Tao, 2015; Department for Transport, 2017; Murtagh, Dempster and Murphy, 2016; Larsen et al., 2009; Buliung, Mitra and Faulkner, 2009; Chillón et al., 2013; Chillón et al., 2010; Bringolf-Isler et al., 2008), including New Zealand (Mandic, Hopkins et al., 2017; Mandic et al., 2015).

In the present study, 61% of adolescents stated that they like to cycle for recreation, and only one in five adolescents perceived that cycling to school is not cool. This suggests that most rural adolescents seem interested in cycling, despite the low percentage that actually cycled to school. Adolescents' enjoyment of cycling should be considered in future actions aimed to encourage cycling to school in this age group. However, recreational cycling is most likely happening in locations different from the roads with traffic that rural adolescents encounter on their school route.

In this study, adolescents reported greater peer and parental support and peer and parental role modelling for walking compared to cycling to school. Only one-fifth of adolescents often cycled with friends or parents. Similar findings were previously reported among urban adolescents (Mandic, Hopkins et al., 2017) and their parents (Mandic et al., 2020) from Dunedin city, New Zealand. Extensive evidence from the literature points to the importance of peer support (Mandic, Hopkins et al., 2017; Hinckson, 2016; Deforche et al., 2010; Carver et al., 2005; Ducheyne et al., 2012) and parental support (Carver et al., 2005; Deforche et al., 2010; Mandic, Hopkins et al., 2017; Ducheyne et al., 2012) for both walking and cycling to school among adolescents. Change over time in social capital, social trust, and parental safety concerns limited adolescents' active transport and independent mobility among Otago adolescents (Porskamp et al., 2019), further emphasising the importance of interventions to increase social support for adolescents' ATS in rural areas.

The built environment also influences adolescents' and their parents' decisions about walking and/or cycling to school. In this study, rural adolescents reported greater availability and quality of infrastructure for walking (footpaths) compared to cycling (cycle lanes) to school. Similar findings have previously been reported by adolescents (Mandic, Hopkins et al., 2017; Hopkins and Mandic, 2017; Mandic et al., 2022) and their parents (Mandic et al., 2020) from Dunedin city, highlighting less physical infrastructure support for cycling in general, compared to walking, in both urban and rural areas of New Zealand. Previous studies conducted in urban centres reported that the presence of footpaths (Boarnet, Anderson et al., 2005a; Ewing, Schroeer and Greene, 2004; Ewing and Cervero, 2010; Fulton et al., 2005; Kerr et al., 2006) and/or cycle lanes (Kerr et al., 2006) and higher quality and greater availability of walking and cycling infrastructure (Aarts et al., 2012; Boarnet, Day et al., 2005b; De Meester et al., 2013; Fulton et al., 2005; McDonald et al., 2013; Stewart, 2011) are positively associated with higher rates of walking and/or cycling to school among adolescents. A systematic review by Smith et al. (2017) suggested that improvements in footpaths and the availability of cycle lanes could increase walking and cycling among adolescents. However, rural settings are

fundamentally different from urban areas in terms of the provision, use, need, and likelihood of development of ATS-supportive physical infrastructure. For example, in rural areas, adolescents can walk on verges/edges and shoulders on roadsides. In contrast, cycling requires more specific infrastructure. Many towns and villages in the Otago region of New Zealand are located along main cycle trails built for tourism (New Zealand Cycle Trails, no date), but those cycle trails do not necessarily link residential areas to adolescents' schools.

Few adolescents in rural New Zealand expressed concern about the safety of walking and cycling to school, which differs from findings in urban adolescents in New Zealand (Mandic, Hopkins et al., 2017; Mandic et al., 2022) and elsewhere (De Meester et al., 2013; Leslie et al., 2010; Aarts et al., 2012), where adolescents' and their parents' concerns about both personal safety (Evenson et al., 2006; Leslie et al., 2010; Aarts et al., 2012) and traffic safety (Mitra and Buliung, 2014; Carver et al., 2005, Hume et al., 2009; Giles-Corti et al., 2011) are negatively associated with adolescents' ATS. The urban New Zealand study revealed a complex range of factors that contributed to perceptions of cycling safety, including features and perceptions of the built environment and traffic safety as well as previous cycling experiences (including crashes) and adolescents' cycling skills and on-road experiences (Hopkins and Mandic, 2017). Since parental (Mandic et al., 2020) and adolescents' (Mandic et al., 2022) perceptions of barriers to walking and cycling (e.g., perceived safety) vary by home-to-school distance, it is possible that the lack of safety concerns reported by rural adolescents in the present study is at least in part attributed to the study sample selection which resulted in half of rural adolescents living 0.7 km (0.4 mi) from their school.

Approximately one-quarter to one-third of rural adolescents in this study identified that cycle-friendly uniforms, having a school locker, being able to cycle without a helmet, safer bicycle storage at school, and slower traffic on the roads would encourage them to cycle to school more frequently. Similar findings were previously reported in urban New Zealand adolescents (Mandic, Hopkins et al., 2017). These findings provide valuable information for future interventions aimed at encouraging cycling to school among adolescents living in both rural and urban areas.

Although 41% of adolescents in the present study believed that cycling skills training would make them safer in traffic, approximately one-quarter stated that they would participate in such training at their schools, which is similar to findings previously reported in urban adolescents in New Zealand (Mandic, Flaherty et al., 2016; Mandic, Flaherty et al., 2017).

Previous studies have shown that cycle skills training can improve cycling-related knowledge of road rules and confidence to cycle among children (Mandic et al., 2018) and adolescent girls (Mandic et al., 2018), although such training did not increase the rates of cycling to school among urban adolescent girls following the 6- to 10-week training programme (Mandic et al., 2018). However, in countries like New Zealand, where traffic safety is a major barrier to cycling for transport, several weeks of cycle skills training is unlikely to prepare adolescents for safely sharing the roads with motorised vehicles. Instead, a cultural shift around cycling (i.e., perceived acceptability and thus appropriate safety measures in place) may be necessary to increase the rates of cycling for transportation.

4.1. Implications

Findings from this study illustrate differences in preferences for walking versus cycling to school as well as mode-specific barriers among adolescents living in rural New Zealand. These rural adolescents enjoyed cycling for recreation, but less than one-quarter had a desire or intention to cycle to school. Rural adolescents also perceived that cycling received less social support and had less favourable infrastructure compared to provisions for walking. Therefore, community consultation regarding safe cycling infrastructure combined with the efforts to

create safe routes for walking and cycling to high school (Rahman et al., 2020) may encourage walking and, specifically, cycling to school among rural adolescents and increase peer, parental, and school support for ATS. Offering cycling-friendly school uniforms and providing safe bicycle storage at schools are also likely to have a positive impact on increasing rates of cycling to school among rural adolescents. Given the geographical specificity of Otago, the insights gained through this research are important to inform policy and intervention to encourage ATS in this region.

Although some urban ATS-related findings may also be relevant to the rural context, ATS interventions and recommendations for encouraging walking and cycling to school among rural adolescents need to be adapted to the local rural context, including context-specific barriers to walking and cycling.

4.2. Study strengths and limitations

The study sample was selected based on a reasonable distance to cycle to school (D'Haese et al., 2011; Nelson et al., 2008; Bere et al., 2008; Van Dyck et al., 2010) and locally relevant criteria (i.e., adolescents' eligibility for school bus transport (Ministry of Education, no date)). Thus, our findings provide initial evidence of context-specific and transport mode–specific perceptions and barriers. In addition, this study examined a wide range of variables based on previous research in urban adolescents and theory that yielded valuable information on mode-specific barriers.

This study was limited by a relatively small sample size of rural adolescents, data collection from five schools in one region of New Zealand, and a lack of detailed assessment of personal versus traffic safety concerns related to ATS. By limiting the study to rural adolescents living within 4.8 km (3 mi) from their school, more than three-quarters of the adolescents surveyed in the BEATS Rural Study were excluded from the current analysis, and some of those who travelled by school bus may have cycled or walked to their bus stop. As rural areas differ across New Zealand, the results from this study may not be generalisable to other geographic locations in New Zealand or internationally.

5. Conclusions

Rural-specific research is necessary for advancing knowledge and understanding and for appropriately designing interventions that encourage walking and cycling within this context. Among adolescents living in rural New Zealand and residing within 4.8 km (3 mi) of their school, ATS participation was high, with the prevalence of walking to school being seven times higher than cycling. Compared to cycling to school, rural adolescents had more favourable perceptions of walking and considered walking as a more desired mode of transport to school, with better social and built environment support. Therefore, future initiatives to encourage ATS among rural adolescents need to consider adolescents' perceptions of walking versus cycling, use mode-specific approaches, and address mode-specific barriers. Interventions in rural areas should also consider context-specific opportunities for, and barriers to, encouraging walking and cycling to and from school among adolescents. The current findings present initial evidence of differences in perceptions of walking versus cycling in a sample of rural adolescents that needs to be replicated in future studies using larger samples and, ideally, longitudinal designs.

Data Accessibility Statement

Data used in data analysis for this project will not be shared due to sensitivity of the collected data as well as participants having received assurances that the collected data will not be shared.

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Competing Interests

Sandra Mandic is the founder and the director of the research consultancy AGILE Research Ltd. (www.agileresearch.nz) and principal advisor transport strategy at the Wellington City Council (Wellington, New Zealand). Other authors have no conflict of interest.

Author Contributions

Jessica Calverley: Conceptualisation, data curation, investigation, methodology, visualisation, writing original draft and review and editing. ***Debbie Hopkins:*** Conceptualisation, funding acquisition, methodology, writing review and editing. ***Enrique García Bengoechea:*** Conceptualisation, formal analysis, funding acquisition, methodology, writing review and editing. ***Kirsten Coppell:*** Conceptualisation, funding acquisition, methodology, writing review and editing. ***John C Spence:*** Conceptualisation, funding acquisition, methodology, writing review and editing. ***Sandra Mandic:*** Conceptualisation, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, supervision, writing original draft and review and editing.

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