



An integrated conceptual model of environmental needs for New Zealand children's active travel to school

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ABSTRACT

Introduction: Active school travel (AST) is important for child and environmental health. In New Zealand, AST has declined over recent decades and is relatively low compared to many other countries. A plethora of evidence related to children's AST exists, yet a holistic and context-specific understanding of factors related to the behaviour remains elusive. The aim of this study is to triangulate data from children, their parents, school representatives, and objectively-assessed environmental features to generate a model that enables a comprehensive understanding of associates of AST in New Zealand children, how these variables interrelate with each other, and where change can occur.

Methods: Data were drawn from recent investigations conducted with children, parents/caregivers, and school representatives, and studies examining objectively-assessed built environment characteristics in relation to AST. Findings were summarised, aggregated, and triangulated, with a focus on themes where consistent findings were observed across data sources or respondents (i.e., children, parents, school representatives, geographic information systems (GIS)-derived variables). Links between variables were investigated and integrated into the final model.

Results: Distance from home to school and ensuring child safety were prevailing factors associated with children's AST. School policies, practices, partnerships and culture play an integral role in supporting children's AST, and in some cases can mitigate environmental barriers. An active community culture, positive neighbourhood social relations, and links between the school and community are important elements to support AST.

Conclusion: This research demonstrates the complexity of AST and reinforces that interventions for increasing active travel modes need to be multi-faceted and not isolated projects. Cross-sector

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approaches that are sustained over time are needed to facilitate meaningful change in AST. Strategic resourcing and national targets for AST rates may be effective ways to harness commitment across sectors and ensure actions to address the needs presented are operationalised.

1. Introduction

1.1. The importance of children getting to school actively

Active school travel (e.g., walking, cycling, or scooting to/from school) is associated with numerous physical and social benefits to children and their broader communities. At the individual level, active school travel is related to increased physical activity (Faulkner et al., 2009; Larouche et al., 2014b; Oliver et al., 2016; Schoeppe et al., 2013), cardiovascular health (Larouche et al., 2014b). There is also some support for links between active school travel and maintenance of a healthy body weight, although conflicting evidence exists (Faulkner et al., 2009; Larouche et al., 2014b). At the community level increasing active school travel can support social connections, urban vitality, and safety through increased presence of people 'out and about,' (Mandic et al., 2019; World Health Organization, 2018) which in turn challenges the dominance of automobility (Sheller and Urry, 2003). In terms of environmental health, replacing motorised school trips with active modes results in reduced traffic congestion and reduced emissions of air pollutants, noise, and greenhouse gases (Mandic et al., 2019; World Health Organization, 2018).

Despite these benefits, active school travel in children and youth in New Zealand/Aotearoa (hereafter New Zealand) has declined significantly over recent decades to the point that less than half of children and young people travel actively for the school journey (Smith et al., 2018). In Auckland alone (New Zealand's most populated city, with one-quarter of the country's population), approximately 260,000 children travel to Auckland schools every day (Auckland Transport, 2019). These statistics demonstrate the considerable untapped potential to shift to active modes for a substantial proportion of current motorised school journeys.

1.2. A socio-ecological approach to understanding active school travel

Numerous reviews reveal the complexity of active school travel, including the range of factors related to active school travel and heterogeneity in study designs and methods; as well as the geographic, cultural, and social differences that exist (Chillón et al., 2011; Egli et al., 2018; Ikeda et al., 2018a; Larouche et al., 2018; Panter et al., 2008; Rothman et al., 2018; Smith et al., 2017; Wong et al., 2011). These reviews show that variables related to active school travel exist across the socio-ecological spectrum. Individual factors include sex (males more than females), age (often an inverted U-shaped relationship with younger children and adolescents least likely to actively travel to school) and ethnicity (in New Zealand, children of Pacific or Māori ethnicities have traditionally had higher levels of active school travel than their peers) (Ministry of Health, 2017). At the household level, access to cars and bikes, family structure, parent/caregiver (hereafter parent) perceptions, and residing in areas of lower socio-economic status (SES) are consistently related to school travel mode. It is worth noting these relationships are not static – for example, in recent decades in New Zealand, children residing in lower SES areas were more likely to actively travel to school, however current evidence suggests shifts are occurring and the reverse scenario could be becoming more common-place (Smith et al., 2019). At the community level, school policies, practices, and physical environments have been the primary area of focus in active school travel literature (Moodie et al., 2011; Wen et al., 2008). Little is known of community contexts beyond the school environment (Buliung et al., 2011). Broader political contexts play an integral role, for example through school siting policies and transport funding allocation (e.g., prioritised budgets for motorised vehicle infrastructure versus that for walking and cycling).

Increasingly, researchers and practitioners have been focusing on perceived and objectively-assessed built environment associates of school travel behaviours, in recognition of the significant potential for infrastructure and urban design to have sustained and meaningful impact on travel behaviours. Unsurprisingly, distance to school is consistently a key associate of travel mode to school (Ikeda et al., 2018a; Rothman et al., 2018; Wong et al., 2011). A range of other built environment features have been related to children's active school travel, including streetscape elements conducive to safety for children's walking and cycling, street connectivity, street quality, and destination accessibility (Christian et al., 2015; Moran et al., 2015; Oliver et al., 2015; Pocock et al., 2019; Smith et al., 2017). Yet, consistency in associations and a comprehensive understanding of these relationships remains elusive (Larsen et al., 2016; Wong et al., 2011). Importantly, evidence suggests a need to understand both perceptions and objective measures of environment features in order to evaluate adequately the role of the built environment on active travel behaviours (Bozovic et al., in submission; Carver et al., 2008; Smith et al., 2019a).

A range of theoretical models focus on understanding children's school travel behaviour, the most recent being the Children's School Travel Behaviour Model (C-STBM) (Ikeda et al., 2019). The C-STBM takes a socio-ecological approach (Sallis et al., 2006) to understanding active school travel, building on earlier models of Mitra (2013), McMillan (2005), and Buliung and Kanaroglou (2007). The model recognises the dynamic relationships between individual characteristics, household/parent factors, and broader school, social, and physical environments and children's active school travel. Substantive behavioural change theories also exist to explain individual decision making processes regarding health behaviours, including social cognitive theory (Bandura, 1986), the behavioural ecological model (Ginja et al., 2018), the theory of planned behaviour, and the transtheoretical (stages of change) model (Marcus and Simkin, 1994). However a gap remains in comprehensive models to understand how active school travel can be changed or facilitated (i.e., what strategies might work best and why), rather than factors that are associated with the behaviour.

1.3. Research aim

While a plethora of evidence related to children's active school travel exists internationally, a holistic understanding of factors related to active school travel from multiple perspectives remains elusive. Context-specific insights are needed to inform effective and meaningful interventions for specific populations. The aim of this study is to triangulate data from children, their parents, school representatives (principals or delegates), and objectively-assessed environmental features to generate a model that enables a comprehensive understanding of associates of active school travel in New Zealand children, how these variables interrelate with each other, and where change can occur.

2. Methods and data sources

Data are drawn from recent published findings (2018 onwards) from New Zealand studies focusing on children's active school travel as detailed below. Findings from these studies were integrated and triangulated to develop a model that proposes interrelationships between key variables in the built and social neighbourhood environments that are important for children's active school travel. Attention was paid to consistency in findings across data sources or respondents (i.e., children, parents, school representatives, geographic information systems (GIS)-derived variables), and identification of links between variables and outcomes.

2.1. Neighbourhoods for Active Kids (NfAK)

NfAK is a cross-sectional survey of 1102 Auckland children in school years 5–8 (ages 8–13 years), their parents/caregivers, and school representatives. Detailed methods have been described previously (Oliver et al., 2016). Schools were invited to participate in the study using a matrix of child-specific walkability (Giles-Corti et al., 2011), area-level socio-economic status (Ministry of Education), and child-specific destination accessibility (Badland et al., 2015) to ensure socio-demographic and geographic heterogeneity. Overall 19 schools across nine neighbourhoods participated in the study. Data were collected between February 2015 and December 2016. Ethical approval to conduct the study was provided by the host institution ethics committees (AUTEK, 14/263, September 3, 2014; MUHECN September 3, 2014; UAHPEC September 9, 2014).

Children were visited in the school setting and completed an online participatory GIS survey. The survey included items on neighbourhood perceptions, usual mode of travel to school, and involved children mapping their usual route to school. Open ended items asked about children's likes and dislikes about their usual route to school, as well as what they liked to do on their school journey. Comments were analysed using content coding to understand key factors of importance from children's perspectives (Egli et al., 2019).

Parents completed a computer-aided telephone interview (CATI) including socio-demographic information, neighbourhood perceptions, and usual mode of travel to and from school. The trip to school is the focus of this research, as it was theorised to have less variability in reasons for travel modes (e.g., through less trip chaining, after-school activities, etc.). Neighbourhood perceptions were measured using items previously used in research with Auckland children and their parents (Lin et al., 2017). These items were drawn from the work of Sampson et al. (1999) and were used to generate measures of perceived neighbourhood safety, cohesion, and connection (together conceptualised as the neighbourhood social environment).

Parents were asked "What are the main reasons [he/she] goes by [transport mode]" for the trip to school, and from school. Thirteen potential response options (plus an open ended "other" category) were generated from previous research with Auckland children and their families (Oliver et al., 2011). Parents were also asked "How important would you say this reason is when deciding how your child gets to school" for each reason. Responses were on a 4-point Likert scale with the following options: not important, a little important, important, very important.

Parent-reported neighbourhood needs to enable their children to walk, cycle, or scooter around their neighbourhood independently were assessed using an open ended item "What would make your neighbourhood a better place for [child name] to walk, bike or scooter by [himself/herself]?" (Smith et al., 2019a). Parents could mention more than one element, or choose not to respond. Content analysis was used to generate a framework of parent-reported needs for children's independent active travel.

School representatives (principal or delegate) were interviewed in person or via telephone with a focus on school policies and practices related to active school travel. Interviews were transcribed verbatim and inductive and deductive thematic analysis conducted to identify key themes (and connections between these themes) related to active school travel.

Neighbourhood built environment measures along the child-mapped school route and around the school were generated using ArcGIS 10.2. An 80 m buffer from the road centreline was used in order to capture key destinations of potential importance to children along their school route (Ikeda, Mavoa, et al., 2018). Measures generated included residential density, street connectivity (ratio of number of intersections with three or more street connections to the land area), and traffic exposure (using road hierarchy as a proxy). Structural equation modelling was employed to assess the direct and mediating pathways between individual, household/parent, and environmental factors and children's active school travel (Ikeda et al., 2019).

2.2. Healthy Future Mobility Solutions: active school travel

The aim of this research was to evaluate the impact of a school travel plan (including minor infrastructural works) on children's active travel to school and related outcomes. Fundamental to this work was the collation of literature and stakeholder perspectives to support the research process, contextualise the research, and aid interpretation of findings. The current examination draws from two activities from this study as below.

A systematic meta-analysis was undertaken to provide an in-depth understanding of how self-reported active travel modes (i.e., walk, cycle, scooter, skateboard) were associated with objectively measured neighbourhood built environment features (e.g., residential density, street connectivity, distance to school) using GIS in New Zealand (Ikeda et al., 2018c). The meta-analysis included five studies across four major cities (Auckland, Wellington, Christchurch, Dunedin) involving 2844 children and youth aged 6–19 years.

Key informant interviews were conducted with school representatives (principal or delegate) of nine “exemplar” schools across six regions in New Zealand with higher-than-average active school travel rates (i.e., reporting approximately 40–60% of students travelling to school actively) (Hawley et al., 2019). The aim of these interviews was to explore what might be unique or different about these exemplar schools and the factors that were perceived to support or encourage active school travel in each context. Interviews were conducted either in person or via telephone, transcribed verbatim and analysed thematically. Interviews were conducted between September 2016 and May 2018. Ethical approval was provided by the Massey University Ethics Committee.

3. Results

Despite substantial variation in measures, respondents, and study foci, a number of consistent over-riding themes were observed across these studies, as outlined in Table 1 and detailed below.

3.1. Children’s perceptions regarding active school travel

Key topics identified from children’s perceptions about their routes to school related to: the built, natural, and social environments; safety (from traffic and personal safety); travel modes and trip characteristics; and activities undertaken during the trip (Egli et al., 2019). Distance to school was most frequently mentioned, in positive and negative ways, and in relation to distance being short or long (“It’s fast and it’s the closest way to get to school”; “its far so it gives me time to talk to my friends”). Children appreciated the opportunity to spend time with friends and family (“i like that we get to pick up my friend so we can walk together”; “Wednesday and Thursdays and Friday I walk to school with my mum and talk with her”). Conversely, the transport/traffic environment was frequently mentioned in a negative light (“it’s hard to check to see if cars are coming when crossing the streets”; “cars are speeding past me when I and other kids are trying to cross the road”; “Car fumes”).

3.2. Parents/caregivers perceptions regarding active school travel

Having a safer traffic environment was the main parent-reported requirement to enable their children’s independent active travel

Table 1
Individual study findings in relation to key themes related to active school travel.

Respondent or data source	Key themes related to active school travel					Reference
	Distance to school	Unsafe traffic environments ^{a,b}	Concerns for child’s personal safety ^{a,c}	School setting ^{a,d}	Social environment ^{a,d}	
Neighbourhoods for Active Kids:						
1102 Auckland children aged 8–13 years	↓ (perceived)	↓	↓	x	↑	Egli et al. (2019)
940 Parents of Auckland children aged 8–13 years	↓ (perceived)	↓	↓	x	↑	Smith et al. (2019a) Smith et al. (2019b).
1085 Auckland children aged 8–13 years and their parents	↓ (objective)	↓	↓	n/a	↑	Ikeda et al. (2019)
19 school representatives from Auckland schools	x	↓	x	↑	x	(Ikeda et al., in submission)
Healthy Future Mobility Solutions:						
Nine school representatives from schools across six regions in New Zealand	x	↓	x	↑	↑	Hawley et al. (2019)
2844 children and youth aged 6–19 years across New Zealand	↓ (objective)	x	n/a	n/a	n/a	Ikeda et al. (2018c)

Notes: n/a, not assessed; ↑ = related to increased active school travel; ↓ = related to decreased active school travel; x = no relationship reported/observed.

^eChildren appreciated time with family and friends, adults reported on the importance of social cohesion and connectivity, and an active community culture.

^a Perceived measures were reported in all studies.

^b Consistent topics included concerns about safety crossing roads, traffic speeds and volume, and the need for safe places/infrastructure that supported active modes.

^c Including concerns about safety from others (antisocial behaviour, bullying) and from dogs.

^d Key factors were school policies, programmes, partnerships, and school and individual leadership.

(50%) (Smith et al., 2019a). Specifically, parents noted a need for less, slower and safer traffic (19.9%), more pedestrian crossings (13.4%), more designated cycle lanes (9.8%), and more and better walking paths (7.2%). Safety from others was the second most frequently reported need by parents (12%; fear of stranger danger, a need for greater community surveillance, and safety from criminal activity occurring in the neighbourhood, bullying and anti-social behaviour).

Distance to school followed by convenience were the primary reasons for mode of travel to school, irrespective of whether children travelled actively or by car (Smith et al., 2019b). For car travel, safety from others (15%) and from traffic (14%) were the third and fourth most common reasons, respectively. For active modes, promoting their child's health and fitness (28%) and promoting their independence (10%) were the third and fourth most frequently noted reasons, respectively. Importance of traffic safety (standardized parameter estimate = -0.14) and importance of convenience (standardized parameter estimate = -0.18) were both directly associated with active school travel in structural equation modelling ($p < 0.01$) (Ikeda et al., 2019). Conversely, positive parent perceptions of neighbourhood safety (standardized parameter estimate = 0.17, $p < 0.01$) and the overall neighbourhood social environment (standardized parameter estimate = 0.11, $p < 0.05$) were directly and positively associated with their child's active school travel.

3.3. School representative perceptions regarding active school travel

The concept of safety was strongly embedded in school policy and practices as well as other matters related to school travel (i.e., 'pedestrian crossings', 'traffic volume and speed', 'pedestrian and cycling infrastructure', 'education' and 'partnership') (Ikeda et al., in submission). These issues were closely linked with each other and never stand-alone. School policy and practices around school travel (e.g., drop-off/pick-up rules, school patrols) were primarily designed to ensure students' safety ("*The policy is, that obviously it's vital the kids are safe first and foremost getting to and from school*"). Pedestrian crossings were specifically identified as the setting where potential dangers and risks existed during school travel. Crossings on busy roads (with high traffic volume and speed) were often manned and patrolled by teachers and/or students ("*We have children working on the crossing so we encourage kids to cross there it's got a teacher manning it every day*"). Community constables, Auckland Transport, and the Auckland Council supported the schools to provide road safety education for students ("*We have that road safety programme that takes place in the school every year*"). Built environment features such as traffic calming and traffic islands, mainly funded by the Auckland Transport as part of the Travelwise programme, were likely to reduce traffic flow and improve safety for pedestrians ("*We've had another thing that's made the area safe is the speed bumps put in around the area which slow people down*"). Critical concerns still existed such as a lack of pedestrian crossings and cycle lanes around school which might prevent the schools from encouraging students to actively travel to school.

Similarly, interviews with exemplar schools revealed interconnections between the school, community, and physical environment, whereby these elements appeared to reinforce each other positively to facilitate active school travel (Hawley et al., 2019). This finding was common across schools; however, there was nuanced variation in the 'mix' of these elements across schools and not all elements were strongly evident in all contexts. School policies, practices, partnerships, and an active community culture were important contributing factors for active travel modes. In some instances, these enablers were so ingrained that these were not 'front of mind' for school representatives, but rather taken for granted as the norm. This was also reflected in comments about the broader community culture, where being active was seen to be customary, and facilitated by the physical environment ("*We didn't do anything, we just work here and we've got this amazing community. It's so well structured to allow safe travel and it's pretty*"). In other schools, active school travel was actively prioritised and promoted in the context of aligning with school values and opportunities for student learning. Partnerships with community providers and projects to implement supportive infrastructure further enabled active travel modes ("*We have a very symbiotic partnership where we work with the community centre to support our families in as much as we can in order that the kids will be achieving better at school.... it all comes back to how do our kids learn in the classroom*"). Schools supported active school travel as long as a perceived traffic safety threshold was met, which included safe places to cross, walk, and cycle; low traffic speeds; and quiet routes that avoided main roads. The combination of an active community culture with good infrastructure was identified as being a powerful support for active school travel ("*... it feels family-focused, it feels like if you're out on a sunny day everybody and their dog is out walking and running, it's very active, friendly. And the infrastructure is there, and we've got the bike paths or the footpaths to do it safely.*")

While not overt, an interesting pattern regarding the impact and importance of individual leadership was observed across the two studies. Variation was observed in the NfAK study regarding supports and mechanisms for promoting active school travel. Often, the success or existence of activities relied on an individual who had a personal interest in supporting active school travel and worked closely with partners such as local Councils to generate change. Conversely, most exemplar schools appeared to have reached a self-reinforcing 'level' of active school travel, where school and community culture elements were strong, removing the need for overt individual leadership because of shared responsibility and alignment with school and community values.

3.4. Associations between objectively-assessed built environment features and active school travel

National meta-analysis findings showed active school travel was positively associated with residing closer to school and residing in neighbourhoods with more connected streets, less residential density, and lower socio-economic status (Ikeda et al., 2018c). The greatest impact was for distance to school whereby almost no children and young people living further than 2.3 km from school actively travelled to school. Distance to school also had the strongest direct association with active school travel (estimate = -1.02, $p < 0.01$) in structural equation modelling for children in the NfAK study (Ikeda et al., 2019). Moreover, distance to school fully mediated the pathway between the active mobility environment (comprising residential density, street connectivity, and traffic exposure (using road hierarchy as a proxy (Giles-Corti et al., 2011)) and active school travel.

3.5. Triangulation of results

Based on triangulation of the individual study results detailed above we propose an interrelationship between five key variables (Fig. 1). The data triangulated here demonstrate the clear role of distance to school and traffic environments in children's active school travel. Based on the evidence presented, children living more than 2.3 km from school are unlikely to travel to school actively. Parents also reported distance to school as a primary reason for their children travelling to school using motorised modes, even when children lived within this 2.3 km threshold. Triangulation of findings also showed that where the route to school is perceived as being not safe from traffic or others (e.g., older children, bullies, criminal and gang activity, roaming dogs), children are less likely to be able to actively travel to school. Beyond these feasibility aspects of the journey (in terms of distance and getting to school safely), school (policies, practices, partnerships, environments) and community (active culture) play an integral role in facilitating active school travel, and might also mitigate or overcome some of the distance and safety barriers.

Explanatory notes: *Personal safety* factors focused on safety from others, including older children, bullies, criminal and gang activity, roaming dogs, and general antisocial behaviour. Potential strategies include Crime Prevention Through Environmental Design. *Traffic safety* included concerns about safety crossing roads, traffic speeds and volume, and the need for safe places/infrastructure that supported active modes. Potential strategies include legislating for slower speeds; and fiscal and practical prioritisation of infrastructure that provides children safe places to cross roads, traffic calming infrastructure, separated cycleways, and complete, wide, and connected footpaths that allow for multiple users to walk safely. *Distance to school* has a pervasive role in discouraging active school travel. Potential strategies include increasing safe cycling infrastructure (connected cycleways that are separated from traffic), improving access to and availability of public transport, schools implementing zoning strategies, and maintaining and advocating for local schools nested within communities. *School factors* included policies, programmes, partnerships, and school and individual leadership, and *social factors* included an active community culture, social cohesion and connectivity, and relationships.

Potential strategies are suggested, with **arrows** in the figure depicting where opportunities for change/intervention may occur, and examples provided below:

A = Recreational facilities proximal to schools (e.g., mountain bike parks), spaces and events for community connection, use of school grounds/facilities for active community events, school travel initiatives that reflect community culture

B = Supporting active school travel programmes (walking school buses, cycle trains), partnering with Police for safety skills development

C = Crossing guards, integrated curriculum – safety, cycle skills training, leadership programmes, walking school buses and cycle trains, traffic management policies, lobbying and collaboration, partnering with community providers for school travel programmes and infrastructural works interventions

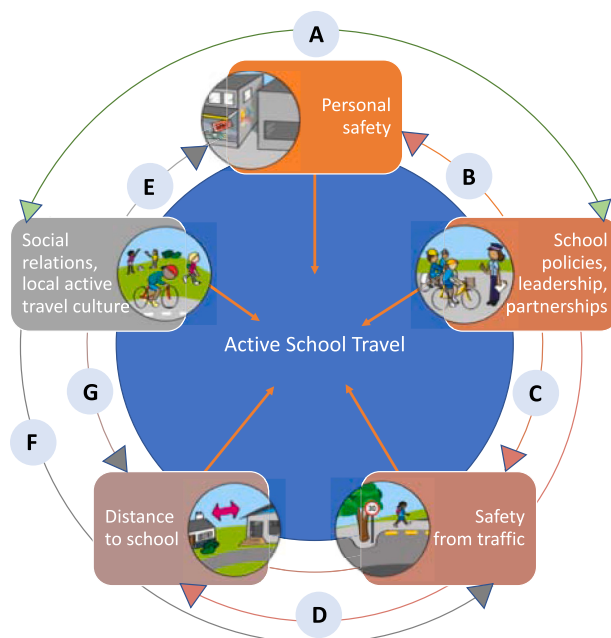


Fig. 1. Conceptual model depicting the 'key ingredients' for active school travel and the interrelationships between variables.

D = Zoning regulations, park and walk, bikes in schools, cycle skills training, bike/scooter/skateboard parking, wheels during breaks, bike trains, integrated curriculum – health & sustainability
 E = People being active in the community contributing to surveillance
 F = People being active in the community contributing to a critical mass of pedestrians and cyclists for improved safety from traffic; community culture of valuing active school travel and taking responsibility for improved driver behaviour
 G = Community culture of supporting and participating in walking school buses, cycle trains, community groups supporting school park and walk/ride initiatives

4. Discussion

Findings from this research align with previous studies demonstrating the importance of distance, safety from traffic, personal safety, school factors, and community/social factors in supporting children's active school travel (Chillón et al., 2014; Larouche et al., 2014a; McDonald et al., 2010; Wilson et al., 2018; Wong et al., 2011). This study advances on earlier research by triangulating data from a range of sources to generate a more comprehensive and context-specific understanding of how these factors are interrelated. Findings show that children's school travel behaviour is complex, multifaceted, and likely influenced by factors both within and outside the school environment. Results suggest that one solution will not fit all individuals, their families, or their school communities and that context-specific knowledge and solutions are important (Larouche et al., 2015). Based on these and previous (Chillón et al., 2011; Larouche et al., 2018; Pang et al., 2017) findings, it is contended that meaningful behaviour change is more likely where interventions are connected, comprehensive and consider both the built and social environment. Triangulation of data sources showed that school policies and partnerships, community culture and social relations, and the built environment were intrinsically linked. Beyond the proposed feasibility factors (distance, traffic safety, personal safety) developed here, it is suggested that school and community factors probably enhance or dilute the impact of any interventions and there will be nuanced differences in needs and solutions across schools and communities. The conceptual model developed in this research can be used as a framework to understand where different stakeholders can play important roles in supporting children's active school travel. At a community level the model can also be used to identify factors that can be leveraged to enhance existing enablers or overcome persisting barriers to active school travel in the short and longer-term.

The conceptual model encapsulates the key variables related to active school travel and interrelationships between variables and could thus be translated to other settings, particularly car-dominant, urbanised, low-to-medium density neighbourhoods. In contrast, the interpretations and examples provided are limited to the contexts and timing of the research outlined here. Given the variability in community, school, and physical environment characteristics across New Zealand, it is highly likely that a level of elasticity exists in what these solutions look like in different contexts and for individual families within these contexts. It is likely that even within this research, variation existed across time and contexts (Larouche et al., 2015), particularly with regard to the reported importance of children's personal safety and their safety from traffic (DeWeese et al., 2013; Lee and Rowe, 1994; Vonderwalde et al., 2019). For example, for a community currently experiencing low levels of criminal activity or where recent traffic incidents have occurred, traffic safety is likely to be front of mind for parents when considering what "safety" looks like. New Zealand has high rates of traffic injuries and deaths compared with developed countries worldwide (Santacreu, 2018). In 2017, death from road traffic injuries was the ninth leading cause of premature death (Institute for Health Metrics and Evaluation). It was unsurprising, therefore, that ensuring safety from traffic was a prominent topic in the qualitative data. Conversely, recent events in a neighbourhood might quickly shift these perceptions and immediate priorities towards personal safety.

Consistent with previous research (Wong et al., 2011), distance to school was the prevailing built environment factor associated with whether children and young people actively travel to school. Almost no children or young people used active travel modes if they lived more than 2.3 km from home (Ikeda et al., 2018c). Strategies to reduce the impact of distance to school include provision of safe "short cuts" (Harrison et al., 2014), improving public transport availability and accessibility (Voss et al., 2015), school zoning, and having localized schools nested within communities (Yang and Diez-Roux, 2013). Since distance thresholds are higher for cycling than for walking (D'Haese et al., 2011; Nelson et al., 2008), mechanisms to support children's cycling are recommended (e.g., skills training, increasing cycle access, improving infrastructural safety, growing the visibility of and social acceptance of cycling (Lenton and Finlay, 2018; Lorenc et al., 2008)). Working with the community to support active school travel initiatives and social cohesion (e.g., use of community setting carparks for "park and walk/wheel" programmes, food/coffee stalls for active travellers and families, walking school buses and cycle trains) may also be beneficial (McDonald et al., 2010; Yang et al., 2014). Another example is Bikes in Schools (a bike track built in the school grounds), which may improve bike skills, safety awareness and school engagement, but can also create a space for communities to socialise after hours and increases the visibility of cycling.

Ensuring safety from traffic is also necessary to support active school travel. Multiple environmental characteristics were found to support safe active modes in children, including safe crossings, slow traffic speeds, separated cycleways, and safe places for children to walk. Although the immediate school environment is an important setting to target these behaviours, it is worth noting that children's school routes extend beyond the immediate school environment (Harrison et al., 2014; Ikeda et al., 2018b). Improving driver behaviour and reducing speeds in communities through environmental design, policy (e.g. speed limits), effective media campaigns and driver training may also be valuable (Goniewicz et al., 2016).

Ensuring a sense of personal safety (e.g. from dogs, crime, bullies, etc.) will likely optimise the potential impact of school travel programmes or interventions (Wilson et al., 2018). Creating a physically active culture within schools and the wider community can normalise and support active travel and also increases passive surveillance for improved safety overall. Social relations are important in supporting school travel initiatives and encouraging independent mobility (Love et al., 2019). In neighbourhoods where parents are

known to one another and interact socially, children are more likely to get to school actively, and be allowed to move independently in their neighbourhood (McDonald et al., 2010). Aligning with previous research (Hinckson, 2016; Zwerts et al., 2010), children valued social aspects of their school journey, reporting enjoying spending time with their friends, and having time to talk to their parents.

Innovative approaches to reducing barriers around convenience are needed (Egli et al., 2018). Examples include workplaces allowing “glide time” or work from home days to enable parents to prioritise actively travelling to school with their children. Walking school buses are well established in the New Zealand context (Collins and Kearns, 2010) but require considerable and ongoing parent and school support (Hinckson, 2016). Sustainable solutions are needed (Kingham and Ussher, 2005), and could include paid roles, including paid leadership opportunities for older youth. As infrastructure for cycling improves, it is likely the popularity of cycle trains will increase but will also require dedicated approaches to ensure their sustainability.

School leadership through policies (e.g., allowing wheels during school hours), valuing active travel as a learning opportunity, dedicated programmes, and partnering with the wider community were important, and in some cases appeared to overcome environmental constraints on active school travel. Previous research has demonstrated the fundamental role schools play in supporting active school travel (e.g., employing crossing guards, identification of safe routes to school) and the importance of multiple factors, rather than one alone (Larouche et al., 2014a). Similarly, in the current study, activities were most effective when tailored to student and community needs and coupled with other elements that support active school travel. The importance of individual leadership within schools observed in this study is a significant risk to the sustainability of active school travel initiatives. Resourcing for specific roles within the school setting may be essential, particularly where active travel culture and social connections are not strong. Optimally, this role would include professional development opportunities to support and sustain activities and facilitate effective links with community partners.

When considering the role of the neighbourhood built environment it is likely a combination of built environment features, rather than one alone, is needed to impact meaningful change (Chillón et al., 2011; Larouche et al., 2018; Pang et al., 2017). Small changes are useful and when combined with other factors, might generate positive shifts for active school travel. Needs will differ between schools and neighbourhoods, with school culture, community values, and the built environment intrinsically linked to the point that the impact of infrastructure may be greater in some areas than in others. As discussed above, needs are likely time and context-dependent, requiring ongoing evaluation to ensure readiness to respond to community needs.

4.1. Strengths, limitations, and future research directions

Results must be interpreted with caution. The research presented here is cross-sectional, and therefore it is not possible to establish causality between features, activities, and active school travel. The conceptual model was developed from recent New Zealand research conducted in urban areas only. While acknowledging the likely elasticity in the distance and traffic safety needs, these primarily focus on feasibility – that is, can a child actually make it from home to school using active travel – whereas the personal safety factor was more nuanced and likely to differ by context and time.

It is possible that this model and its application will look different for other countries, or may change over time. It is also important to recognize that the data presented here do not account for macro-level factors (e.g., car dominant cultures, sprawling cities, broad socio-economic conditions, and national-level policies) that may have key constraints on children’s active school travel and could weaken the potential beneficial effects of interventions to improve active school travel.

Strengths of the research include triangulation of multiple perspectives (child, parent, school representative) and objective environmental information across a range of studies to generate a conceptual model of needs for active school travel. The evidence is recent, providing an up-to-date and timely representation of factors of importance for the ‘essential ingredients for’ for active school travel. Future research directions include increasing focus on rural areas to understand geographic variations in environmental needs for children’s active school travel. The conceptual model can be used as a framework for decision-making, evaluation, and to help contextualise research findings (e.g., why an intervention may or may not have been effective) in future research.

5. Conclusion

This research demonstrates the complexity of active school travel and reinforces that interventions for increasing active travel modes need to be multi-faceted and integrated across social and environmental domains. A conceptual model of needs has been developed, where distance to school and safety are proposed as fundamental to supporting active school travel; and all aspects of the model, in combination, are desirable for optimal active school travel outcomes. Unique findings about the importance of social relations, a physically active community culture, and understanding New Zealand children’s school journey preferences can inform messages and approaches for supporting active school travel. This research suggests that community-based, cross-sector approaches that are sustained over time are needed to facilitate meaningful change in active school travel. Progress is more likely where active school travel is integrated and prioritised in national and local level policy across education, urban planning, transport, and health. Strategic resourcing and national targets for active school travel rates may be effective ways to harness commitment across sectors and ensure actions to improve active school travel rates are operationalised.

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Declaration of competing interest

We the undersigned declare that this manuscript is original, has not been published before and is not currently being considered for publication elsewhere.

We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us.

We confirm that each author has disclosed on the form below any conflict of interest, in accordance with Elsevier's standard guidelines. These are summarised below,¹ and given in full at: www.elsevier.com/authors/author-rights-and-responsibilities#responsibilities.

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