Australasian Transport Research Forum 2018 Proceedings
30 October – 1 November, Darwin, Australia
Publication website: http://www.atrf.info

Families, children and car: the environmental cost of chauffeuring children

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Abstract

Parenting responsibilities in the context of children's mobility have been subject to a substantial change over the last few decades. Children's current activities and travel patterns are significantly different to the previous generations when they were at the same age. Today's children are exposed to increased car use and are chauffeured for the majority of their trips. A range of social and environmental factors have contributed to the formation of these travel patterns which include the changing societal perceptions of safety (traffic and stranger danger), easy access to cars, increased income levels, higher employment rates for women, increased number of trips children undertake due to contemporary lifestyles and the built environment conditions that privilege private car usage over other travel modes. Social issues associated with reduced independent mobility of children have been highlighted by previous research. However, the environmental cost of these lifestyles have been researched to a lesser degree. Based on the preliminary findings of an ongoing major research project, this paper delves further into the environmental cost of 'parental taxis' through examination of 53 parental surveys regarding travel patterns to and from extra-curricular activities. The paper aims to produce an evidence base surrounding the environmental cost of the parental car dependent lifestyles of today's children and their families. The findings exhibit a large number of round trips (both during the week and on the weekend) to educational destinations other than school for 10 to 13 year old children. These figures highlight the significant potential for carbon emission reduction through the conversion of some of these trips to non-car modes.

1. Introduction

While the increased number of car trips taken by school aged children and the increased responsibility of parents to accompany children has been widely acknowledged, the 'journey to work' is still the main focus of official statistical data from the Australian Bureau of Statistics. Children's travel patterns and parents' time spent on accompanying their children to school and other educational activities are not represented in these statistics. Similarly, the carbon emission outcomes of child related private usage is generally overlooked in the fields related to sustainability mobility. For example, while a few researchers discussed the link between child friendly cities and sustainable cities (Malone & Tranter 2003; Tranter & Pawson 2001; Tranter & Sharpe 2008), a systematic understanding of how child related private car usage contributes to carbon footprint of our cities is still lacking.

This paper examines the preliminary results of parental surveys as part of an ongoing research project into the number of car trips parents make to accompany their children to various extra-curricular activities and the associated carbon footprints of these trips.
The first two sections of the paper provide an overview of the contemporary lives of families with children and the place of the car in their daily lives along with transport related carbon emissions. The data analysis section is followed by the survey results regarding the round trips, private car usage for transporting children to extra-curricular activities and parents' thoughts on chauffeuring their children. The carbon emission outcomes of the parent accompanied car trips to extra-curricular activities are calculated in this section followed by discussion and a conclusion.

2. Background

2.1. Children in the car era

Post-war planning policies prescribing low density and segregated land uses as well as an obsession with developing high speed motorways, made car centric cities the norm particularly across the developed countries. It has been well documented that private car use is significantly correlated with urban sprawl and urban design as a barrier to sustainability on many levels (Newman & Kenworthy 1999; 2006; Girardet 2010). For example, the residents in post-war, outer suburbs exhibit higher levels of car dependence (Newton & Meyer 2010). This car era, which is continuously reinforced by planning and transport policies favouring sprawl and highway construction, has significant implications for families with children. For example, in many Australian cities outer suburbs have been presented as the default choice for families with children because of greater housing affordability and space (Freeman & Tranter 2011; Malone & Hasluck 2016; Woolcock, Gleeson & Randolph 2010).
Despite the well reported social, physical and emotional benefits of active transport for children (Veitch et al. 2017; Wolfe & McDonald 2016; van Loon et al. 2014) it is known that families with children have complex travel patterns that heavily rely on cars (Bierbaum & Vincent 2013; Warner & Rukus 2013; Fyhri et al. 2011; Sallis et al. 2006).
It has been recognised that the car is a key instrument to manage the demanding expectations (created by ourselves or others) in our increasingly complex social lives as a result of structural changes such as 'an increase in the number of families in which both parents are working, increased divorce rates and growing number of single parents' (Corsaro 2011, p.276; Chatterton et al. 2015; Hjorthol & Fyhri 2009). This is particularly evident within the daily life of families with school aged children and the desire to be a responsible parent (Bennetts et al. 2018; Chatterton et al. 2015; Nakanishi, Dillon & Tranter 2017).
Throughout this era, the car has continued to change the meaning of distance and often has been associated with freedom and quality of life in political discourses (Hillman 2003). In the meantime, children and their families were highlighted as distinctive subjects of the spatial and social inequities that were generated by car privileging transport policies (Collins & Kearns 2005). Lehner-Lierz (2003) contested the view of cars affording freedom and explained how it created new dependencies for women in the context of women generally being responsible for 'escorting their children, grandchildren and other sick and older members of the family and neighbours' (p.137). In the context of the complex

employment and commute characteristics of dual earner families with children, Schwanen (2007) elaborated on how fathers' lifestyles and labor force participation were also affected by their responsibilities to chauffeur children, particularly to school and childcare.
Concerns about traffic danger is one of the most commonly cited reasons for increased parental car trips and reduced walking and cycling rates among children (Kottyan et al. 2014; Carver, Timperio & Crawford 2013; van Loon & Frank 2011; Malone 2007; Salmon et al. 2013). The car dominated environments characterised by large volumes of high speed traffic continue to compromise children's safety in cities (Ewing & Dumbaugh 2009; Hillman 2003; Sheller & Urry 2000). Corresponding with this car dominance of the streets and cities in general and parental concerns over traffic safety children disappeared from the streets and public places, with the car becoming the standard travel mode when accessing school and other educational and recreational activities (McLaren & Parusel 2011; Tranter & Sharpe 2008; Tranter & Sharpe 2012). This shift has also corresponded with the creation of child specific places aiming to keep children out of harm's way. Many scholars have been critical of these children specific places that eventually segregate children from the broader neighbourhood and cities in general (Broberg, Kyttä & Fagerholm 2013; Whitzman & Mizrachi 2012; Gillespie 2013; Tranter & Pawson 2001; Spencer & Woolley 2000).
Lehner-Lierz (2003) described this complex travel patterns of families with children as the phenomenon of 'islandisation' that induces numerous short trips. She outlined that children's lives take place in the islands that are separated with driving distances, such as home island, school island, sports island, ballet island and playing island (p. 131). She highlighted the importance of de-emphasising the 'kilometres driven' and the recognition of these short trips in transport planning discourses (p. 135). Similarly, Carver, Timperio and Crawford (2013) recognised the importance of children's freedom to every day non-school destinations such as sports grounds, parks and shops.
Another critical way in which this era has manifested itself is the ideologic shift of traffic problems from being a social policy issue to an individual issue (Sauter 2003). For example, de-politicisation and individualisation of traffic accidents became evident with children and their parents generally being the responsible parties not the system (Sauter 2003; Hillman 2006). Parusel and McLaren (2010) also criticised the political environment that endorses the 'traffic safekeeping' as the responsibility of parents and children and the lack of political will to address the actual issues about the dominance of cars. Similarly, granting children independent mobility has often been associated with irresponsible parenting or in some cases criminalised (Hillman 2006; Acharya 2016). This is highly problematic in relation to the importance of social culture emphasised by Fujii and Taniguchi (2014) where the sustainable travel modes are socially desirable values.

2.2. Transport related carbon emissions

In general, the environmental impact of car oriented mobility has been long recognised. For example, road transport related carbon emissions (mainly from passenger motor vehicles) account for 10% to 35% of total carbon emissions in countries such as US, Canada, UK, Sweden and Australia. In Australia, transport is the third largest and highest growing source of greenhouse gas emissions and cars are responsible for 46% of total transport related emissions (Climate Council 2018). It was also projected that these transport related emissions will increase (Commonwealth of Australia 2017).

While technological improvements related to fuel efficiency of passenger vehicles are important in arresting these trends (Commonwealth of Australia 2017), it has been argued that the reduced cost of travel as a result of increased fuel efficiency is likely to increase demand and therefore private car usage (Hensher 2008; Sorrell 2015). In addition, the preference of fuel intensive vehicles such as 4WDs and SUVs amongst families with children is likely to offset the emission reductions through technological improvements (Gilbert et al. 2018).

Children and transport related carbon emissions are generally an under researched area with the exception of a few scholars. In Sweden, children's contribution to increased transport related carbon emissions were compared to households without children in research highlighted by Nordström, Shogren and Thunström (2017). With regard to the age of children, they found that children aged 7 to 17 year old had the largest impact in relation to transport related carbon emissions compared to younger and older children. Australian scholars have also emphasised the environmental issues associated with reduced independent mobility of children (Malone & Tranter 2003; Tranter & Pawson 2001; Tranter & Sharpe 2008), while Hillman (2010) listed the potential carbon reduction amongst the benefits of children's independent mobility. This paper aims to quantify the carbon emission outcomes of parental car trips to transport children to extra-curricular activities and explore the potential for carbon reduction through converting some of these trips to more sustainable modes.

3. Methodology

As part of an ongoing research project, 53 surveys were completed by parents of children aged 10 to 13 years, across 4 schools (2 primary, 1 secondary and 1 P-12 school) in inner city and middle ring suburbs of Melbourne in 2017. In addition to various socio-demographic attributes such as housing type, suburb lived, ethnicity, household size, the survey questions were designed to capture the number and type of extra-curricular activities, travel patterns to/from these activities and parents' view on the private car usage for their children's transport.

Schools were selected to represent local catchment areas, diverse socio-economic characteristics and mixed residential density. All schools were located within 8km radius to the CBD. The land use of the suburbs where the schools were located ranged from medium to high density housing. Socio-economically these suburbs had medium to high SES. All schools were in close proximity to train and/or tram stops and situated in areas with a provision of walking and cycling infrastructure (e.g. traffic calming, pedestrian crossings, overpasses on nearby main roads and dedicated bike lanes). This study has been approved by the UniSA Ethics Committee and gained the required approval from educational authorities as well as approval from school principals and teachers.

Children in the selected classes (across Year 5 to 7) were provided with participation information sheets and parental consent forms to take home. Only those who returned their consent forms were eligible to participate in the research activities administered by the researcher during class time (children's surveys are not included in this article). Participant children took the parental surveys home with a reply-paid envelope provided by the researcher. The parental surveys were completed between April and September in 2017 (Term 2 and 3).

4. Data analysis

SPSS (version 24) software was used to create frequency tables, descriptive statistics and cross tabulations to identify the frequency of round trips to non-school destinations (i.e. extra-curricular activities). The open ended questions aimed to have an understanding of parents' views on the private car usage for transporting their children and their opinions on the barriers and solutions to improve children's use of active transport and public transport. Parents' thoughts on ways to decrease the car usage for their children's activities were categorised into six groups, namely proximity, public transport, active transport in groups, active transport infrastructure, lifestyle and other transport modes.

In terms of the type of extra-curricular activities, parents reported the type of activity, travel mode for this activity and duration of the return trip. The actual travel times reported by parents were categorised into groups of 15 minutes or less, 16-30 minutes, 31-45 minutes, 46-60, 61-90 and 91-120 minutes. The average trip length was calculated for each trip (return) to non-school activities. Based on the average urban speed of 40km/h (Austroads 2015 cited in BITRE 2015, p.15) these time values were converted to average distances. The average travel times and distances ranged from '8 minutes, 5.3km' to '105.5 minutes, 70.3km' (Table 1).

Prior to calculating the carbon emission outcomes of these trips, the tailpipe CO_2 (gr/km) for each vehicle type (based on the vehicle types that parents reported for using for these activities) was found out through the calculators in the Green Vehicle Guide (Commonwealth of Australia 2018). The total carbon emission outcomes of each trip within a week was calculated via the following formula:

Total amount of CO_2 = tailpipe CO_2 (gr/km) x distance travelled (km)

The potential carbon reductions resulting from short trips was calculated based on the car trips with average distance of 5.3km for return (2.7km one way). The design of the questionnaires was based on the number of round trips undertaken to attend these extra-curricular activities and did not consider the trips that were made as part of a tour.

Table 1: Average travel time and distance

Trip codes	Average minutes (return)	Average distance based on 40 km/h (return)
A	8	5.3
B	23	15.3
C	38	25.3
D	53	35.3
E	75.5	50.3
F	105.5	70.3

5. Sample characteristics

Parents were asked to answer the questions only about the child who brought the questionnaire home. Out of the 53 parents completing the questionnaires that had children aged 10 to 13 years, 28 were girls (54.9%),23 were boys (45.1%) and 2 were unstated. The year levels of children ranged from Year 5 (34.6%), 6 (34.6%) and 7 (30.8%). The sample had 100% car ownership rates with 17% owning one car, with 71.7 % owning two cars and 11.3% owning three cars. More than half of the families lived in a single storey house (either

separate or attached to another) (n= 29) while 43.4% lived in 2-3 storey townhouses (n=23) and only 1 family lived in apartment blocks (1.9%). Out of respondent parents, 11.8 % had one child (n=6) while the 52.9 % had two children (n=27) and 35.3 % had 3 or more children under the age of 18 years (n=18).

In terms of the ethnic background of the families, majority of the parents indicated that they spoke no language other than English at home (86.5%, n=45).

Just over 28% of families lived within 1km from their schools, while 67.9 % lived within 2 km (n=36). The weekly travel patterns to/from school data indicated that 35.2 % families drove their children to school 1 to 3 times while nearly 30 % drove 4 to 5 times a week. The amount of car usage from school was less, with 19.5 % using the car for school pick up 1 to 3 times and 33.3 % using the car 4 to 5 times a week. Overall the weekly frequency of car usage was higher for the school drop offs than for school pick ups. The corollary of this is that the proportion of children who were never picked up from school by a car was 47.1 % compared to 35.3 % for those who were never dropped off to school by a car.

6. Results

6.1. Number of round trips, destinations, travel mode and trip length

Out of 53 parents, only 6 parents indicated that they did not undertake any weekday or weekend round trips to accompany their children to non-school destinations. For the weekday trips, more than half of the parents reported three or more round trips during the week (60.2%). For the weekend trips, a similar proportion of parents reported two or more round trips for the child who participated in the research project (59.2%) (Table 2). Out of all extra-curricular activities, swimming and basketball were the most commonly attended activities by respondent families (n=19) followed by football and dance/drama (n=14) (Figure 1). The car was the most dominant travel mode for all of these activities. The only other travel mode used to access these non-school activities was walking which took place for music and tennis classes (Table 3).

With regard to the duration of these trips, basketball trips had the biggest variety followed by football trips. Nevertheless, the majority of basketball and football trips required car travel time less than 30 minutes. In total, the non-school destination with the highest frequency of shortest trips (less than 15 minutes) was swimming with seven trips followed by dance/drama trips (n=6) (Table 4).

The cross tabulations between the total number of school aged children per household and the amount of car usage to access extra-curricular activities indicated that car usage was the highest with the families with two and three children, compared to families with less or more children.

Table 2: The frequency of weekly trips to non-school activities (#)

No of weekday round trips	No of parents	% parents	No of weekend round trips	No of parents	% parents
0	6	11.3	0	6	12.2
1	6	11.3	1	14	28.6
2	9	17.0	2	16	32.7
3	13	24.5	3	6	12.2
4	7	13.2	4	4	8.2
5	2	3.8	5	2	4.1
6	4	7.5	6	1	2.0
7	3	5.7			
8	1	1.9			
9+	2	3.8			

Figure 1: Type of extra-curricular activities (#)

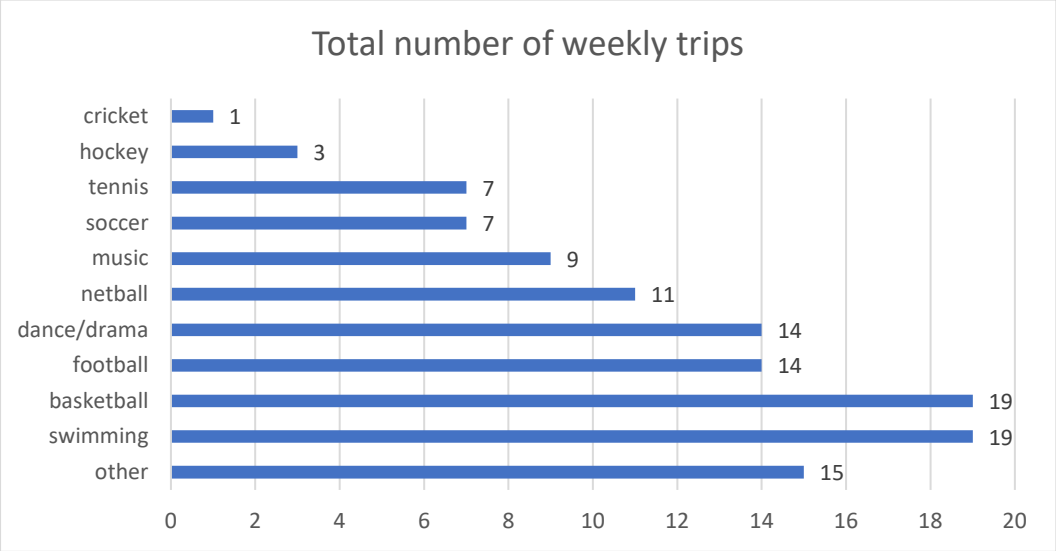

Table 3: Travel mode to weekly extra-curricular activities (#)

	Car	Walk	Cycle	Bus	Tram/train
Swimming	19				
Basketball	19				
Football	14				
Dance/drama	14				
Netball	11				
Soccer	7				
Music	6	3			
Tennis	6	1			
Cricket	1				
Hockey	3				
Other	14	1			

Table 4: Duration of trips to extra-curricular activities

	Swim		Basketball		Football		Dance/drama		Netball		Music		Soccer		Tennis		Hockey		Cricket		Other	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
15 mins or less	7	43.8	5	29.4	5	41.7	6	60.0	2	25.0	5	71.4	3	50.0	4	66.7	1	1.9	1	1.9	2	18.2
16-30 mins	9	56.3	7	41.2	4	33.3	3	30.0	4	50.0	1	14.3	1	16.7	2	33.3					7	63.6
31-45 mins			2	11.8	2	16.7	1	10.0	1	12.5	1	14.3	1	16.7							2	18.2
46-60 mins			1	5.9	1	8.3			1	12.5			1	16.7								
61-90 mins			1	5.9																		
91 mins or more			1	5.9																		
Total	16	100.0	17	100.0	12	100.0	10	100.0	8	100.0	7	100.0	6	100.0	6	100.0	1	1.9	1	1.9	11	100.0

6.2. Reasons for driving

In response to the question for reasons for driving their children to school and other activities, time constraints due to other commitments was the most frequently mentioned reason by parents (n=23, 65.7%) followed by weather (n=12, 34.3%). Some parents specifically stated that having extra-curricular activities after school was a reason for them to drive to/from school (n=5, 14.3%) (Table 5).

Table 5: Reasons for driving

Reasons for driving	Responses	Percent of Cases*
Time constraints	23	65.7%
Weather	12	34.3%
Distance	6	17.1%
Extra-curricular	5	14.3%
On the way to work or train station	5	14.3%
Poor public transport	3	8.6%

* do not sum to 100% due to multiple responses

6.3. Thoughts on car usage for child transport

In response to the question regarding what parents think about their car usage to transport their children, just over 40% of the parents indicated that they would want to use the car less while the remaining 60% reported that they are not sure or they believe they do not use the car much. When asked about the reasons for wanting to use the car less, environmental benefits were recognised by most of the parents followed by the health benefits such as physical activity opportunities created by active transport.

When asked what interventions could be conducted to make their child's life less car dependent, 'close proximity to non-school destinations' such as sports, dance and music venues was the most common response. This was followed by the need for better public transport particularly with access to outer suburbs where some sports events take place (Table 6).

Table 6: Thoughts on overall car usage for transporting children

Parents' thoughts	N	Percent of Cases*
Close proximity to non-school destinations e.g. sports, dance, music venues	18	56.3%
Better public transport	9	28.1%
Active transport together, parents taking turns for supervision	4	12.5%
Better AT infrastructure e.g. pedestrian bridge over highways	3	9.4%
Less busy lifestyles, women stop being expected to do everything	2	6.3%
Car pooling, school bus	2	6.3%

* do not sum to 100% due to multiple responses

6.4. Carbon emission outcomes of the car trips to extra-curricular activities

Total tailpipe carbon emissions for each type of extra-curricular activity indicated that the largest amount was for basketball followed by swimming. The carbon emissions emitted from all the car trips to these activities in total was 374,316 grams (0.37 tonnes) for a week. When the carbon emissions for the shortest car trips (average 8 minutes, 5.3 km for return) were separated from this amount, it was reduced by 50,662 grams of CO2 in a week. In the scenario where these short car trips are converted to active transport trips, this would be equivalent to a 13.5% reduction and 1.82 tonnes of CO2 annually (Table 7).

Table 7: Carbon emissions from the car trips to extra-curricular activities

	Swimming	Basketball	Football	Soccer	Netball	Hockey	Tennis	Cricket	Music	Dance/drama	Total (gr)	Total (tonne
For all trips	72163	80446.7	63973.8	30539.7	30623.9	1489.3	11654.4	3320.1	15880.9	64224.6	374316.4	0.37
Shortest trips* removed	62485.2	73397.7	55912.5	27741.3	28005.7		6089.4	3320.1	9001.5	57700.3	323653.7	0.32
Reduction for a week	9677.8	7049	8061.3	2798.4	2618.2	1489.3	5565		6879.4	6524.3	50662.7	0.05
Reduction %	13.4	8.8	12.6	9.2	8.5	100.0	47.8		43.3	10.2	13.5	
Reduction for a term**	87100.2	63441	72551.7	25185.6	23563.8	13403.7	50085		61914.6	58718.7	455964.3	0.46
Reduction for a year***	348400.8	253764	290206.8	100742.4	94255.2	53614.8	200340		247658.4	234874.8	1823857.2	1.82
* trips with average 8min travel time (return)												
** 9 weeks a term												
**** 4 terms a year												

7. Discussion

This paper presents some preliminary findings of a larger study which is amongst the first to examine the creation of socially and environmentally sustainable communities through child and youth friendly places, in the context of active transport and active play. These findings, while preliminary, demonstrate a high number of round trips (both during the week and on the weekend) to educational destinations other than school amongst children aged 10 to 13 years old. The most frequently attended activities were swimming and basketball. It is possible that some of these results are influenced by the time of the year the surveys were conducted (during autumn and winter). For example, the Australian schools offer season specific sports curriculum and basketball (along with football, soccer and hockey) is generally played during Term 2 and 3.

The findings of this paper also demonstrated that car use rates were higher for non-school destinations compared to school trips. For example, the proportion of school trips where parents did not drive their children ranged between 35% (to school) to 47% (from school). This was compared to less than 5% for trips to extra-curricular activities. Basketball and football trips exhibited the biggest variation in duration reflecting the multiple destinations used for these activities rather than fixed venues that are likely to be local e.g. music, swimming.

The car was the most frequently used travel mode to these activities. Music and tennis were the only classes to where children had a non-car access, indicating a local venue, probably within the school grounds. Public transport was the least used travel mode amongst children involved which was consistent with the findings of previous studies (Hjorthol & Fyhri 2009). In terms of the type of cars parents reported, 43.4% of cars used for these activities were 4WDs and SUVs. Out of 53 families involved, only 2 families (3.8%) reported hybrid car ownership. Overall, the proportion of fuel intensive cars were high with 32.1% (cars with 6 cylinders or more). This compares to the 51-55% in some agricultural locations with the highest proportion of these vehicles in Australia (BITRE 2017, p.20).

These high rates of private car usage for parents transporting their children to organised activities are consistent with the downward trends in the children's independent mobility (Hillman 2010; Tranter & Sharpe 2008; Malone & Tranter 2003; Tranter & Pawson 2001). A common reason reported by parents for high rates of car trips to extra-curricular activities was the proximity to venues for extra-curricular activities. This was particularly evident in the way that sports training or matches were often undertaken at different venues each week, highlighting the extension of children's daily activities beyond their local areas and the large range afforded by car. Also, a lack of efficient, reliable and well connected public transport services was highlighted by many families as a barrier to using more sustainable modes of transport.

There were some suggestions to establish parental protection network to take turns for supervising active transport trips in groups. In the context of time constraints being a major reason for many parents for choosing car over other modes, this suggestion for active transport as a group is likely to meet with more support if pursued. For example, nearly 66 % (n=23) of respondent parents indicated that time constraints was a primary barrier to using more sustainable modes of travel. Parents who were working or studying (either part time or full time) were more likely to mention time constraints and the weather conditions compared

to non-working parents. Similarly, the parents who had two or three children were more likely to report 'time constraints' as a reason to drive their children to school and other activities.

In terms of the solutions suggested by parents to improve active transport and public transport use, two broad themes emerged. Namely infrastructure and policy related improvements. Infrastructure related suggestions included land use improvements in the context of mixed land use and proximity to various child and youth related services. Policy related suggestions ranged from school/sports club based interventions (e.g. active transport as a group, school bus, car pooling) to changes at a society level such as less busy life styles.

These results further support the idea of the promotion of sustainable mobility being a multi-faceted issue that requires changes not only to infrastructure but also to policies and educational programs (Davison et al. 2008; McDonald & Aalborg 2009).

In terms of the environmental cost of these trends, if the shortest car trips to these extra-curricular activities were to be converted to active transport, then the data from this sample indicates that the carbon savings for a week would be around 50,662 grams. This would equate to approximately 0.46 tonnes for a school term and 1.8 tonnes for a year. This compares to the average Australian household's annual greenhouse gas emissions of 18 tonnes (Environment Protection Authority 2011).

Since the carbon emission outcomes of the non-school activities were calculated based on a single trip in a week for each category (and only for one child per family), the actual amounts each week (and per year) would likely to be higher as most parents reported more than once a week attendance at these activities (such as basketball training taking place on several days each week). Also, the short trips to schools have not been included in the analysis and their inclusion would again increase this amount.

Additional carbon savings are likely to be realised if these trips can be converted, since short trips associated with cold engine starts result in larger carbon emissions compared to longer trips (Frank et al. 2000; de Nazelle et al. 2010).

In terms of the other trips made to areas outside of the reach of active transport modes, the carbon savings would be substantial if some of these trips could be replaced with public transport trips. Many parents already expressed an interest in a higher uptake of public transport by reporting the importance of having better public transport options that are frequent, reliable and with access to destinations other than the CBD (e.g. along the routes from west to east rather than south to north in Melbourne).

Many schools across Australia have developed school travel plans with the assistance from their local or state governments. Though this is an important step towards promoting active transport for school aged children, their adoption by schools is optional and the focus of these travel plans is only the journey to/from school. Schools and sports clubs appear to place greater responsibility on parents to transport children to extra-curricular activities than was the case decades ago. The inclusion of after school activities, particularly sports events organised as school based teams, would provide a more comprehensive approach and would have a greater impact on reducing individual car reliance. Such travel plans would likely to meet with high acceptance rates amongst school families given the desire for more community based initiatives for children's mobility (e.g. parental networks for transport, car pooling) that were indicated by parents in this study.

8. Conclusion

The contribution of transport in greenhouse gas emissions and the disproportionally high share of private cars in transport-related emissions in Australia, has been widely recognised. These transport emissions are projected to increase despite the predicted improvements in vehicle efficiency. This article elaborates on the fact that transport related carbon emissions are higher for families with children by describing the context in which these carbon emissions occur. The preliminary findings demonstrate that the conversion of children's short trips to their activities from car-based to other transport modes would result in significant environmental savings. In the scenario where all return trips to destinations within 2.7 km converted to active transport, the possible carbon reduction would be approximately 13.5%. This amount is substantial compared to the Australia's carbon emission reduction target of 26% between 2005 and 2030.

The other implication of this paper for policy and practice is the contribution to the evidence base on the importance of children's trips to non-school destinations for low carbon mobility. Some researchers (Carver, Timperio & Crawford 2013; Hjorthol & Fyhri 2009) previously argued that the 'journey to school' is not the most significant journey for families with children. Though the conversion of parental taxis to/from schools into active transport trips are more easily achievable (de Nazelle et al. 2010) and still present a wide range of benefits in relation to public health and social and environmental sustainability, the trips to extra-curricular activities are often more in the form of single purpose trips compared to school trips (e.g. school trips are often a chain of wider travel patterns on the way to work, on the way to 'park n ride' facility for work). Furthermore, the findings of this study showed that having extra-curricular activities after school was a reason for some parents to drive to/from school. It can therefore be assumed that switching these trips to extra-curricular activities to non-car modes would also decrease the frequency of car trips to and from school.

Creating a behaviour change that results in the conversion of all car trips to non-car trips for families with children is not realistic (at least in the short term) for many reasons. However, given the high frequency of trips that parents undertake to transport their children, the carbon abatement potential is significant even if a small number of these trips replaced by non-car modes. Parents need to be supported by physical and social conditions to reduce their car usage, rather than being expected to individually break their daily habits and travel patterns within existing conditions. Their concerns for safety, their special needs created by complex lifestyles as parents, their fears about appearing as a 'neglecting parent' all need to be addressed to make way for this change. For this, a concerted approach consisting of changes related to physical transport infrastructure, urban form, land use, social norms and educational programs are needed.

A good starting point would be re-shifting the centre of expectations and responsibilities for one's mobility (and traffic safety) from the individuals and their cars to a wider society and system. In the context of highly car dependent lifestyle of families with children, this future society might ideally look like a place where children's trips to schools and other educational activities are enacted by parents, schools, sports clubs and local governments, with the perception that driving is not an automatic human right (Sauter 2003) and perhaps with an assumption that no families have access to cars rather than assuming the opposite. How would the daily life of a school aged child look like if the car was not an option for travelling?

9. Acknowledgements

This work was supported by a PhD scholarship provided by the CRC Low Carbon Living Limited.

10. References

Acharya, M 2016, "Parents fined for letting kids walk to school unsupervised", SBS News, viewed 10 June 2018, https://www.sbs.com.au/yourlanguage/hindi/en/article/2016/08/05/parents-fined-letting-kids-walk-school-unsupervised.

Bennetts, SK, Cooklin, AR, Crawford, S, D'Esposito, F, Hackworth, NJ, Green, J, Matthews, J, Strazdins, L, Zubrick, SR, & Nicholson, JM 2018, 'What Influences Parents' Fear about Children's Independent Mobility? Evidence from a State-Wide Survey of Australian Parents', *American Journal of Health Promotion*, doi: 10.1177/0890117117740442.

Bierbaum, A & Vincent, J 2013, 'Putting Schools on the Map: Linking Transit-Oriented Development, Households with Children, and Schools', *Transportation Research Record: Journal of the Transportation Research Board*, no.2357, pp. 77–85.

Broberg, A, Kyttä, M, & Fagerholm, N 2013, 'Child-friendly urban structures: Bullerby revisited', *Journal of Environmental Psychology*, vol. 35, pp. 110–120.

Bureau of Infrastructure, Transport and Regional Economics (BITRE) 2017, *Fuel economy of Australian passenger vehicles — a regional perspective*, Information Sheet 91, BITRE, Canberra.

Bureau of Infrastructure, Transport and Regional Economics (BITRE) 2015, *Traffic and congestion cost trends for Australian capital cities* Information Sheet 74, BITRE, Canberra.

Carver, A, Timperio, A, & Crawford, D 2013, 'Parental chauffeurs: what drives their transport choice?', *Journal of Transport Geography*, vol. 26, pp. 72–77.

Chatterton, T, Williams, D, Marsden, G, Mullen, C, Anable, J, Docherty, I, Faulconbridge, J, Cass, N, Roby, H, & Doughty, K 2015, 'Flexi-mobility: Helping local authorities unlock low carbon travel?'

Collins, DCA & Kearns, RA 2005, 'Geographies of inequality: Child pedestrian injury and walking school buses in Auckland, New Zealand', *Social Science and Medicine*, doi: 10.1016/j.socscimed.2004.04.015.

Commonwealth of Australia 2018, *Green Vehicle Guide*, viewed June 2018, https://www.greenvehicleguide.gov.au/.

Commonwealth of Australia 2017, *Australia's emissions projections 2017*, viewed 1 June 2018, http://www.environment.gov.au/system/files/resources/eb62f30f-3e0f-4bfa-bb7a-c87818160fcf/files/australia-emissions-projections-2017.pdf.

Corsaro, WA 2011, *The sociology of childhood* (3rd ed.), Pine Forge Press, Thousand Oaks, CA.

Davison, KK, Werder, JL & Lawson, CT 2008, 'Peer reviewed: Children's active commuting to school: Current knowledge and future directions', *Preventing chronic disease*, vol. 5, no. 3.

de Nazelle, A, Morton, BJ, Jerrett, M, & Crawford-Brown, D 2010, 'Short trips: An opportunity for reducing mobile-source emissions?', *Transportation Research Part D: Transport and Environment*, doi: 10.1016/j.trd.2010.04.012.

Environment Protection Authority 2011, *Australian Greenhouse Calculator*, viewed 28 July 2018, https://www.epa.vic.gov.au/agc/r_emissions.html#/!

Ewing, R. and Dumbaugh, E 2009, 'The built environment and traffic safety: a review of empirical evidence', *Journal of Planning Literature*, *23*(4), pp.347-367.

Frank, LD, Stone, B, & Bachman, W 2000, 'Linking land use with household vehicle emissions in the central puget sound: Methodological framework and findings', *Transportation Research Part D: Transport and Environment*, doi: 10.1016/S1361-9209(99)00032-2.

Freeman, C & Tranter, PJ 2011, *Children and their urban environment: Changing worlds*, , Routledge.

Fujii, S & Taniguchi, A 2014, 'Theoretical Underpinnings of Practical Strategies for Changing Travel Behaviour', in *Handbook of Sustainable Travel*, doi: 10.1007/978-94-007-7034-8.

Fyhri, A, Hjorthol, R, Mackett, RL, Fotel, TN, & Kyttä, M 2011, 'Children's active travel and independent mobility in four countries: Development, social contributing trends and measures', *Transport Policy*, vol. 18, no.5, pp. 703–710.

Gilbert, H, Whitzman, C, Pieters, JH, & Allan, A 2018, 'Children and sustainable mobility : small feet making smaller carbon footprints Children and sustainable mobility : small feet making smaller carbon footprints', *Australian Planner*, vol. 0, no.0, pp. 1–8, doi: 10.1080/07293682.2018.1480500.

Gillespie, J 2013, 'Being and becoming: Writing children into planning theory', *Planning Theory*, vol. 12, no.1, pp. 64–80.

Girardet, H 2010, *Regenerative cities*, , World Future Council.

Hensher, DA 2008, 'Climate change, enhanced greenhouse gas emissions and passenger transport – What can we do to make a difference?', *Transportation Research Part D*, doi: 10.1016/j.trd.2007.12.003.

Hillman, M 2003, 'The relevance of climate change to future policy on walking and cycling', in *Sustainable Transport*, , pp. 20–31, Elsevier.

Hillman, M 2006, 'Children's rights and adults' wrongs', *Children's Geographies*, doi: 10.1080/14733280600577418.

Hillman, M 2010, 'More daylight, better health: why we shouldn't be putting the clocks back this weekend.', *BMJ (Clinical Research Ed.)*, doi: 10.1136/bmj.c5964.

Hjorthol, R & Fyhri, A 2009, 'Do organized leisure activities for children encourage car-use?', *Transportation Research Part A: Policy and Practice*, doi: 10.1016/j.tra.2008.11.005.

Kottyan, G, Kottyan, L, Edwards, N, & Unaka, N 2014, 'Assessment of Active Play, Inactivity and Perceived Barriers in an Inner City Neighborhood', *Journal of Community Health*, vol. 39, no.3, pp. 538–544, doi: 10.1007/s10900-013-9794-6.

Lehner-Lierz, U 2003, 'The role of cycling for women', in *Sustainable Transport*, , pp. 123–143, Elsevier.

Malone, K 2007, 'The bubble-wrap generation: children growing up in walled gardens', *Environmental Education Research*, vol. 13, no.4, pp. 513–527, doi: 10.1080/13504620701581612.

Malone, K & Hasluck, L 2016, 'Aliens in a Suburban Environment', *Growing Up in an Urbanizing World*, p. 81.

Malone, K & Tranter, PJ 2003, 'School grounds as sites for learning: Making the most of environmental opportunities', *Environmental Education Research*, vol. 9, no.3, pp. 283–303.

McDonald, NC & Aalborg, AE 2009. 'Why parents drive children to school: implications for

safe routes to school programs', *Journal of the American Planning Association* 75 (3):331-342.

Mclaren, AT & Parusel, S 2011, 'Parental traffic safeguarding at school sites: Unequal risks and responsibilities', *Canadian Journal of Sociology, 36(2)*, pp. 161-184.

Nakanishi, H, Dillon, A & Tranter, P 2017, Getting more children walking and cycling to school: insights from parents in three Australian cities, paper presented at the *Australian Transport Research Forum Conference*, 27 – 29 November 2017, Auckland, New Zealand, viewed 10 June 2018, http://atrf.info/papers/2017/index.aspx.

Newman, P & Kenworthy, J 1999, *Sustainability and cities: overcoming automobile dependence*, , Island Press.

Newman, P & Kenworthy, J 2006, 'Urban design to reduce automobile dependence', *Opolis*, vol. 2, no.1.

Newton, P & Meyer, D 2010, 'The determinants of urban resource consumption', *Environment and Behavior*, p. 0013916510390494.

Nordström, J., Shogren, J. F., & Thunstrom, L, 2017, *Do parents leave a smaller carbon footprint?*, IFRO Working Paper, Vol. 2017, No. 12, Copenhagen: Department of Food and Resource Economics, University of Copenhagen.

Parusel, S & McLaren, AT 2010, 'Cars before kids: Automobility and the Illusion of school traffic safety', *Canadian Review of Sociology*, doi: 10.1111/j.1755-618X.2010.01227.x.

Sallis, JF, Cervero, RB, Ascher, W, Henderson, KA, Kraft, MK, & Kerr, J 2006, 'An ecological approach to creating active living communities', *Annu. Rev. Public Health*, vol. 27, pp. 297–322.

Salmon, J, Veitch, J, Abbott, G, ChinApaw, M, Brug, JJ, teVelde, SJ, Cleland, V, Hume, C, Crawford, D, & Ball, K 2013, 'Are associations between the perceived home and neighbourhood environment and children′s physical activity and sedentary behaviour moderated by urban/rural location?', *Health Place*, vol. 24, pp. 44–53, doi: 10.1016/j.healthplace.2013.07.010.

Sauter, D 2003, 'Perceptions of walking–ideologies of perception', in *Sustainable Transport*, , pp. 200–209, Elsevier.

Schwanen, T 2007, 'Gender differences in chauffeuring children among dual-earner families', *Professional Geographer*, doi: 10.1111/j.1467-9272.2007.00634.x.

Sheller, M. and Urry, J 2000. 'The city and the car', *International journal of urban and regional research*, *24*(4), pp.737-757.

Sorrell, S 2015, 'Reducing energy demand: A review of issues, challenges and approaches', *Renewable and Sustainable Energy Reviews*, doi: 10.1016/j.rser.2015.03.002.

Spencer, C & Woolley, H 2000, 'Children and the city: a summary of recent environmental psychology research', *Child: Care, Health and Development*, vol. 26, no.3, pp. 181–198.

The Climate Council, 2018, *What's the deal with transport emissions*, viewed 20 June 2018, https://www.climatecouncil.org.au/resources/transport-emissions-and-climate-solutions/.

Tranter, P & Pawson, E 2001, 'Children's Access to Local Environments: a case-study of Christchurch, New Zealand', *Local Environment*, vol. 6, no.1, pp. 27–48, doi: 10.1080/13549830120024233.

Tranter, P & Sharpe, S 2008, 'Escaping Monstropolis: child-friendly cities, peak oil and Monsters, Inc', *Children's Geographies*, vol. 6, no.3, pp. 295–308.

Tranter, P & Sharpe, S 2012, 'Disney-Pixar to the rescue: harnessing positive affect for enhancing children's active mobility', *Journal of Transport Geography*, vol. 20, no.1, pp. 34–40, Retrieved from http://ac.els-cdn.com/S0966692311000470/1-s2.0-S0966692311000470-main.pdf?_tid=d36ecec2-34c5-11e5-ac50-00000aacb362&acdnat=1438046176_cda73ad4eb7105ab7420b6c055788da2.

van Loon, J & Frank, L 2011, 'Urban Form Relationships with Youth Physical Activity: Implications for Research and Practice', *Journal of Planning Literature*, vol. 26, no.3, pp. 280–308, doi: 10.1177/0885412211400978.

van Loon, J, Frank, LD, Nettlefold, L, & Naylor, P-J 2014, 'Youth physical activity and the neighbourhood environment: Examining correlates and the role of neighbourhood definition', *Soc Sci Med*, vol. 104, pp. 107–115, doi: 10.1016/j.socscimed.2013.12.013.

Veitch, J, Carver, A, Salmon, J, Abbott, G, Ball, K, Crawford, D, Cleland, V, & Timperio, A 2017, 'What predicts children's active transport and independent mobility in disadvantaged neighborhoods?', *Health and Place*, doi: 10.1016/j.healthplace.2017.02.003.

Warner, ME & Rukus, J 2013, 'Planning for Family Friendly Communities: Motivators, Barriers and Benefits', Issue Brief. Ithaca, NY: Department of City and Regional Planning, Cornell University.

Whitzman, C & Mizrachi, D 2012, 'Creating Child-Friendly High-Rise Environments: Beyond Wastelands and Glasshouses', *Urban Policy & Research*, vol. 30, no.3, pp. 233–249, doi: 10.1080/08111146.2012.663729.

Wolfe, MK & McDonald, NC 2016, 'Association Between Neighborhood Social Environment and Children's Independent Mobility.', *Journal of Physical Activity & Health*, doi: 10.1123/jpah.2015-0662.

Woolcock, G, Gleeson, B, & Randolph, B 2010, 'Urban research and child-friendly cities: a new Australian outline', *Children's Geographies*, vol. 8, no.2, pp. 177–192, doi: 10.1080/14733281003691426.