Transportation Research Part F 71 (2020) 238–249

Contents lists available at ScienceDirect

Transportation Research Part F

journal homepage: www.elsevier.com/locate/trf

Differences in parental perceptions of walking and cycling to high school according to distance

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ARTICLE INFO

Article history:
Received 18 December 2019
Received in revised form 1 April 2020
Accepted 17 April 2020
Available online 15 May 2020

Keywords:
Active transport
Walking
Cycling
School
Parents
Adolescents

ABSTRACT

Background: Parental perceptions towards different modes of transport correlate with adolescents' mode choice for school trips. Whether parental attitudes differ for walking versus cycling and/or home-to-school distance is unknown. We compared parental perceptions of walking versus cycling to school in adolescents in Dunedin, New Zealand and examined whether mode-specific barriers differ by distance to school.

Methods: Parents (n = 341; age: 47.5 ± 5.2 years; 77.1% females) completed a survey about their adolescent's (age: 13–18 years; 48.1% boys) school travel and their own perceptions of walking/cycling to school. Participants were categorised into three groups according to distance to school as 'walkable' (≤2.25 km), 'cyclable' (>2.25–≤4.0 km) and 'beyond cyclable' (>4.0 km).

Results: Common modes of transport to school differed significantly across the 'walkable'/'cyclable'/'beyond cyclable' categories (car passenger: 25.7%/40.5%/60.6%; public/school bus: 5.5%/15.4%/28.4%; walking: 66.2%/28.2%/1.2%; cycling: 0.0%/7.7%/0.5%; all $p < 0.001$). Compared to walking, parents perceived cycling to school to be less important (walking/cycling: 87.5%/62.5%), with less social support from parents (46.2%/17.1%), peers (20.6%/4.8%) and school (24.5%/12.4%), less interest from adolescents (48.5%/31.9%), fewer cycle paths (26.5%) versus footpaths (65.0%) and more safety concerns (35.0%/64.6%; all $p < 0.001$). As distance to school increased, parents' social support decreased whereas personal, environmental and safety-related barriers increased for both modes, with less consistent findings for cycling. Overall, 68.2% of parents expected to participate in adolescents' walking/cycling to school decision-making.

Conclusions: Parents favoured walking compared to cycling to school with parental attitudes for both modes changing with increasing distance to school. The findings illustrate the importance of addressing parental concerns, considering the specificity of walking and cycling and taking into account distance to school in active transport to school initiatives.

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https://doi.org/10.1016/j.trf.2020.04.013
1369-8478/

1. Introduction

Regular physical activity is associated with a range of health, environmental, social and economic benefits (Poitras et al., 2016; World Health Organization, 2018). However, declining levels of physical activity among adolescents have been reported worldwide (Aubert et al., 2018; Guthold, Stevens, Riley, & Bull, 2019), including in New Zealand (Smith et al., 2018). If feasible, active transport to school (ATS) is a convenient way to integrate physical activity into the everyday lives of children and adolescents (Rainham et al., 2012). These practices can maintain or increase physical activity levels (Faulkner, Buliung, Flora, & Fusco, 2009; Kek, García Bengoechea, Spence, & Mandic, 2019; Mendoza et al., 2011; Pabayo et al., 2012), thereby reducing the risk of excess weight and early onset of non-communicable diseases (e.g., type 2 diabetes, cardiovascular disease) (Abrignani et al., 2019; Bjerregaard et al., 2018). They may also develop into environmentally sustainable travel practices over a lifetime (Simons et al., 2017), for instance with the adoption of norms that are favourable toward active transport modes. Yet, although rates vary considerably between and within countries (Aubert et al., 2018; Uddin et al., 2020), the prevalence of ATS in adolescents has been consistently declining over recent decades (McDonald, 2007; Ministry of Transport, 2015). In New Zealand approximately 40% of children and adolescents currently use ATS (Smith et al., 2018, 2019).

A complex set of individual, social, environmental and policy factors correlate with practices of walking and cycling to school among adolescents (13–18 years of age) (Davison, Werder, & Lawson, 2008; Ducheyne, De Bourdeaudhuij, Spittaels, & Cardon, 2012; Panter, Jones, & van Sluijs, 2008; Pont, Ziviani, Wadley, Bennett, & Abbott, 2009; Wong, Faulkner, & Buliung, 2011). For example, higher rates of ATS have been reported among older adolescents, boys and those living closer to school compared to their counterparts. Beyond these, characteristics of the school route (Panter, Jones, Van Sluijs, & Griffin, 2010) and features of the built environment around home (Kerr et al., 2006; Larsen et al., 2009; Panter et al., 2010; Timperio et al., 2006) and school neighbourhoods (Pocock, Moore, Keall, & Mandic, 2019) also influence ATS rates in adolescents. Moreover, social factors, including peer, parental and school support are important in encouraging walking and cycling to school in this age group (Carver et al., 2005; Ducheyne et al., 2012; Emond & Handy, 2012; Esteban-Cornejo et al., 2016; Frater et al., 2017). Research has shown that parental attitudes towards different modes of transport (e.g. walking, cycling, driving, busing) correlate with adolescents' mode choice for school trips (Woldeamanuel, 2016). For example, parental safety concerns about ATS-related traffic and personal safety are negatively associated with ATS among adolescents (Carver et al., 2005; Carver, 2010; Hume et al., 2009). In addition, parental perceptions of the built environment (e.g., street connectivity) are associated with ATS among adolescents (Aranda-Balboa, Huertas-Delgado, Herrador-Colmenero, Cardon, & Chillon, 2019).

In addition, the travel modes used by different household members (parents/caregivers, siblings, other relatives or non-relatives), along with norms and encouragements, can influence the adoption of active or motorised modes (Baslington, 2008). For instance, parents may drive adolescents to school on their way to work (Keall et al., in review), and thus the decisions of how adolescents get to school are part of a complex array of family practices, with movement intrinsic to family practice (Holdsworth, 2013). The dominance of car-based transport in most countries around the world means that motorised private car-transport is associated with normality, while active modes are characterised as deviant (Manderschield, 2014).

Previous studies have examined parental perceptions of adolescents' walking and cycling to/from school either individually (Ducheyne et al., 2012; Emond & Handy, 2012; Hopkins & Mandic, 2017) or considered walking and cycling together under the umbrella term of 'active transport' (Aibar, Mandic, Generelo Lanaspa, Gallardo, & Zaragoza, 2018; Huertas-Delgado et al., 2017; Hume et al., 2009). Though some parental concerns such as the distance between home and school, hills, and personal safety may be similar for both modes, other concerns such as traffic-related safety are greater for cycling than for walking to school (Hopkins & Mandic, 2017; Mandic et al., 2017). For instance, a recent New Zealand study reported greater use of walking, more positive adolescents' perceptions of walking, and better social and infrastructure support for walking versus for cycling to school (Mandic et al., 2017). However, mode-specific motivations and barriers to ATS have yet to be examined from the parental perspective (Mandic et al., 2017).

Home-to-school *distance* is the strongest predictor of ATS in adolescents (Ikeda et al., 2018; Mandic et al., 2015; McDonald, 2007). Although most previous ATS research controlled for distance to school in the multivariate analyses, few studies have analysed adolescents' perceptions of walking and/or cycling to school by limiting the study sample to those adolescents who lived within reasonable walking and/or cycling distance to school (Mandic et al., 2017; Pocock et al., 2019). Moreover, the definition of *reasonable* distances for these modes varies between countries, ranging from 1.4 km to 3.0 km for walking (Bere, van der Horst, Oenema, Prins, & Brug, 2008; Chillón, Panter, Corder, Jones, & Van Sluijs, 2015; Nelson, Foley, O'Gorman, Moyna, & Woods, 2008; Pocock et al., 2019) and from 3.0 km to 8.0 km for cycling to school (Bere et al., 2008; D'Haese, De Meester, De Bourdeaudhuij, Deforche, & Cardon, 2011; Nelson et al., 2008; Van Dyck, De Bourdeaudhuij, Cardon, & Deforche, 2010). No studies to date have examined whether adolescents' and their parents' perceptions of walking and cycling to school differed based on whether they lived within walking and/or cycling distance to school or not. Therefore, the purpose of this study is two-fold: a) to compare parental perceptions of walking versus cycling to school in an urban setting; and, b) to examine if those parental perceptions of motivations for, and barriers to, walking and cycling to school differ based on distance between adolescents' home and their school.

2. Materials and methods

2.1. Setting

New Zealand is a long and narrow country, with varied topography across two main islands, the North Island and the South Island. Climate is predominantly temperate maritime (Köppen classification), but with distinct variability in conditions across the regions, ranging from subtropical in the far north to conditions influenced by a closer proximity to Antarctica in the far south. Dunedin is situated in Otago, on the lower east coast of the South Island, with a population of over 120,000 and a central built-up area extending about 8 km from north to south and 7 km from east to west. The city has highly varied topographical features, including steep residential roads, a largely flat urban centre, and a long peninsula. This topography, relatively small population and land area (3,314.8 km^2) results in low-density neighbourhoods, with physical and built environment features creating and sustaining separation of suburbs and satellite towns including Mosgiel. State Highway 1, which runs the length of the country, cuts through the centre of Dunedin as the main route for intercity road transport, leading to high volumes and a diversity of vehicle types through the city; including a high percentage of heavy vehicles. In recent years, Dunedin has had a series of new walking and cycling infrastructures developed, which have sought to connect residential areas with schools, sporting areas and other central sites.

2.2. Participants

Parent participants were recruited as part of the Built Environment and Active Transport to School (BEATS) Study in Dunedin, New Zealand, in 2014–2017 (Mandic et al., 2015, 2016). Recruitment was conducted through schools, workplaces, social media and at sport events for adolescents, as described elsewhere (Mandic et al., 2016, 2018). Parents were able to participate in this study irrespective of whether their son or daughter participated in the BEATS Student Survey. Parent participants signed consent either online or on paper. Those who completed the survey entered into a draw for an iPad or one of three NZD$250 (~USD$180) grocery or petrol vouchers. The study was approved by the University of Otago Human Ethics Committee (reference number: 13/203).

2.3. Questionnaire

Parents completed a 20- to 25-minute questionnaire either online (n = 267) or on paper (n = 74), as described previously (Mandic et al., 2016, 2018). Questions related to demographic characteristics of participants and their adolescents, participant perceptions of walking and cycling to school, and their adolescents' travel to school behaviour.

Parents reported their age, gender, ethnicity, marital status, employment status, education level and household-related items (home address, the number of children, vehicles and bicycles at home). The home address was attributed a New Zealand index of deprivation value (a measure of neighbourhood socioeconomic status, with 1 = least deprived to 10 = most deprived). This was achieved by geocoding the address (converting to coordinates) and spatially joining that point with the co-located census meshblock containing the deprivation score (which is how the scores are published by the New Zealand Index of Deprivation Study (Salmond, Crampton, & Atkinson, 2007)). Parents also reported age and gender of their eldest child enrolled in a secondary school.

The geocoded home address was also used to calculate distance from home to adolescents' school based on the shortest path on a connected street network using Geographic Information System (GIS) network analysis (Mandic et al., 2016). A distance of $\leq$ 2.25 km was used as a reasonable distance for walking to school (Pocock et al., 2019) and $\leq$ 4.0 km as a reasonable cycling distance for adolescents (Nelson et al., 2008). Parent participants were grouped into three categories based on distance to school: 'within walking distance' ($\leq$2.25 km), 'within cycling distance' (>2.25 km and $\leq$ 4.0 km), and 'beyond cycling distance' (>4.0 km).

As described previously, parents reported adolescents' *travel to school habits* using the question "How does your child usually travel to school?" for different transport modes, with response categories 'never', 'rarely', 'sometimes', 'most of the time' and 'all of the time' (Mandic et al., 2017). In our sample, each participant reported on their adolescent using at least one of the modes 'most of the time' and/or 'all of the time', which was used as a basis for classifying adolescents into active transport, motorized transport or combined active and motorized transport users (Mandic et al., 2017).

Perceptions of walking and cycling to school were assessed with a parental version of the items used in the BEATS Study Student Survey (see supplement) (Mandic et al., 2015, 2016, 2017). Briefly, most items assessed parental attitudes towards walking and cycling to school separately, and included ATS-related decision making, parental perceptions of value of active transport, encouragement, personal barriers (e.g., time constraints, preferences, convenience), environmental barriers (distance, lack of footpaths/cycle paths) and safety perceptions of each mode. Finally, parents reported their perceptions of their adolescents' cycle skills and beliefs about cycling in general. Most items were assessed using a 4-point Likert scale ranging from 'strongly agree' to 'strongly disagree'. An item about adolescents' ability to cycle to school was assessed using a 7-point Likert scale anchored in 'incapable (not able to)' and 'capable (able to)'.

2.4. Data analysis

Categorical variables were compared using χ^2-test. The 4-point or 7-point Likert scale data were analysed as continuous variables with paired t-tests to compare parental perceptions of walking versus cycling to school. One-way ANOVA with Scheffe post-hoc multiple comparisons or, when the assumption of homogeneity of variance was violated, Tamahane's T2 test for comparisons across three distance to school categories was used. Comparison across two distance to school categories were conducted using independent *t*-test or Mann-Whitney *U* test when the assumption of homogeneity of variance was not met. Findings reported in the tables include proportion of parent participants agreeing with each statement. Specifically, all 4-point Likert scale items were recoded into 'disagree' and 'agree' and a 7-point Likert scale item was recoded as a 3-category item (e.g., 'incapable', 'neutral' and 'capable'). Data analysis was performed using SPSS Statistical Package (Version 24). To account for multiple tests, a p-value of < 0.001 was chosen to indicate statistical significance for all statistical tests, including post-hoc comparisons.

3. Results

A total of 365 parents of adolescents from all 12 Dunedin secondary schools completed the survey. Where two parents from the same address responded, data from mothers (n = 8) were removed from the sample. In addition, participants who lacked distance to school data (n = 13) or relevant survey data (n = 1) or had an adolescent boarding at school or privately (n = 2) were excluded. Therefore, 341 parents were included in the analysis.

Participants were mostly married females with half having university education, working full time and living in families with two or more children (Table 1), with similar sociodemographic characteristics between participants who completed the online versus paper survey (data not presented). The sociodemographic characteristics of parents were similar across distance to school categories ('walkable', 'cyclable', or 'beyond cycling') with the exception of neighbourhood level socioeconomic status. Specifically, families from the least deprived neighbourhoods were more likely to live beyond walking distance to school.

On average, the children of participants were 15.1 ± 1.6 years of age, and evenly split by gender (Table 2). Approximately three-quarters of parents lived in households with two or more vehicles and nearly two-thirds had at least one bicycle that their adolescent could use to cycle to school. In the total sample, over two-thirds of adolescents used motorised transport only to travel to school, less than one-quarter used ATS only and less than one in 10 used mixed modes. Adolescents' sociodemographic characteristics, driving licence status, as well as the availability of cars and bicycles in a household were similar across the three distance to school groups, except the proportion of households with two or more cars significantly increased with increasing distance to school (Table 2). However, modes of transport to school differed significantly across the three groups with increasing rates of adolescents being driven or travelling to school by bus and decreasing rates of walking to school as the distance to school increased.

Most parents agreed that both walking and cycling to work are important (Table 3). The personal barriers associated with ATS and convenience of driving adolescents to school as part of trip-chaining practice increased from 'walking' to 'cycling' and 'beyond cycling' distance to school categories. Most statistically significant differences were between 'walking distance' versus 'beyond cycling distance' to school. Although the proportion of parents who believed that adolescents' participation in decision-making about walking and/or cycling to school varied across the three distance to school categories, approximately two-thirds of parents believed that they should be involved in making such decisions (Table 3).

Compared to perceptions of walking to school, parents perceived cycling to school to be less important, with less social support, more personal and environmental barriers and more safety concerns (Table 3). Comparisons across the three distance to school groups showed that the parental perceptions of social support for walking to school decreased whereas perceived personal, environmental and safety-related barriers increased with the increasing distance to school (Table 3). Most of the statistically significant differences were observed between 'within walking distance' and 'beyond cycling distance' categories, although clear patterns were apparent between walkable and beyond walkable distance to school (Table 3).

Similar findings were also observed for parental perceptions of cycling to school but with less consistency in statistical significance of differences across the three groups (Table 3). For cycling, parental perceptions of time constraints, the distance to school being too far for cycling, and cycling-related safety concerns were the only variables that showed statistically significant differences across the three groups as the distance from home to school increased as well as between those living within versus beyond cycling distance (Table 3).

Overall, six in 10 parents perceived that their adolescent was capable of cycling to school and over half perceived their adolescents' cycling skills to be 'very good' or 'excellent' compared to their peers (Table 4). On the other hand, two in 10 parents perceived their adolescent as incapable of cycling to school and one in 10 parents rated their adolescents' cycling skills as 'fair' or 'not good' (Table 4). Two-thirds of parents reported that their adolescents liked cycling in general and approximately one-quarter of adolescents often cycled with their friends or a surveyed parent. Parental perceptions of their adolescents' cycle skills and cycling in general did not differ across the three distance to school categories.

Table 1
Sociodemographic characteristics of parent participants.

	Total sample	Distance from adolescent's school			
		Within walking distance (≤2.25 km)	Within cycling distance (>2.25–4.0 km)	Beyond cycling distance (>4.0 km)	p-value
	(n = 341)	*(n = 74)*	*(n = 79)*	*(n = 188)*	
Age (years) (mean ± SD)	47.5 ± 5.2	47.5 ± 5.9	47.5 ± 5.2	47.5 ± 5.4	0.999
Gender (%)					
Male	22.9	27.8	24.5	22.9	
Female	77.1	72.2	75.5	77.1	0.080
Ethnicity (%)	*(n = 334)*	*(n = 72)*	*(n = 79)*	*(n = 183)*	
New Zealand European	77.2	83.3	72.2	77.0	
Māori	6.6	5.6	10.1	5.5	
Pacific	1.5	0.0	3.8	1.1	
Asian	1.5	2.8	2.5	0.5	
Other	13.2	8.3	11.4	15.8	0.171
Neighbourhood deprivation score (%)	*(n = 338)*	*(n = 73)*	*(n = 79)*	*(n = 186)*	
1 (least deprived)	35.5	31.5	19.0	44.1	
2	26.3	31.5	22.8	25.8	
3	19.2	13.7	24.1	19.4	
4	13.6	15.1	25.3	8.1	
5 (most deprived)	5.3	8.2	8.9	2.7	<0.001
Marital status (%)	*(n = 336)*	*(n = 73)*	*(n = 79)*	*(n = 184)*	
Married	72.9	72.6	68.4	75.0	
Widowed/divorced/separated	11.0	12.3	11.4	1.3	
Single and never married	3.9	5.5	6.3	2.2	
Living with partner	12.2	9.6	13.9	12.5	0.664
Employment outside home (%)	*(n = 336)*	*(n = 73)*	*(n = 79)*	*(n = 184)*	
0–15 h/week (none or less than part time)	10.7	11.0	15.2	8.7	
16–35 h/week (part time)	34.8	38.4	27.8	36.4	
≥36 h/week (full time)	54.5	50.7	57.0	54.9	0.410
Highest level of education (%)	*(n = 336)*	*(n = 73)*	*(n = 79)*	*(n = 184)*	
Less than high school	0.9	1.4	0.0	1.1	
High school	24.7	23.3	27.8	23.9	
Polytechnic degree	16.4	8.2	21.5	17.4	
University degree	55.4	63.0	46.8	56.0	
Other	2.7	4.1	3.8	1.6	0.321
Highest level of education of most educated adult in a household (%)	*(n = 336)*	*(n = 73)*	*(n = 79)*	*(n = 184)*	
Less than high school	0.0	0.0	0.0	0.0	
High school	16.7	19.2	19.0	14.7	
Polytechnic degree	16.1	11.0	13.9	19.0	
University degree	64.6	65.8	64.6	64.1	
Other	2.7	4.1	2.5	2.2	0.658
Home to school distance (km)	7.4 ± 7.7	1.2 ± 0.6 [b,c]	3.1 ± 0.5 [a,c]	11.6 ± 8.2 [a,b]	<0.001
Number of children in a family (%)					
One	15.2	10.8	17.7	16.0	
Two	48.7	52.7	41.8	50.0	
Three or more	36.1	36.5	40.5	34.0	0.457
Children's enrolment in a high school (only in families with more than one child) (%)	*(n = 56)*	*(n = 7)*	*(n = 22)*	*(n = 27)*	
Children are attending the same school	12.5	0.0	18.2	11.1	
Children attending different school	5.4	0.0	4.5	7.4	
Only one child in a secondary school	82.1	100.0	77.3	81.5	0.656

[a] $p < 0.001$ vs. within walking distance.
[b] $p < 0.001$ vs. within cycling distance.
[c] $p < 0.001$ vs. beyond cycling distance.

4. Discussion

This study compared parental perceptions of adolescents' walking versus cycling to school in an urban setting and examined whether mode-specific motivations and barriers differed by distance to school. Although the rates of ATS decreased with increasing distance to school, most parents regarded both walking and cycling to work and school to be important, irrespective of the distance. As distance to school increased, parents more frequently reported ATS-related barriers including the amount of material adolescents carry to school, the need for planning ahead, adolescents' after-school schedule and convenience of driving adolescents to school as part of trip-chaining practices. When compared to walking, parents perceived cycling to school to be less important, with less social support from parents, peers and school, less interest from adolescents, less infrastructure support and more safety concerns. As distance from home to school increased, parental perceptions of

Table 2
Sociodemographic characteristics of adolescents, household resources and adolescents' travel to school patterns.

	Total sample	Distance from adolescent's school			
	(n = 341)	Within walking distance (≤2.25 km) *(n = 74)*	Within cycling distance (>2.25–4.0 km) *(n = 79)*	Beyond cycling distance (>4.0 km) *(n = 188)*	p-value
Age (years) (mean ± SD)	15.0 ± 1.6	15.0 ± 1.5	15.0 ± 1.6	14.9 ± 1.6	0.879
Gender (%)					
Boys	48.1	41.9	53.2	48.4	
Girls	51.9	58.1	46.8	51.6	0.375
Adolescent has driving licence (%)	19.6	21.6	20.3	18.6	0.849
Number of vehicles in a household (%)					
None	1.2	2.7	0.0	1.1	
One	25.5	33.8	31.6	19.7	
Two or more	73.3	63.5	68.4	79.3	0.037
Number of bicycles that child(ren) can use to get to school at home (%)					
None	22.9	21.6	22.8	23.4	
One	16.1	18.9	15.2	15.4	
Two or more	61.0	59.5	62.0	61.2	0.966
Regular mode of adolescents' transport to school (used 'most of the time' or 'all of the time') (%)					
Car passenger	48.4	25.7	40.5	60.6	<0.001
Car driver	5.9	1.4	6.4	7.5	0.114
By school bus	11.2	1.4	7.7	16.6	<0.001
By public transport	9.2	4.1	7.7	11.8	0.001
On foot	26.6	66.2	28.2	1.2	<0.001
By bicycle	2.1	0.0	7.7	0.5	<0.001
Other	2.4	0.0	6.4	1.6	0.029
Adolescents' transport to school (%)					
Active transport only	22.3	66.2	26.6	3.2	
Motorized transport only	71.8	33.8	65.8	89.4	
Combined active and motorized transport	5.9	0.0	7.6	7.4	<0.001

social support for walking to school decreased whereas personal, environmental and safety-related barriers increased; although less consistent, similar findings were observed for cycling to school. These study findings are summarised in Fig. 1. Two-thirds of parents expected to participate in decision-making related to their adolescent's walking and/or cycling to school. Thus, understanding and differentiating the motivations for and barriers to walking versus cycling to school as perceived by parents/caregivers of adolescents are important for tailoring future ATS interventions. In other words, parents/-caregivers retain a critical role in ATS decision-making for teenagers.

Even though using only ATS is not always feasible due to distance and/or safety issues, future initiatives should consider creative ways to incite all adolescents (irrespective of their distance to school) to engage in ATS. An accessible, affordable, reliable and frequent public transport service is one of the essential elements for supporting active transport in general and reducing reliance on private vehicles (Mandic et al., 2020), and it plays an important role in encouraging ATS especially among adolescents living beyond walking and/or cycling distance to their school (Mindell, Ergler, Hopkins, & Mandic, in review). Encouraging the use of public bus (Mindell et al., in review) and/or mixed modes (Kek et al., 2019) as alternatives to private vehicle travel for school journeys would help integrate active transport into adolescents' school day routines and may contribute to higher levels of physical activity (Kek et al., 2019). However, it has been reported that parental perceptions of distance as a barrier to active commuting is often found in those who live within walkable and cyclable distances (Heelan et al., 2005). Understanding perceptions is therefore important for designing *acceptable* and *feasible* solutions. Built environment interventions such as designing safe walking and cycling routes to school with drop-off and pick-up points within reasonable walking and cycling distances to school could encourage even those adolescents living further away from school to engage in ATS as part of their school journey (Rahman et al., 2020).

Adolescent travel practices are better understood within the context of their family's activities, travel and decision-making. In the present study, most parents expected to participate in ATS decision-making for their adolescent. In addition, as distance to school increased, parents more frequently reported ATS-related personal barriers and convenience of driving adolescents to school as part of trip-chaining practices. Trip chaining occurs where multiple stops with different purposes take place along what has been reported as a single origin–destination route. Our recent work showed that half of any private vehicle trips related to adolescents' travel to/from school involved trip chaining (Keall et al., in review). It is likely that as adolescents' distance to school increases, their parents may also travel greater distances to their place of work. This means that whole-of-family travel decision making is likely to include motorised transport, with increased propensity of private car-dependence and family trip-chaining. In addition, educational policies such as requirements to enrol in the closest school or not have significant implications on adolescents' transport to school patterns (Mandic et al., 2017). Combined with

Table 3
Parental perceptions of individual, social, environmental and safety factors related to walking and cycling to school by distance to school categories.

(%)	Total sample (*n = 341*) (%)	Distance from adolescent's school ≤2.25 km (*n = 74*) (%)	>2.25–4.0 km (*n = 79*) (%)	>4.0 km (*n = 188*)	p-value (%)	Walking distance to school Yes (≤2.25 km) (n = 74) (%)	No (>2.25 km) (n = 267)	p-value (%)	Cycling distance to school Yes (≤4.0 km) (n = 153) (%)	No (>4.0 km) (n = 188)	p-value
Value of active transport											
Walking to work is important.	80.8	81.8	81.3	80.2	0.089						
Cycling to work is important.	60.7	54.1	62.9	62.1	0.708						
Walking to school is important	87.5	97.3 [c]	87.2	83.8 [a]	<0.001	97.3	84.8	<0.001			
Cycling to school is important	62.5 [*]	58.6	60.0	65.0	0.519				59.3	65.0	0.330
Personal barriers											
My child gets too hot and sweaty walking or cycling to school	27.8	20.0	20.8	33.7	0.013						
My child has too much stuff to carry to walk or cycle to school	68.5	47.1 [c]	69.4	76.6 [a]	<0.001						
It involves too much planning ahead to walk or cycle to school	30.8	7.2 [c]	22.2	43.7 [a]	<0.001						
It is not convenient for my child to walk or cycle to school because of his/her after-school schedule	56.8	24.3 [b,c]	54.2 [a]	70.9 [a]	<0.001						
Walking to school takes too much time	60.2	8.1 [b,c]	53.2 [a,c]	83.9 [a,b]	<0.001	8.1	74.7	<0.001			
Cycling to school takes too much time	44.5 [*]	2.7 [b,c]	17.8 [a,c]	72.6 [a,b]	<0.001				10.5	72.6	<0.001
My child does not want to or like to walk to school	51.5	24.3 [c]	49.4	63.2 [a]	<0.001	24.3	59.0	<0.001			
My child does not want to or like to cycle to school	68.1 [*]	62.2	73.1	68.4	0.385				67.8	68.4	0.675
Convenience											
It is easier for someone to drive my child to school, on the way to something else.	57.2	28.4[b,c]	58.3 [a]	68.1 [a]	<0.001						
Social support											
As parents, we encourage our child to walk to school	46.2	88.6 [b,c]	56.9 [a,c]	25.0 [a,b]	<0.001	88.6	34.3	<0.001			
As parents, we encourage our child to cycle to school	17.1 [*]	24.6	25.0	1.9	0.003				24.8	10.9	0.009
I do not want my child to walk to school	38.2	5.4 [b,c]	23.1 [a,c]	57.4 [a,b]	<0.001	5.4	47.4	<0.001			
I do not want my child to cycle to school	64.9 [*]	47.3	65.4	71.7	0.001				56.6	71.7	0.002
Friends encourage my child to walk to school	20.6	44.3 [c]	33.3 [c]	5.7 [a,b]	<0.001	44.3	13.8	<0.001			
Friends encourage my child to cycle to school	4.8 [*]	7.4	9.7	1.7	0.004				8.6	1.7	0.006
No other teenagers walk to school	23.7	4.1 [c]	9.0 [c]	37.8 [a,b]	<0.001	4.1	29.3	<0.001			
No other teenagers cycle to school	40.2 [*]	28.4	4.5	44.9	0.002				34.6	44.9	0.003
The school encourages my child to walk to school	24.5	44.2 [c]	3.6	14.4 [a]	<0.001	44.2	19.1	<0.001			
The school encourages my child to cycle to school	12.4 [*]	16.2	15.3	9.8	0.006				15.7	9.8	0.002
In my neighbourhood many teenagers walk or cycle to school.	47.0	88.6 [b,c]	50.0 [a,c]	29.4 [a,b]	<0.001						
In my neighbourhood, many parents walk or cycle to work.	24.9	47.6 [c]	25.4	15.7 [a]	<0.001						
Environmental barriers											
It is too far for my child to walk to school	63.0	2.7 [b,c]	46.8 [a,c]	93.6 [a,b]	<0.001	2.7	79.8	<0.001			
It is too far for my child to cycle to school	51.3 [*]	2.7 [b,c]	22.8 [a,c]	82.4 [a,b]	<0.001				13.1	82.4	<0.001
There are no footpaths along the way	35.0	4.1 [c]	12.7 [c]	56.7 [a,b]	<0.001	4.1	43.6	<0.001			
There are no cycle paths along the way	73.5 [*]	65.8	72.2	77.0	0.241				69.1	77.0	0.198
Safety perceptions											
It is unsafe for my child to walk to school	35.0	5.7 [c]	15.7 [c]	54.6 [a,b]	<0.001	5.7	43.4	<0.001			
It is unsafe for my child to cycle to school	64.6 [*]	38.6[b,c]	70.0 [a]	73.0 [b]	<0.001				54.3	73.0	<0.001
Decision making											
It is up to my child to decide if he/she walks or cycles to school.	42.6	44.3	56.9	36.0	0.002						
It is up to the parents to decide if their child walks or cycles to school.	68.2	67.1	72.2	67.0	0.871						

P-values from ANOVA are reported in this table. For clarity, data are presented as proportion of participants who agreed with each statement.

[*] $p < 0.001$ vs. corresponding statement for walking to school in the total sample.

[a] $p < 0.001$ vs. within walking distance.

[b] $p < 0.001$ vs. within cycling distance.

[c] $p < 0.001$ vs. beyond cycling distance.

Table 4
Parental perceptions of adolescents' cycle skills and cycling in general across the three distance to school categories.

		Total sample	Distance from adolescent's school			p-value
			Within walking distance (≤2.25 km)	Within cycling distance (>2.25–4.0 km)	Beyond cycling distance (>4.0 km)	
		(%) (*n = 341*)	(%) (*n = 74*)	(%) (*n = 79*)	(%) (*n = 188*)	
To what extent do you see your child as being capable of riding a bicycle to school?	(*n* = 318)	(*n* = 70)	(*n* = 71)	(*n* = 177)		
	Incapable (not able to)	19.8%	11.4%	16.9%	24.3%	
	Neutral	18.9%	21.4%	14.1%	19.8%	
	Capable (able to)	61.3%	67.1%	69.0%	55.9%	0.104
In general, compared to other children of your child's age, how would you rate your child's cycling skills?						
	Not good at all	5.0%	5.4%	5.1%	4.8%	
	Fair	5.9%	1.4%	1.1%	5.9%	
	Average	29.3%	28.4%	34.2%	27.7%	
	Very good	32.8%	36.5%	26.6%	34.0%	
	Excellent	25.2%	27.0%	22.8%	25.5%	
	I do not know	1.8%	1.4%	1.3%	2.1%	0.645
My child likes bike riding		66.3%	59.5%	71.8%	0.063	
My child often cycle with his/her friends		22.0%	17.4%	18.1%	25.4%	0.295
I often cycle with my child		26.4%	23.0%	24.1%	28.7%	0.055

findings previously reported among New Zealand adolescents (Emond & Handy, 2012), the current findings suggest also the relevance of understanding individual perceptions of ATS as part of a broader socialisation process through which adolescents' attitudes toward walking and cycling are shaped, at least in part, by their parents' attitudes.

Compared to walking, parents surveyed in this Dunedin study perceived cycling to school to be less important, with less social support from parents, peers and school, less interest from adolescents, less infrastructure support and more safety concerns. These findings extend similar findings previously reported among New Zealand urban adolescents living within 4 km from their school (Mandic et al., 2017) suggesting that walking and cycling have their own unique mode-specific personal, social, environmental and policy determinants which may also vary across countries, regions or cities/towns. For example, in New Zealand, it is illegal to cycle on footpaths; given the limited availability or absence of separated cycleways in New Zealand towns and cities, adolescents cycling to school are thereby forced to share the roads with motorised traffic during peak commuting times.

As distance to school increased, parental perceptions of social support for walking to school decreased whereas personal, environmental and safety-related barriers increased. Although less consistent, similar findings were observed for cycling to school. These findings are consistent with and extend the conclusions from a recent systematic review that identified built environment characteristics, distance, traffic safety and motivation barriers are the main barriers to ATS reported by parents of adolescents (Aranda-Balboa et al., 2019). It is also worth noting that parental perceptions of their adolescents' cycle skills and cycling in general did not differ across the three distance to school categories. This means that parental confidence in their adolescent's cycling skills may not be sufficient to mitigate the increasing perceived barriers for cycling associated with greater distance to school even when living within a reasonable distance to school. Among other things, the hilly terrain, required school uniforms, and lack of cycling infrastructure are barriers to cycling in Dunedin that would be magnified as distance to school increases (Hopkins & Mandic, 2017; Mandic et al., 2017).

4.1. Implications

These findings have implications for future studies and efforts to encourage ATS among adolescents. Rather than considering walking and cycling to school as one common active transport mode (Aibar et al., 2018; Huertas-Delgado et al., 2017; Hume et al., 2009), they need to be examined separately and may require distinct strategies to address mode-specific barriers.

Distance to school should be taken into account as some ATS barriers such as traffic safety concerns, convenience of driving, and convenience of trip-chaining increase as distance to school increases. The impact of actions taken to minimise traffic and safety concerns within school neighbourhoods, and address other personal barriers while strengthening social support for ATS is likely to be enhanced by harnessing the value that parents attach to ATS, which was evidenced in this study.

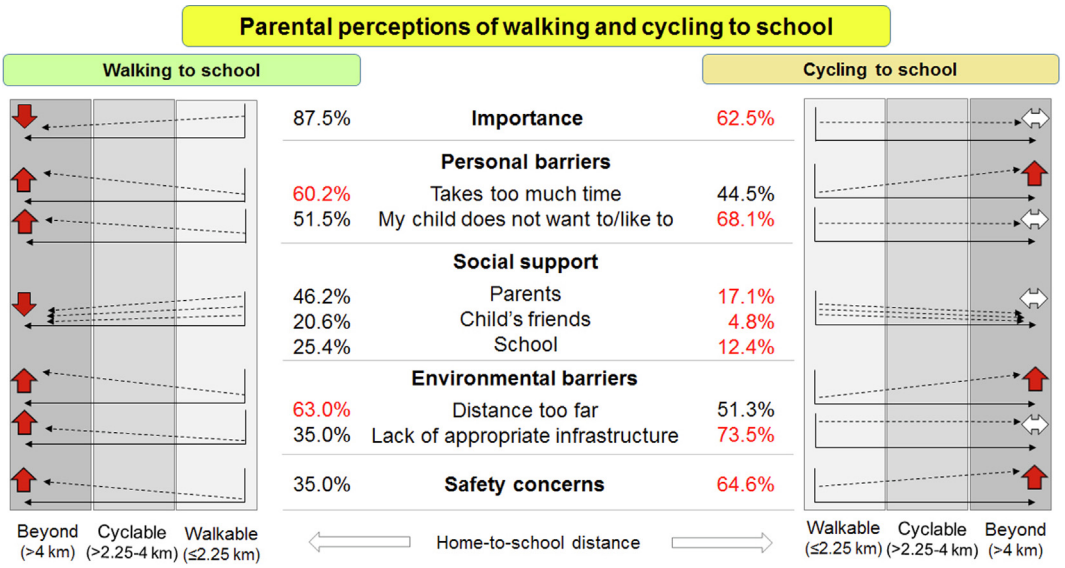

Fig. 1. Parental perceptions of walking and cycling to school and differences by distance to school.

Our findings highlight the importance of improving traffic safety for adolescents living within cycling distance to school. Parental concerns for cycling-related traffic safety are greater than for walking to school. Compared to other age groups, adolescents in New Zealand (Ministry of Transport, 2015) and Australia (Boufous, Rome, Senserrick, & Ivers, 2011) have the highest rates of bicycle-related crashes. In New Zealand, approximately one in five cyclists who die or are injured in traffic crashes are between 10 and 19 years of age (Ministry of Transport, 2015). Minimising parental safety concerns is particularly relevant for adolescents living beyond walkable but within reasonable cycling distance to school. Traffic safety-specific initiatives (such as mode separation infrastructure, creating safe routes to school, reducing distance to school by locating future schools in proximity to or within residential areas, and/or considering policy interventions such as school zoning) could help in part to minimize traffic safety concerns of adolescents and their parents related to both walking and cycling to school.

Finally, strategies need to be designed to enable adolescents living beyond walking and cycling distance to school to integrate ATS as part of their daily school journey. Some of the strategies could include creating safe routes to school with drop-off/pick-up points within reasonable walking/cycling distance from secondary schools as well as providing accessible, affordable and convenient public transport.

Taken together, the findings from this study further reiterate the importance of considering family factors, including parental perceptions of different modes of transport to school and parental concerns related to walking and cycling to school, when designing initiatives to encourage ATS among adolescents. The findings also highlight the importance of understanding the local social, cultural, regulatory, natural and built environment context considering that reasonable walking and cycling distances to school and walking and cycling-specific barriers vary between cities, regions and countries. These results are relevant not only to researchers but also to transport agencies, urban planners, city councils, schools as well as health promoters.

4.2. Study strengths and limitations

Strengths of this study include comprehensive data on parental perceptions of walking and cycling to school assessed separately for each transport mode, objective measurements of distance to school, recruitment of parents from all 12 secondary schools in the study city and analysis of parental perceptions across mode-specific distance to school categories for adolescents drawing upon local data and using available international evidence to assist with interpretation of findings.

However, several limitations should be acknowledged including data collection from only one parent per household at a single point in time, a relatively small sample size, lack of detail for complex trips (e.g. where trip chaining is used), non-probability sampling procedures, and lack of differentiation between parental (fathers) versus maternal (mothers) perceptions and between parental concerns regarding ATS-related traffic versus personal safety. For example, previous research showed that mothers perceived different barriers to adolescents' ATS compared to fathers living in the same household (Aibar et al., 2018); recruiting similar numbers of mothers and fathers would allow for replication studies. Given the relatively small sample size and non-probability sampling procedures, the sample may not be representative of parents in the community. Although examination of parental perceptions of both traffic and personal safety related to ATS in adolescents would have been desirable, this study collected only generic information about safety perceptions due to schools' concerns related to asking their students and/or parents more specific safety-related questions as part of our study. In addition,

though this analysis identified parental perceptions that varied by mode choice and across distances, we did not examine which perceptions were more salient in each of the distance categories according to mode choice. Finally, this study focused exclusively on the perception of parents. Future studies with a larger sample size should examine whether distance to school moderates adolescents' and their parents' perceptions of walking and cycling to school in different geographical areas including hilly/flat areas and a range of urbanisation settings. Future studies should also take into account access to and availability of public transport beyond cycling distance to school.

5. Conclusions

Parents favoured their adolescents walking compared to cycling to school. Parental perceptions of both modes of ATS differed based on how far families lived from the adolescent's school. As distance to school increased, so did parents' reported ATS-related barriers. Parents of households beyond cycling distance to school (>4 km) perceived less social support and more personal, environmental, and safety-related barriers to walking compared to those living within walking (≤2.25 km) or cycling (>2.25–≤4 km) distance to school. These findings suggest that future efforts to promote ATS among adolescents should be mode-specific and take into account how far adolescents live from their school. To be successful, ATS initiatives should also make an effort to engage parents of adolescents, understand their perceived barriers to ATS in the local context, and address or minimize parental concerns since parents play a critical role in ATS decision making for teenagers.

CRediT authorship contribution statement

Sandra Mandic: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Visualization, Writing - original draft, Writing - review & editing. **Debbie Hopkins:** Conceptualization, Methodology, Writing - review & editing. **Enrique García Bengoechea:** Conceptualization, Funding acquisition, Methodology, Writing - review & editing. **Charlotte Flaherty:** Conceptualization, Investigation, Writing - review & editing. **Kirsten Coppell:** Conceptualization, Writing - review & editing. **Antoni Moore:** Data curation, Funding acquisition, Resources, Writing - review & editing. **John Williams:** Funding acquisition, Methodology, Writing - review & editing. **John C. Spence:** Conceptualization, Funding acquisition, Methodology, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The BEATS Research Programme is a collaboration between Dunedin Secondary Schools' Partnership, Dunedin City Council and University of Otago. We acknowledge our research team members, the members of the BEATS Study Advisory Board, research personnel (research assistants, students and volunteers), and all participating schools, parents and students.

Funding

The BEATS Study was supported by the Health Research Council of New Zealand Emerging Researcher First Grant (14/565), National Heart Foundation of New Zealand (1602 and 1615), Lottery Health Research Grant (Applic 341129), University of Otago Research Grant (UORG 2014), Dunedin City Council and internal grants from the School of Physical Education, Sport and Exercise Sciences, University of Otago.

Data 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 been given assurances that the collected data will not be shared.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.trf.2020.04.013.

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