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Strategies to shift adolescents out of cars: a qualitative study among adolescents and parents

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Abstract

Background Promoting active travel is a promising and sustainable strategy to mitigate declining physical activity among adolescents. However, interventions to increase active travel among this age group is rare. This study aimed to explore strategies adolescents and parents consider most effective for adolescents to replace short car trips with active travel.

Methods Adolescents ($n=22$; mean age of 16 ± 0.9 years; 45% girls) and parents of adolescents ($n=20$; mean age of their adolescents $= 14.6 \pm 1.9$ years; 45% girls) living in Melbourne or Geelong, Australia were recruited from social media platforms and convenience sampling. One-on-one online interviews via Zoom were conducted. Participants were asked about strategies that would encourage them (their adolescent) to switch from car travel to walking and cycling. The interviews were audio-recorded, transcribed verbatim, and analyzed using qualitative content analysis in NVivo 14 software (QSR International PTY Ltd, Melbourne, Australia).

Results Key themes that emerged from the data were similar for both adolescents and parents of adolescents. These were: (1) provide access to or improve walking and cycling infrastructure, (2) develop capability, (3) incentive-based interventions, (4) improve car driver behavior, (5) discourage car parking, and (6) shift social norms.

Conclusion To encourage uptake of active travel and discourage car dependency for short distance trips among adolescents, a multisectoral approach intervening at multiple levels is important to support behavior change towards more active and sustainable transportation. Findings from this study can support the development of youth-centered interventions to promote physical activity and sustainable transport.

Keywords Active transport, Youth, Behavior change, Complex interventions, Parent, Sustainable

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Background

The World Health Organization (WHO) estimates that 81% of adolescents aged 11–17 years worldwide do not meet the physical activity guidelines [1]; this proportion appears even higher (90%) among Australian adolescents [2]. This is concerning as evidence has shown that physical activity tends to decline as adolescents transition into adulthood [3].

Active travel, such as walking, cycling or wheeling from one place to another [4], is an easy way to incorporate physical activity into daily life and may contribute to increasing population levels of physical activity [5, 6]. Active travel has also been highlighted as a unique behavior that could have benefits for health, the environment and the local economy [7–10]. However, most Victorian adolescents are car-dependent [11]. Using GPS data [6], a study of adolescents living in Melbourne, Australia, identified considerable potential for many adolescents to shift at least one of their short car trips to active travel– about 16% of car trips made by adolescents could be walked (≤1.3 km) and 60% could be cycled (≤4.2 km). The study also found that up to 15 min/day of physical activity could be gained if these short car trips were replaced with walking or cycling [6]. Focusing on switching short car trips to active trips may be a feasible and effective way to increase physical activity at the population level.

Numerous studies have examined factors associated with active travel among young people [12–14]. Among adolescents, studies have shown distance to destinations, perceived safety from crime and traffic, and access to a supportive built environment to be consistent determinants of active travel [13, 14]. A priority setting exercise among researchers and stakeholders identified research related to behavior change to be the top priority to advance active travel research in Australia [15]. Overwhelmingly, interventions promoting active travel have focussed on primary school children's journey to school. Few interventions have been developed for adolescents [16, 17] and interventions that appeal to children may not resonate with adolescents. Adolescence is a distinct developmental stage characterized by an increased need for autonomy and stronger peer influence on behavior compared to children who remain largely dependent on, and influenced by, parents or caregivers [18]. Differences in developmental and social context in the two age groups may shape different behavioral drivers, including active travel [18, 19]. For example, implementation of Safe Routes to School (SRTS), a well-known, multicomponent program that incorporates infrastructure improvements, education, encouragement and enforcement (i.e., speed limits around schools) in 801 primary schools in the US resulted in a 25% relative increase in walking and cycling (from 2007 to 2012) compared to control schools [20]. However, efficacy of similar interventions in teens is unknown.

Adolescence represents a unique life stage characterized by increased independence [19]. To date, little is known about the views of adolescents on appealing strategies to help them make the shift from car travel to active travel. There is a need for qualitative research to address this gap, as it offers comprehensive and in-depth insights into individuals' lived experiences and perceptions. The perspectives of parents are also critical given they still guide adolescent decision making [21]. Therefore, this study aimed to explore strategies adolescents and parents consider the most effective for adolescents to replace short car trips with walking or cycling. 'Short' car trips are the focus of this study as they are more amenable to change than longer trips.

Methods

Participants and setting

Adolescents aged 12–17 years, attending secondary school and parents/guardians with at least one adolescent under their care living in Melbourne or Geelong, Australia, were eligible to participate. Participants were recruited using social media advertisements and convenience sampling. Interested participants were invited to follow a link to complete a short pre-screening questionnaire (hosted by Qualtrics) to determine eligibility and collect sociodemographic (e.g., age, year level in secondary school, gender, postcode) and usual travel mode data (e.g., walk, bike, public transport, car, various modes (selection of more than one main mode)). Neighborhood disadvantage was determined based on participants' self-reported postcode using the Index of Relative Socioeconomic Disadvantage (IRSD) [22]. The IRSD measures the overall level of disadvantage based on 17 variables that capture a wide range of socioeconomic characteristics, such as income, education, occupation and household structure. As recommended by the ABS [22], the state-specific (Victoria) IRSD deciles were used for descriptive analysis, with the 1st decile denoting the most disadvantaged areas and the 10th decide denoting the least disadvantage areas. Eligible participants identified from the pre-screener ($n=102$ adolescents, $n=77$ parents) were sent an invitation email containing a plain language statement about the study, a digital consent form, a digital parental/guardian consent form (for adolescent participants only) and a link to select suitable time(s) and date(s) for an interview. A total of 24 adolescents and 23 parents provided informed consent. Of these, 22 interviews were conducted with adolescents and 20 with parents of adolescents; there was only one parent-adolescent dyad. Parents who had more than one adolescent under their care ($n=10$) were asked to report on the adolescent whose birthday was closest to the time of survey.

Procedure and measurements

All participants attended an online one-on-one semi structured interview hosted via Zoom. The interview guides were developed in consultation with all co-authors and pilot tested with two adolescents and two parents to ensure relevance and clarity. The guides for parents and adolescents consisted of several questions (Supplementary materials), including opening questions (e.g., can you describe your journey to school on a typical school day), transitioning questions (e.g., what do you think is an acceptable distance or time to walk to places; thinking about some of your car trips, can any of these trips be replaced by walking or cycling?), key questions (e.g., in a perfect world, how would you change your local neighborhood to encourage you (your adolescent) to walk instead of being driven for short distance trips?; imagine you are a student representative promoting walking and cycling at your school, what could be done to get more people your age to swap short car trips with walking or cycling?; what could be done to help you or other parents feel confident for your adolescent to swap car trips with walking and cycling?). Interviews lasted approximately 25 min and all were audio-recorded with permission. Participants were offered a $20 electronic gift voucher via email upon completion of their interview as compensation for their time. Following the interview, adolescents received an age-appropriate voucher redeemable at a range of retail and entertainment venues, while parents received a supermarket gift card. To ensure data confidentiality, each participant was assigned a unique identification number. Personal information (e.g., names and email addresses) was stored separately from the de-identified interview transcripts. Ethics clearance was obtained from Human Ethics Advisory Group—Health, Deakin University (HEAG-H 16_2022) on 12 May 2022.

Data analysis

Data obtained from the pre-screener questionnaire were exported into Stata to calculate descriptive statistics. Data from the interview audio-recordings were transcribed verbatim and transcripts from adolescents and parents were exported and analyzed separately in NVivo 14 (QSR International PTY Ltd, Melbourne, Australia) using qualitative content analysis [23]. An inductive approach was used to allow categories and themes to emerge from the data without imposing preconceived theories or frameworks [23]. An open coding process was used [24], where the text was broken into small, meaningful segments and each segment was assigned a code that captured its underlying meaning. Codes relevant to the study aim were developed by VL throughout the semi-structured interviews and during the transcription review. To enhance credibility, a co-author (CP) independently double coded the transcripts. Coding decisions, including the allocation of specific quotes to one or multiple codes, were then discussed and validated with CP. In consultation with the remaining co-authors (SS, JV and AT), these codes were then grouped into broader categories or themes and disagreements were discussed until consensus was reached. The Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist [25] was applied in the study design, analysis and reporting of this study.

Results

Descriptive

The mean age of adolescents ($n = 22$) was 16 ± 0.9 years, over half (55%) were boys and 32% were living in 9th decile of disadvantaged neighborhoods (least disadvantaged). Overall, the three most commonly reported *usual* modes of travel among adolescents were: being driven in a car (23%), cycling (23%) and multiple modes (23%). For parents ($n = 20$), the mean age of their adolescent, who was the focus of the interview, was 14.6 ± 1.9 years, with a relatively even distribution across deciles of neighborhood disadvantage. Over half (55%) of parents reported that their adolescent was *usually* driven to places and 35% reported that their adolescent used various modes of transport to travel to places (Table 1).

Travel behaviors

When asked if participants (participants' adolescent) travel to other places after school, it was commonly mentioned that they did not typically go straight home, rather, they would go from school to sports, socialise with friends at a friend's house, restaurant or shopping mall or go to paid work. When asked about the acceptable distance or time to walk or cycle to places, it was commonly mentioned that around 15–20 min walking and 20–30 min cycling were acceptable. Some participants also mentioned that these "acceptable" durations could be longer if they were to walk or ride with their friends. When asked, most participants mentioned that they (or their adolescent) had at least one car trip that could be walked or cycled. However, many reasons were provided for not walking or cycling for these trips, with the most commonly mentioned reason being the convenience. Adolescents found it convenient to be driven, while parents also considered it convenient when the trip aligned with their onward journey to work.

Content analysis

While the data were analyzed separately for adolescents and parents, the key themes that emerged in relation to ideas or strategies that would encourage adolescents to shift short distance car trips to walking or cycling were similar and therefore they are presented together. No notable differences were observed by gender among

Table 1 Demographic and travel behavior of the study sample

	Adolescents (*n* = 22)	Parents of adolescent (*n* = 20)
	%	%
Gender (adolescent)		
Male	54.0	45.0
Female	45.0	50.0
Gender fluid	-	5.0
Age		
12–15 years	18.0	55.0
16–17 years	82.0	45.0
Usual mode of travel		
Walk	13.6	5.0
Bike	22.7	0
Car	22.7	55.0
Public transport	18.2	10.0
Various modes[1]	22.7	35.0
Neighbourhood disadvantage (decile)		
1 (most disadvantage)	13.6	0
2	0	15.0
3	0	0
4	4.5	20.0
5	4.5	0
6	18.2	10.0
7	13.6	10.0
8	9.1	10.0
9	31.8	15.0
10 (least disadvantage)	4.5	20.0

[1]More than one main mode selected as usual mode of travel

adolescents or between mothers and fathers. The six key themes include: (1) providing access to or improving walking and cycling infrastructure, (2) developing capability, (3) offering incentive-based interventions, (4) improving car driver behavior, (5) discouraging car parking, and (6) shifting social norms.

Provide access to or improve walking and cycling infrastructure

Almost all participants mentioned the importance of having better access or improvements to walking and cycling infrastructure for encouraging them to shift car trips to active travel. In particular, the provision of bicycle lanes separated from cars or other motorized vehicles was emphasized as key to providing a sense of safety from traffic.

> *"There's not many bike lanes around here, where riding on the road just isn't an option or it's a bit scary because even on the side streets, the cars go very fast along." (Parent of a 16–17-year-old adolescent, various modes of travel).*

Micro-level design features of walking and cycling infrastructure were mentioned by several participants who reported walking or cycling as their usual travel mode. This included: streetlights along the path, wider footpaths and bike paths, and continuous paths that lead to destinations.

> *"…adding more lights along the streets to make it a bit safer and along other paths." (12–15-year-old, various modes of travel).*
> *"More bike paths on roads…especially ones where the bike path is more well-defined because you get ones where it's tiny and barely existent and then you have to dodge parked cars and that's more dangerous, or you get ones where the bike path disappears and it's a lane for turning cars and that's really frustrating." (Parent of a 16–17-year-old adolescent, various modes of travel).*

The quality of the footpath and bike lane were important considerations:

> *"The place where you walk, the concrete, it gets really uneven. I've tripped a lot. It gets really slippery. If you fall, you fall a great distance…I'd change that, maybe use more flexible material other than concrete or rubber." (16–17-year-old, walker).*
> *"Separated bicycle lane that are further away from cars, there's these green shiny bike lanes in the city… it's really grippy…I'd feel safe riding in the rain if that was there." (16-17-year-old, bike rider).*

Bicycle theft was frequently mentioned by cycling participants as a common barrier to cycling. Some participants suggested having more bike parking in various destinations, including schools and shops, and improving the quality of existing storage by providing lockers for bike accessories, such as helmets, are important.

> *"…places to lock your bike, so that's a big thing." (Parent of a 12–15 year-old adolescent, walker).*
> *"I would make the bike sheds a lot safer… people can still come in unsupervised and cut the locks. I'd install lockers where you can put your bike accessories, helmets." (12-15-year-old, bike rider).*

Develop capability

Providing age-appropriate bicycle education, as well as road safety education were frequently mentioned by parents and adolescents to encourage the uptake of cycling specifically. For instance, some parents were concerned about their adolescents' lack of confidence to cycle on

the road and their awareness of the best route to get from one location to another.

> *"[It's] not just [about] learning to ride a bike… but confidence about riding your bike in traffic…One big thing is that maps on phones don't show cycling directions or they show really bad cycling directions that don't take into account the shared paths that are available." (Parent of a 12-15-year-old adolescent, various modes of travel).*

Parents and adolescents offered suggestions for and examples of how bicycle education could be delivered or embedded within the school curriculum, which included cycling confidence classes, bicycle maintenance workshops and local bike route navigation.

> *"…offering cycling confidence classes or providing some incentive or education around cycling…would be really good…Education around bike maintenance…Instigation of activities involving cycling. The schools have probably got a role to play, in terms of encouraging an education around bike riding, maybe it should be part of school curriculum." (Parent of a 12-15-year-old adolescent, driven).*
>
> *"I know at my brother's school they had an elective that he did it's called ecotourism, it was just riding bikes around Melbourne… my brother now saved up his money and bought a BMX bike." (16-17-year-old, bike rider).*

A parent who had recently moved to Melbourne from interstate highlighted that an orientation program by local councils would be useful to ensure new residents could navigate their neighbourhood on bike. It was suggested that programs could provide new residents with detailed information about the different bike paths and potential hazards cyclists may encounter.

> *"As a family that's recently moved to Melbourne, that would probably help if you could go [to a] council…and do a little webinar like the best ways to ride your bike or the best ways to get from A to B." (Parent of a 12-15-year-old adolescent, various modes of travel).*

Incentive-based interventions

Incentivising active travel was offered as a potential strategy, including financial incentives (e.g., cash, voucher, free subscription services) and incentives to make cycling (specifically) to school more convenient and appealing (e.g., free dress day or free breakfast for those who cycle to school).

Adolescents and parents suggested that 'gamification' (e.g., goal setting, turning walking/cycling into game or competition) could be achieved using mobile phone applications that recorded all trips and provided a platform to compete with friends and family to reduce car travel or increase walking and cycling (as examples) or to share their active journeys via social media.

> *"Smartphone app promoting, walking and cycling… would be good to track the movement, so you can validate it…and give you activities and goals set up for yourself." (12-15-year-old, various modes of travel).*
>
> *"From a family's perspective, if you had an app, you could almost have a little mini competition between siblings, and parents getting everyone involved to try and see who does travel the farthest distance by foot or by bike, have a bit of a tally going." (Parent of a 12-15-year-old adolescent, driven).*

Improving car driver behaviors

While participants did not specifically mention that improving car driver behavior would change their travel mode, poor car driver behavior was frequently mentioned as substantial safety concern or as altering their cycling journey. An adolescent who frequently cycled explained that he had experienced several 'near-miss' car-dooring incidences.

> *"My biggest fear in cycling is someone opens a car door and I just go over… Just awareness for that, but I don't think many people would listen. (16-17-year-old, bike rider)*

Another adolescent, also a usual bike-rider, felt that many car drivers lack cyclist awareness on the road and so purposively rode on quiet streets to avoid cars.

> *"I think sometimes it's a bit scary because a lot of car drivers are not so sure how to drive around bikes… so you don't know where cars are going, not stopping at stop signs, sometimes it'll be a little bit dangerous, not often, but that's why I try and take the back streets and not try and ride on any busy road." (16-17-year-old, bike rider).*

Parents also spoke about driver behavior more generally, and one expressed concern about car drivers not slowing down at crossings.

> *"I do though worry about motorists. Where we live, he does have to cross the main road, which does have the zebra crossing there but he does know cars*

don't stop." (Parent of a 12-15-year-old adolescent, driven).

When asked about what change they would like to see in their local neighborhood to make cycling safe, an adolescent participant said:

"...driver's attitude towards cyclists as well. People driving on the road tend to be quite aggressive and I think that can be hard for people commuting." (16-17-year-old, public transport user).

Discourage car parking

Increasing parking fees or reducing parking spaces or parking time restrictions were suggested by adolescents to help them switch to active travel.

"...people don't like paying money. I think we should make those paid parking stuff you see in the city—it'll get less people to park there." (16-17-year-old, walker).
"[For] teenagers in general, I'd say less car parks near schools...my school is opposite a massive car park shopping centre...a lot of the girls in my year levels as they get their Ps, they drive to school every day." (16-17-year-old, bike rider).

Shifting social norms

A number of parents highlighted a clear need to change the social norm of driving their adolescents to places so that walking or cycling for travel is seen as a socially acceptable option.

"Some way of making it more the norm to turn up on a bike than be walking, whether it's to sport or whether it's to [elsewhere]...how do you stop the parents from offering to drive people all the time or wanting to drive their kids around all the time. How do you stop the kids from wanting to rely on their parents for lifts all the time...It's stopping the kids asking, so that means making it a norm." (Parent of a 12-15-year-old adolescent, various modes of travel).

The notion that riding a bike is 'uncool' or 'embarrassing' was mentioned by both adolescents and parents. For example, when asked if participants ever cycled, an adolescent said:

"I wouldn't cycle to school...it is embarrassing to come to school with a bike" (16-17-year-old, driven).

In addition to social norms it, some parents spoke about the importance for adolescents to have the "right" bike to fit in with their peers.

"My son said that his friends don't like going to the park with him... because his bike is really old and it's not in good condition...That status symbol of having that brand-name helmet or a good bike rather than something that's old and that doesn't look so good... It's not necessarily about the bike...it's having the right equipment to not be embarrassed to be on a bicycle." (Parent of a 12-15-year-old adolescent, various modes of travel).
"[My son] is just embarrassed by his bike. He wants a branded bike like all his friends". (Parent of a 12-15-year-old adolescent, driven)

Discussion

The aim of this qualitative study was to gather the views of adolescents and parents of adolescents on strategies to swap short car trips for walking or cycling. Notably, the key themes that emerged were similar for both adolescents and parents, suggesting a universal or shared set of challenges. Overall, the findings highlight that a multisectoral approach is needed to promote modal shift from car travel. The strongest themes related to the conditions that need to exist to support active travel before travel behavior can shift, including the provision of accessible or improved walking and cycling infrastructure and better driver behavior towards pedestrians and cyclists. Once these conditions are in place, incentives such as financial or non-financial rewards, providing bicycle education programs at the school or community level, and discouraging car parking are important considerations. Efforts to change social norms are also required.

Our findings align with established research, emphasizing the key role of the built environment on active travel [13, 14]. Specifically, to facilitate active travel, access or improvements to walking or cycling infrastructure were raised most by both parents and adolescents. Macro-level features, such as bicycle lanes and footpaths, as well as the availability of secure bike parking in public spaces and schools were frequently mentioned as facilitators for active travel. The importance of the built environment has also been demonstrated in natural experiment studies conducted among adults that have assessed new routes for walking and cycling in the UK [26, 27], US [28] and Australia [29, 30]. They found new infrastructure for walking and cycling were associated with increases in walking and cycling. These findings, along with ours, further highlight the importance of walking and cycling infrastructure as a prerequisite to support an increase frequency of walking and cycling at the population level.

While these macro-level infrastructures are important, micro-level features of the walking and cycling infrastructure were also highlighted by our study adolescents who regularly walked and cycled to places, and may contribute to perceptions of safety. For example, they emphasized the importance of even and non-slip path surfaces, ensuring paths are free from potholes and debris, having streetlights along paths and continuous paths from origins to destinations. The placement of the bike lanes also appears to be important. Specifically, bike lanes should be separated from cars (including parked cars) using bollards, curbs or planters. It has been suggested that having bike lanes without these micro-level features (e.g., painted along a roadway, not physically separated from cars) are only suitable for 'enthused and confident' adult bike riders [31].

In addition to the importance of the built environment, our findings suggest that additional complementary strategies are required including those that aim to improve car driver awareness and behavior, and bicycle education. Study participants who frequently walked or cycled places raised concerns about driver behavior specifically in relation to drivers failing to stop at zebra crossings and stop signs. Pedestrians and cyclists are among the most vulnerable road users [32] and driving practices have previously been reported to influence perceptions of active travel safety [33]. A mixed-method study focused on school active travel among children and adolescents in New Zealand [34] found that active travellers often expressed safety concerns near pedestrian crossings and around areas with a high concentration of cars. This suggests safe traffic-light crossings around school coupled with road safety education and skills training are essential to facilitate active school travel [34]. While bicycle education is often targeted at children and adolescents, interventions aimed at improving cycling skills among parents may also be valuable. Given that overall rates of cycling in Australia remain low [35], providing cycling education to parents may enable them to better support and model active travel behaviours for their children [36]. It may be beneficial to review the education and training material within the driver licence process to ensure risk assessment and interactions with vulnerable road users (e.g., pedestrian, cyclists, children) is adequately addressed [37]. An Australian driver licensing process review found that among eight jurisdictions, only two made cyclist-related road rules testing mandatory, and no jurisdictions required novice drivers to demonstrate knowledge of interacting safely with cyclists during a practical test [38]. For example, incorporating 'anticipatory' education, where drivers are taught to interpret and prepare for different road environments and road user behaviors using immersive virtual reality simulation, may better equip future car driver behaviors [39, 40].

Social norms can operate as a potential enabler or barrier to active travel. In Australia, car travel is the norm, with more than 60% of trips among adolescents made by car [41]. In our study, a number of parents expressed the need to make walking and cycling the norm as they felt pressured to chauffeur their children everywhere. Within the context of social norms, participants also mentioned that riding a bike (and that riding a particular brand of bike) was perceived as *uncool* or embarrassing. These findings align with Social Identity Theory [42], which posits that individuals, particularly adolescents, are motivated to adopt behaviors that reinforce their sense of belonging within their social groups. If riding a bike or riding a certain brand of bike does not align with the identity of their peer group, adolescents may be less likely to engage in this behavior due to concerns about social acceptance or fitting in. Increasing awareness of health, social good and planetary benefits of cycling may help shift perceptions of coolness and improve norms. However, social norms for public health related behaviors can undergo changes over time, changing norms requires a sustained effort from various stakeholders, such as government, community groups, and private organisations [43]. Sustained implementation of comprehensive tobacco control measures targeted at multiple levels of the socioecological model in Australia, for example, transformed the social norm of smoking [44]. Initiatives such as the *Mind.Body.Pedal* by Bicycle Network [45] and *This Girl Can* by Sport England [46] are examples of holistic programs that aim to change social norms around cycling and physical activity among adolescent girls while addressing issues of self-esteem, and may serve as promising approaches for future interventions and programs among adolescents and other age groups.

A variety of financial and non-financial incentives were suggested by our participants to encourage behavior change to active travel including vouchers, money, gamification (e.g., goal setting and competition), and complimentary breakfast and uniform-free days for those who walk or cycle to school. In a systematic review, offering a cash payment contingent on active travel was found to be an effective strategy to increase active travel in adults, along with the provision of free bicycles, subsidies for public transport use and congestion charges, however, more robust causal inference is required to confirm the impact of these strategies [47]. In recent years, gamification has been introduced as an intervention to achieve travel behavior change [48]. A school-based program in the US combined the use of gamification with financial incentives to promote active travel among children aged 9–10 years [49]. Students who cycled to school were entered into a lottery for a chance to win either a ten-dollar cash or a bicycle store voucher. This resulted in a 16% increase in cycling to school during the prize period [49].

Another successful primary school-based active travel initiative utilised leaderboards to rank individuals, classes and school progress. This fostered a sense of competition and 35% of car trips were converted to active travel trips in participating schools [50]. Whilst incentive-based interventions can be a promising way to encourage behavior change among children, less is known about whether these types of interventions are effective among adolescents. Further, it is important to consider the feasibility and sustainability of financial incentives, and the ability of settings such as schools to provide financial support. Notably, studies have found that incentives are most successful in encouraging non-complex single health behavior (e.g., vaccination), rather than behavior that requires ongoing commitment (e.g., habitual active travel) [51]. It is possible that non-financial incentives highlighted in our findings, such as uniform-free days and free breakfasts, could serve as more cost-effective alternatives to promote walking and cycling sustainably, although their acceptability and feasibility within schools needs to be determined. This could be examined in future research. The utilisation of smartphone apps was mentioned by participants to encourage more walking and cycling by incorporating route planning, trip logging, goal setting and social competition features. Among adults, smartphone-delivered interventions have been shown to improve a range of health behaviors [52]. However, evidence examining the efficacy of smartphone interventions for travel behavior among adolescents is lacking. Given that adolescents are the earliest adopters of digital technology, smartphone-delivered interventions should be a priority for future studies. Nonetheless, it is important to acknowledge potential challenges, such as the reliance on third-party platforms and concerns around data privacy and cybersecurity, especially when interventions may involve location tracking [53]. These issues may affect the reach, equity and sustainability of such interventions.

Our findings suggest subtle but important differences in strategy priorities among different transport users. Participants who regularly walk or cycle tend to emphasize the need for micro-level infrastructure improvements, such as having separated bike lanes and the use of anti-slip surface on bike lanes. They also more frequently advocated for strategies to disincentivize car use through reduced parking provisions. In contrast, those who primarily relied on being driven rarely mentioned any strategies related to micro-level infrastructure improvements or strategies disincentivising car use. Prior research suggests that perceptions of the environment differ depending on a person's primary mode of travel [54, 55]. Recognising these differences is essential to designing inclusive strategies that support active travel across all transport users.

Strengths and limitations

Interviewing both adolescents and parents of adolescents is a key strength of this study. Adolescence is a unique life stage characterized by increased independence within the constraints of parental supervision [56]. Thus, exploring the views of both adolescents and parents is important to gain a comprehensive understanding of factors influencing travel behavior change. The current study also recruited diverse participants who reported a range of usual travel modes. This allowed us to gather rich data on the most attractive behavior change strategies among those who are being driven often, as well as strategies to make walking and cycling more pleasant and safe among those who regularly walk or cycle. As most previous studies have focused on promoting active travel to/from school, the current study takes a broader approach to explore strategies for all trip types. This is important, as our previous study conducted among Victorian adolescents found that only 40% of their daily trips were made for school purposes, and non-school trips (e.g., trips for social, shopping and recreational purposes) tend to be shorter, making them more amenable for active travel [41]. Thus, while our findings can inform the development of school-based interventions, they also hold promise for non-school trip purposes. However, there are several limitations to acknowledge. Due to the qualitative design, it was not possible to determine the most appealing theme/strategies (relative to others) for intervention design as the study did not intend to quantify the frequency or ranking of perceived importance in each theme. Future research using quantitative or mixed-methods approaches is needed to identify and prioritise the most effective combination of intervention components building on the themes identified in this study. All participants lived in metropolitan Melbourne, so the results may not be generalisable to rural or regional areas or to other countries, especially where walking and cycling for transport are deemed to be the 'norm'.

Conclusion

Adolescents and parents of adolescents highlighted individual, social and environmental strategies to support behavior change, and the congruence in their findings underscores the universal barriers towards more active and sustainable transportation. Notably, these strategies were commonly mentioned together, rather than in isolation, highlighting the significance of adopting an orchestrated multifaceted-, interdisciplinary-approach to address the complexities of travel behavior change. By drawing directly on the perspectives of adolescents and parents, our findings may inform public policy or school-based programs to promote active travel among this important age group. This qualitative study forms a good basis for further quantitative research to examine

the most important combination of strategies to promote active travel and discourage car-dependence.

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

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V.L.: Conceptualisation, Methodology, Formal analysis, Investigation, Writing- Original Draft, Project administration, Funding acquisition.S.S.: Conceptualisation, Methodology, Writing-Review & Editing, SupervisionJ.V.: Conceptualisation, Methodology, Writing-Review & Editing, SupervisionC.P.: Validation, Writing-Review & EditingA.T.: Conceptualisation, Methodology, Writing-Review & Editing, Supervision.

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Data availability
The dataset generated and analysed during the current study are not publicly available due to confidentiality of the participants. Anonymized transcripts may be available from the corresponding author on reasonable request, subject to approval from the ethics committee.

Declarations

Ethics approval and consent to participate
Approval for this study was obtained from the Human Ethics Advisory Committee- Health, Deakin University (HEAG-H 16_2022). Informed consent was obtained from all participants prior to the interview. For participants under the age of 18 years, informed consent was also obtained from parents of legal guardians. The study was conducted in accordance with the Declaration of Helsinki.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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