DEAKIN UNIVERSITY AUSTRALIA

Active transport among youth—how important is the road environment?

Centre for Physical Activity and Nutrition Research

Summary report

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Executive summary

The health benefits of physical activity during childhood are now well established and include reduced risk of cardiovascular disease, higher bone mineral density and favourable psychosocial health. For young people, active transport, that is walking or cycling to local destinations, is an important source of physical activity. However, it appears that parents may restrict these activities due to safety concerns.

This study sought to inform interventions aimed at increasing walking and cycling among youth by gaining an understanding of how levels of active transport vary between children and adolescents, and what safety-related aspects of the local road environment are associated with active transport.

The study involved parents and children in metropolitan Melbourne over a two-year period from 2004 to 2006. In 2004, 166 parents of children (aged 8 – 9 years) and 265 parents of adolescents (aged 13 – 15 years) were surveyed regarding their family demographics. Children's levels of active transport were reported by their parents, while adolescents self-reported their behaviour. Safety-related features of the local road environment within 800m of each participant's home were gathered using a Geographical Information System (GIS).

On average, boys in this study walked or cycled for transport more frequently than girls. Adolescents made more walking trips per week than children, however, children's levels of active transport increased over the two-year period, while adolescents' levels of active transport declined.

At baseline, the road environment features most consistently associated with active transport were intersection density and traffic/pedestrian lights.

The presence of walking tracks was also found to be associated with increases in active transport among girls in both age-groups over time. This is an important finding in light of the observed age-related decline in physical activity, and the low levels of activity seen amongst adolescent girls in particular.

The study highlights the importance of traffic calming measures and other physical infrastructure in creating environments that support active transport among youth. This report will be of interest to parents and families of children and adolescents; teachers and schools; policy makers; health professionals; urban planners and others interested in promoting active transport among youth.

Background and study aims

1.1 The importance of physical activity in childhood

It is well established that physical activity is beneficial to children's health. Compared with less active children, those who are highly active have a reduced risk of cardiovascular disease and tend to have leaner body composition, higher bone mineral density and better psychosocial health [1,2]. These benefits are also related to health later in life. Growing rates of childhood obesity [3], as well as increased prevalence of type 2 diabetes and other diseases associated with sedentary lifestyles [2], further highlight the importance of investigating children's physical activity.

In recognition of the health benefits of regular physical activity, national guidelines recommend that children perform at least 60 minutes of moderate-to vigorous-intensity physical activity (MVPA) every day [4]. Activities typically classified as moderate-to vigorous-intensity include brisk walking, cycling and playing netball or football. Evidence suggests that MVPA levels decrease significantly between ages 9 and 15 years [5]. However, one important potential source of habitual physical activity, which may actually increase with age is active transport. This takes the form of walking or cycling to school and to other local destinations [6].

1.2 Children's active transport

It has been suggested that, compared with previous generations, children's freedom of movement outside the home is more restricted by spatial boundaries and greater adult supervision [7,8]. Declines in active transport to school over recent decades have been reported in Australia and the USA. For example, an Australian study [9] demonstrated that between 1985 and 2001, participation rates among 9 – 13 year-olds in walking to/from school 6 – 10 times per week dropped from 37% to 26%, while participation rates in cycling to school at least once per week dropped from 20% to 8%. A US study [10] reported that 41% of children walked or cycled to school in 1969, but only 13% did so in 2001. While that study reported that distance to school had increased over time and may account for half of the decline in active transportation to school, other factors such as road safety concerns were also suggested to contribute to this decline [10].

1.3 What influences children's active transport?

Numerous studies have shown that restrictions on children's active transport are mostly due to parental concern about road safety [11–13], and about strangers and social dangers [12–14]. An English study found that over 40% of parents restricted their children aged 7 – 11 years from coming home alone from school because of concerns regarding traffic danger [11]. Two Australian studies have also found that perceptions of unsafe road environments are negatively associated with walking and cycling among 10 – 12 year olds [15] and adolescents [16]. There is, however, a paucity of empirical evidence of associations between the actual road environment and active transport among youth.

1.4 Study aims

In order to inform policy and strategy development in relation to active transport among youth, this study aimed:

1. To examine active transport among children and adolescents, as well as changes in their active transport over a two year period; and

2. To examine associations between objectively-measured features of the road environment related to traffic calming, and active transport among children and adolescents.

Study design and methods

2.1 Study design

This longitudinal study, known as the 'Children Living in Active Neighbourhoods' (CLAN), examined active transport among children and adolescents over a two-year period. It also examined associations between safety-related features of the local road environment and active transport among children and adolescents in their neighbourhood.

The study involved surveys of children's and adolescents' active transport in 2004 and 2006. Children's walking and cycling in their local neighbourhood were reported by parents while adolescents reported their own walking and cycling behaviour. Objective measures of the local road environment were gathered using a Geographical Information System (GIS).

Approval to conduct all phases of this study was received from the Deakin University Human Research Ethics Committee, from the Victorian Department of Education and from the Catholic Education Office. Consent for participation in the study was provided by the parents on behalf of themselves and their child.

2.2 Study participants

Participants were recruited from those who had participated previously in the Children's Leisure Activities Study (CLASS) conducted in 2001. They were recruited from ten primary schools in the eastern suburbs (high socioeconomic status (SES)) and nine primary schools in the western suburbs (low SES) of metropolitan Melbourne. All children aged 5 – 6 years and 10 – 12 years, and their parents were eligible to participate in the study. Participants of CLASS in 2001 were re-contacted in 2004 and again in 2006 to be part of the follow-up study (CLAN). This report contains information collected from parents of children and adolescents participating in the CLAN study in 2004 and 2006.

In 2004, participants were:

- Children aged 8 – 9 years
- Adolescents aged 13 – 15 years

In 2006, participants were:

- Children aged 10 – 11 years
- Adolescents aged 15 – 17 years

2.3 Measures of active transport

In order to measure active transport at each time-point (2004 and 2006), children's parents were asked to report how often per week their child walked or cycled to 15 neighbourhood destinations:

- bike/walking tracks;
- friends' houses;
- sports venues/leisure centres;
- skate ramps;
- parks/playgrounds;
- waterways;
- beaches;
- other open spaces;
- public transport;
- school;
- amusement arcades;
- DVD rental stores;
- convenience stores;
- takeaway/fast food outlets; and
- other shops or destinations.

Adolescents self-reported how often they walked or cycled to these destinations. Frequency values (in parenthesis) were assigned to each response category.

- Not within walking/riding distance (0);
- Never/rarely (0);
- Less than once per week (0.5);
- 1–2 times per week (1.5);
- 3–4 times per week (3.5);
- 5–6 times per week (5.5); and
- Daily (7).

These measures were based on a pre-existing instrument with eight destinations [15]. Using these frequency values, the total number of walking/cycling trips per week was calculated. Change in the number of walking/cycling trips made per week between 2004 and 2006 was also calculated (total trips per week in 2006 minus total trips per week in 2004).

2.4 Objective measures of the local road environment

A Geographical Information System (GIS) was built using Arcview GIS 3.3 (Environmental Systems Research Institute, Inc., California, 2002), spatial data (address points, cadastral and road network data) owned and supplied by the State Government of Victoria [17–19], and street directory maps [20]. Using this GIS, road environment variables were objectively measured within each participant's neighbourhood.

Each child's neighbourhood was defined as a radius of 800m around their home. The rationale for this definition is based on evidence that parents have reported 1600m as an appropriate walking distance for their children [15], and that most child pedestrian injuries take place within 500m of a child's home [21].

Each participant's home address was geocoded (i.e. converted to representative coordinates and mapped using the GIS) and their neighbourhood mapped. Eight measures of the road environment to be examined within participants' neighbourhoods were generated and are described below. These fall under two broad categories: street network and re-engineering of road environment.

Street network

Four variables relating to the local road environment were sourced or derived from the VICMAP Transport database [19]. This database classifies road segments according to type and lists them in descending order within the road network hierarchy: freeway; highway; arterial; sub-arterial; collector; local; two-wheel drive (unsealed, suitable for standard, two-wheel drive vehicles); four-wheel drive (unsealed, suitable for four-wheel drive vehicles); unknown; proposed; and walking tracks [19]. Road types that were unknown or proposed were excluded from the analyses.

The variables were:

- *Total length of local roads:* The total length (km) of roads classed as 'local' (i.e. residential streets) and unsealed tracks suitable either for 'two-wheel drive' or 'four-wheel drive' vehicles [19] was calculated. The maximum speed limits for these roads is 50km/h or less [22];
- *Intersection density:* The total number of intersections was calculated. As all neighbourhoods were equal in area, no adjustment for area was required. Areas with high intersection density tend to have greater street connectivity and traffic calming as vehicles usually slow down as they approach intersections [23];
- *Residing on a cul-de-sac:* This indicates whether the participant's home was on a cul-de-sac. Neighbourhoods with many cul-de-sacs tend to have low street connectivity [24]. However, parents consider cul-de-sacs as safe play venues for their children, because they lack through traffic and allow parents to monitor their children at play [25];
- *Total length of walking tracks:* The total length (m) of walking tracks was calculated.

Re-engineering of road environment

Four indicators of traffic calming were gathered from street directory data, including:

- *Speed humps,* which have been shown to reduce risk of child pedestrian injury[26];
- *Gates/barriers on roads,* which may also have a traffic calming effect;
- *Slow points,* which are defined as sections of road narrowing (e.g. chicanes) and are engineered to encourage slower driving[27]; and
- *Traffic/pedestrian lights,* which provide safe places to cross roads and therefore may encourage children's active transport.

The total number of each of these features was calculated for each study participant's neighbourhood.

Study findings

3.1 Characteristics of study participants

Table 1 shows the characteristics of the children and adolescents who participated in the study and for whom parent survey data for 2004 and 2006 were reported.

The majority of parents in the study were married and, on average, children in the study had one other child aged less than 18 years living in their home. Maternal education, a commonly used indicator of family-level SES, varied between the child and adolescent groups. Overall, almost half of all mothers in the sample had a university/tertiary education.

Table 1. Family characteristics of children and adolescents, 2004

	Children		**Adolescents**	
	Boys (n=82)	Girls (n=84)	Boys (n=114)	Girls (n=151)
Child age (mean years)	9.1	9.0	14.5	14.5
Parental marital status (%)				
Married	81.7	77.1	84.1	77.0
Defacto/living together	4.9	12.0	3.5	6.0
Separated/divorced	12.2	10.9	9.7	14.9
Never married	1.2	-	2.7	1.4
Widowed	-	-	-	0.7
Number of other children				
aged <18yrs living in the house (mean)	1.4	1.5	1.2	1.1
Maternal education level (%)				
Some high school or less	12.2	24.4	21.2	24.3
High school or technical certificate	34.1	26.8	38.1	29.2
University/tertiary	53.7	48.8	40.7	46.5

3.2 Levels of active transport

Key findings:

- **Boys walked or cycled for transport more frequently than girls – this was the case in both the younger and older age groups.**
- **Adolescents participated more in active transport than children.**
- **Children increased their involvement in active transport as they got older (between 2004 and 2006).**

The mean numbers of walking/cycling trips made by children and adolescents per week in 2004 and 2006 are shown in Figure 1.

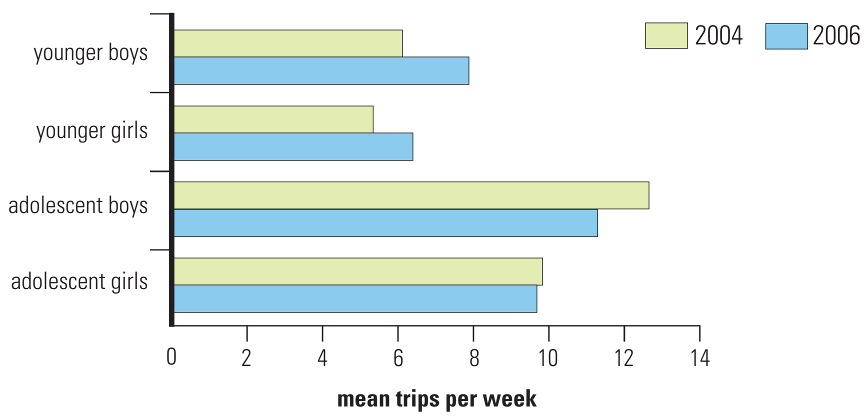
Across both age groups, boys cycled or walked to local destinations more frequently than girls. For example in 2004, younger boys undertook an average of 6.0 walking/cycling trips per week compared to 5.2 for girls. In 2004, adolescent boys undertook an average of 12.6 walking/cycling trips per week compared to 9.8 trips per week for girls.

In both 2004 and 2006, adolescents made more walking/cycling trips per week than children.

Children made significantly more walking/cycling trips per week as they got older. This equated to an average of 1.8 more walking/cycling trips per week for younger boys in 2006 compared with 2004 (p=0.001); and an average of 1.1 more walking/cycling trips per week for younger girls (p=0.03).

In contrast, adolescent boys and girls made fewer walking/cycling trips per week in 2006 compared with 2004 (mean change -1.3 trips, p=0.069 and -0.1 trips, p=0.839, for boys and girls respectively).

Figure 1. Change between 2004 and 2006 in mean number of walking/cycling trips per week according to age-group and sex



3.3 Road environment features and associations with children's and adolescents' active transport in 2004

Key findings:

- **Greater intersection density was associated with more walking/cycling trips among boys and girls in both age-groups.**
- **Higher numbers of traffic/pedestrian lights were associated with more walking/cycling trips among all participants except adolescent boys.**
- **Higher numbers of speed humps were associated with more walking/cycling trips among younger girls and adolescent boys.**
- **Living on a cul-de-sac (compared to a through street) was associated with fewer walking/cycling trips among adolescent girls.**

The median (and range of) values of road environment measures within participants' neighbourhoods are presented in Table 2. Among all participants, 20% resided on a cul-de-sac.

Significant associations between road environment features and the number of walking/cycling trips made per week by children and adolescents in 2004 are shown in Table 3.

Table 2. Median (and range of) values of road environment measures within participants' neighbourhoods

Measure of road environment (within 800m radius of home)	Median (range)
Total length of local roads (km)	16 (0 – 37)
No. of intersections (n)	88 (2 – 279)
Total length of walking tracks (m)	0 (0 – 3977)
No. of speed humps (n)	4 (0 – 89)
No. of gates/barriers on road (n)	0 (0 – 8)
No. of "slow points" or sections of road narrowing (n)	0 (0 – 24)
No. of traffic and/or pedestrian lights (n)	2 (0 – 21)

Table 3. Significant associations between road environment features and children's and adolescents' active transport in 2004

Road safety factors showing significant associations with no. of walking/cycling trips per week (2004)	**Study group for whom the association was significant**	**Regression coefficient (95% CI)**
Total length of local roads (km)	Younger boys	0.203 (0.042, 0.364)
	Adolescent girls	0.231 (0.043, 0.419)
No. of intersections (n)	Younger boys	0.024 (0.006, 0.042)
	Younger girls	0.022 (0.002, 0.043)
	Adolescent boys	0.040 (0.004, 0.076)
	Adolescent girls	0.051 (0.021, 0.080)
Reside on cul-de-sac (y/n)	Adolescent girls	-3.75 (-6.458,-1.038)
No. of speed humps (n)	Younger girls	0.151 (0.017, 0.284)
	Adolescent boys	0.112 (0.001, 0.223)
No. of gates/barrier (n)	Adolescent girls	0.947 (0.050, 1.844)
No. of traffic/pedestrian lights (n)	Younger boys	0.344 (0.130, 0.559)
	Younger girls	0.333 (0.040, 0.627)
	Adolescent girls	0.472 (0.138, 0.806)

Table shows significant ($p<0.05$) associations only

These cross-sectional data, when children and adolescents were aged 8–9 and 13–15 years respectively, show that intersection density was related to active transport among all participant groups. Traffic/pedestrian lights were also positively associated with active transport among all participant groups except adolescent boys. For example, on average, 10 extra sets of traffic/pedestrian lights within an 800m radius of home were associated with around 3 to 4 more walking/cycling trips per week, made by children or adolescent girls.

Some traffic calming measures had stronger associations with active transport among particular groups of participants, for example speed humps were associated with greater levels of active transport amongst younger girls and adolescent boys, whilst gates/barriers had associations with active transport only amongst adolescent girls.

Cul-de-sacs were associated with lower levels of active transport among adolescent girls. On average, those who resided on cul-de-sacs made 3 to 4 walking/cycling trips less per week than those who resided on through streets.

3.4 Road environment features and associations with change in children's and adolescents' active transport between 2004 and 2006

Key findings

- **Almost all identified associations between road environment measures and change in active transport were for girls.**
- **High intersection density was the only feature associated with greater change in active transport among boys (adolescent boys only).**
- **Total length of walking tracks in the neighbourhood was the only feature positively associated with change in active transport among more than one group, being associated for girls in both age-groups.**

The study explored whether safety-related features of the road environment were associated with changes in levels of active transport among children and adolescents between 2004 and 2006. Significant results are shown in Table 4.

Table 4. Significant associations between road environment features and change between 2004 and 2006 in children's and adolescents' active transport

Road safety features showing significant associations with change in active transport (2006-2004)	Study group for whom the association was significant	Regression coefficient (95% CI)
Total length of local roads (km)	Younger girls	0.206 (0.023, 0.389)
No. of intersections (n)	Adolescent boys	0.032 (0.003, 0.062)
Total length of walking tracks (m)	Younger girls Adolescent girls	0.002 (0.0003, 0.003) 0.002 (0.0006, 0.003)
No. of slow points (n)	Adolescent girls	-0.385 (-0.730,-0.040)
No. of traffic/pedestrian lights (n)	Younger girls	0.448 (0.151, 0.745)

Table shows significant (p<0.05) associations only

Among younger boys there were no significant associations between any of the objective measures of the road environment and change in their levels of active transport between 2004 and 2006.

For adolescent boys, only intersection density was associated with change in their levels of active transport.

All other associations between the road environment and change in active transport levels were for younger girls or adolescent girls. Features associated with increased active transport amongst younger girls included the total length of local roads and the number of traffic/pedestrian lights. The total length of walking tracks in the neighbourhood was the only feature positively associated with change in active transport among girls in both age-groups.

Study conclusions

The CLAN study is one of the first studies internationally to examine active transport longitudinally among a sample of children and adolescents, and to explore associations between the local road environment and changes in active transport over a two-year period.

Levels of active transport among children and adolescents

The study found that, on average, levels of active transport among children aged 8 – 9 years at baseline (2004) increased over the two years to 2006, while there were declines in levels of active transport among adolescent participants. Nevertheless, adolescents engaged more in active transport than did children at both time points. These findings may be due to greater independent mobility among older children. Independent mobility, which refers to the ability of children and adolescents to walk or cycle around their neighbourhood without adult accompaniment, has been shown to increase with age [28]. Furthermore, while younger boys engaged more in active transport than younger girls at baseline, their levels of active transport also increased more than those of younger girls. These findings concur with those of an Italian study that found that boys are more independently mobile at an earlier age than girls [28].

Road environment features and active transport at baseline

The road environment features most consistently associated with active transport in 2004 were intersection density and traffic/pedestrian lights. Intersection density is associated with traffic calming as vehicles usually slow down as they approach intersections [23]. In addition, neighbourhoods with high intersection density tend to have greater street connectivity. This in turn may promote active transport due to directness of walking/cycling routes as well as greater choice of routes [24].

Higher prevalence of traffic/pedestrian lights was associated with greater levels of active transport among children and adolescent girls, but not among adolescent boys. Although adolescent boys engaged most in active transport, this was not associated with the number of traffic/pedestrian lights in their neighbourhood. It is likely that these boys were competent in road crossing skills by age 13–15 years. However, research also suggests that from an early age, boys are socialised to take greater risks than are girls [29]. Thus adolescent boys may be less likely than girls to rely on pedestrian crossings.

Speed humps were positively associated with active transport among younger girls and adolescent boys. This is consistent with recent research, which has demonstrated an association between speed humps on local streets and physical activity among adolescent boys [30]. Speed humps have also been associated with reduced likelihood of child pedestrian injury [26]. Furthermore, traffic calming interventions in the Netherlands have been found to be associated with low child pedestrian injury rates [31,32] and high participation rates in active transport [33].

Residing in a cul-de-sac was found to have a negative association with active transport for adolescent girls, with these girls making fewer walking/cycling trips than those whose homes were located on through streets. This finding concurs with research on adults' walking in which cul-de-sacs have been found to be indicative of low street connectivity [24] and hence less prevalent active transport. Nevertheless, it is important to consider the benefits of cul-de-sacs for children and adolescents. A recent study demonstrated that adolescent boys who lived on cul-de-sacs spent more time in moderate-to-vigorous physical activity outside school hours than those who lived on through streets [30]. These findings are further supported by those of an earlier study which reported that parents consider cul-de-sacs to be safe play venues for children due to lack of through traffic and ease of parental supervision [25].

Road environment features and change in active transport over time

Several features of the road environment were positively associated with change in active transport over the two-year period, especially among girls. In particular, the importance of physical infrastructure such as walking tracks, residential streets with low speed limits and traffic/pedestrian lights was highlighted in relation to increases in active transport among girls.

Research suggests that parents are more protective of their daughters than sons [29], and that girls are granted independent mobility at a later age than boys [28], so traffic calming may be related more to change in girls' active transport compared with that of boys. Thus, while safety-related features of the local road environment may be beneficial to the broader community, these features may be particularly important for promoting active transport among girls. As described earlier, international research has identified that girls, in general, are less active than boys, and become less active during adolescence [34–36]. Therefore, it is crucial to identify strategies to increase aspects of girls' physical activity.

This research may inform urban planners, policy makers and local government in the development and design of neighbourhoods. In particular it highlights the importance of traffic calming measures and other physical infrastructure such as walking tracks in creating neighbourhoods that support and encourage active transport among youth. By promoting habitual physical activity such as active transport among children and adolescents, it may be possible to stem age-related declines in physical activity.

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Summary report