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## **Cities for children: the effects of car use on their lives**

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### ***Abstract***

In Britain, children are walking less than they used to. A major factor causing this decrease is the growth in car use. These trends are reducing children's quantity of physical activity, with serious implications for their health. The purpose of this paper is to explore these themes using results from a 3-year research project entitled 'Reducing children's car use: the health and potential car dependency impacts' which has been carried out in the Centre for Transport Studies at University College London in collaboration with others including Hertfordshire County Council, with fieldwork being carried out in Hertfordshire, an area immediately north of London.

A major component of the project was a study of 200 children aged between 10 and 13 years of age using motion sensors coupled with the use of a travel and activity diary over four days. The sensors measured movement in three dimensions which was converted to activity calories, a measure of physical activity. Events from the travel and activity diaries were mapped onto the data from the sensors so that it was possible to isolate and analyse specific time periods, events and journeys.

From these data, the comparative effects of different forms of transport on children's physical activity have been established, producing clear evidence of the benefits of walking compared with car travel. It is found that the use of the car is linked to particular types of activity. For example, structured out-of-home activities, such as clubs and sports lessons tend to be reached by car while informal activities such as playing, are associated more with walking. This means that the shift from the latter to the former is one of the factors underlying children's increasing use of the car. The motion sensors have facilitated the calculation of the intensity of various activities in terms of using activity calories. Walking is second only to physical education (PE) or games lessons in intensity. It was found that, for the older children, walking to and from school for a week used more activity calories than two hours of PE or games lessons, which is the recommended standard in Britain. It was also found that children who walk to activities are more active when they arrive at activities than those who travel by car, particularly in the more energetic activities, which suggests that walking brings wider health benefits than is generally recognised.

Another strand of the project upon which this paper is based is the evaluation of walking buses. From the various surveys in the study it appears that about half of the trips on walking buses were previously walked, but there is not an equivalent decrease in the number of car trips because many of the children were being dropped at school in the course of a longer trip by a parent.

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## ***Introduction***

In Britain, children are walking less than they used to. The percentage of trips by children that were walked declined from 47% in 1985/86 to 32% in 2002, while the percentage of trips by children that are by car increased from 35% to 52%, over the same period, with even greater shares of the total distance travelled. Cycling has also shown a major decline, from 4% to 2% of children's trips (Department for Transport, 2004).

The major factor causing the decrease in walking is the growth in car use. There are a number of causal factors including increasing car ownership, the general process of urban decentralisation, school admission policies, women's working and childcare arrangements, and concerns about children's safety. For example, the percentage of trips to school made alone by children aged 5-10 years in Britain fell from 21% in 1985/86 to 10% in 2002 (Department for Transport, 2004). Much of the overall increase in car use is associated with meeting the needs of children, particularly for short trips (Mackett, 2001, 2003). It is likely that these trends will continue (Mackett, 2002).

These trends are reducing children's quantity of physical activity, with serious implications for their health. The purpose of this paper is to explore these themes within the context of a research project entitled 'Reducing children's car use: the health and potential car dependency impacts' which has been carried out in the Centre for Transport Studies at University College London in collaboration with others including Hertfordshire County Council, with fieldwork being carried out in Hertfordshire, an area immediately north of London. The project is described in more detail elsewhere (Mackett et al, 2004).

## ***Methodology***

A major main strand of the project was the assessment of children's travel and activity patterns using portable motion sensors. The equipment used was the RT3 tri-axial accelerometer which produces total activity counts in units of vector magnitude. These can be converted to activity calories using formulae programmed into the equipment using data on the age, gender, weight and height of the child. (Activity calories are calories used in undertaking physical activity. The RT3s can also convert activity calories to total calories, i.e. including the calories that are used by the body to function and develop even when the person is passive, by adding on a constant based on the physical characteristics of the person. Activity calories are used in this work).

The RT3s are the size of a small pager and are worn around the waist in a purpose-made holster on a belt. They can be worn for all activities except those which would make them wet. They were set to record movements on a minute-by-minute basis. An example of the output is shown in Figure 1. In this study, the volunteers were asked to wear the monitor from a Wednesday to a Monday, with data being collected for the four days Thursday, Friday, Saturday and Sunday. These days were chosen so that both school days and weekend days were included.

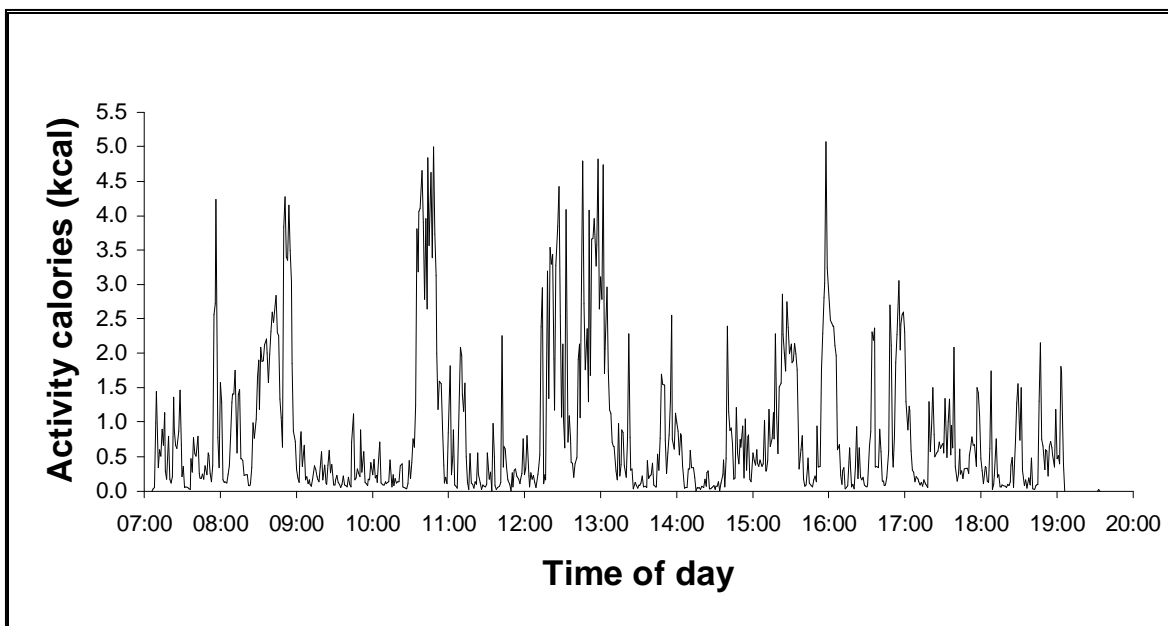


Figure 1 An example of the output from an RT3 motion sensor

The children were asked to keep a travel and activity diary for the four days. An example extract from the diary is shown in Figure 2. The events from the diary have been mapped on the output traces from the RT3s so that the activity levels associated with each event or trip could be identified. (This was done in consultation with the children in order to reduce the number of possible miscodings).

Then I went to...	I got there at	Played on the computer then played football
Peter's house	15:20	
	I travelled there by	
	Walked	I left at
		18:40
Then I went to...	I got there at	Watched TV and went to bed
Home	19:00	
	I travelled there by	
	Car	I left at
		:

Figure 2 An example extract from a travel and activity diary

The events recorded in the children's activity and travel diaries have been classified, using the typology shown in Table 1. There are three levels so that analysis can be carried out using whichever level is most appropriate in terms of the trade-off between the number of cases and having sufficient detail to illustrate the point. It can be seen that five modes of travel have been represented including 'other'. For the school day, the only type of lesson that is differentiated is physical education (PE) or games lessons, since these are likely to be significantly more active than other lessons. Periods not in class have been classified as 'break', including the period before entering school, lunch time and morning break.

Table 1 The classification system for events recorded in the children's diaries

<b>Broad level</b>	<b>Middle level</b>	<b>Narrow level</b>
Travel	Travel to school	Walk, car, bicycle, bus, and other
	Travel from school	Walk, car, bicycle, bus, and other
	Other travel	Walk, car, bicycle, bus, and other
School	PE or games lessons	PE or games lessons
	Other lessons	Other lessons
	Break	Break
Structured out-of-home activities	Structured ball games	Badminton, basketball, cricket, football, golf, netball, squash, and tennis club or lesson
	Other structured sport	Athletics, cycling, dance, gymnastics, horse riding, martial arts, and skating club or lesson
	Organisations	After-school clubs, Air Training Corps, Crusaders, Scouts/Guides, and youth club
	Tuition	Choir, drama, extra tuition, and music lesson
Unstructured out-of-home activities	Unstructured ball games	Badminton, basketball, cricket, football, rounders, tennis, and unclassified ball games
	Other unstructured activities	Cycling, disco, dog walking, jogging, scootering, skateboarding, and walking
	Other outdoor play	Active play and general play
Out-of-home activities shared with parents	Out-of-home activities shared with parents	Appointment, event, fair/fete, meal out, and shopping
In home	At own home	At own home
	At other people's homes	At other people's homes
Other	Physical work	Physical work
	Waiting	Waiting
Not monitored	Not monitored	Not monitored

The children's activities outside home and school are divided into three categories: 'Structured out-of-home activities', 'Unstructured out-of-home activities' and 'Out-of-home activities shared with parents'. Unstructured activities include activities that are regarded as 'playing'. 'Active play' describes play where a specific energetic activity, such as 'On the swings' was mentioned. 'Out-of-home activities shared with parents' includes events that parents take children on, but may include similar events which where the child was not accompanied by an adult such as some shopping trips, because the diary did not ask questions about who accompanied the child on a trip. The category of 'Not monitored' covers the period when the RT3 was not worn, which is mainly when the children were in bed.

A total of 200 children at eight schools in Hertfordshire were involved in this part of the study. Five children provided inadequate data for analysis, leaving a sample of 195. These are split fairly evenly between boys and girls. They were in two year groups: Year 6 (aged 10-11) and Year 8 (aged 12-13), with rather more in the former than the latter, as shown in Table 2.

Table 2 The number of children providing data for analysis

	<b>Boys</b>	<b>Girls</b>	<b>Total</b>
Year 6 (age 10-11)	54	58	112
Year 8 (age 12-13)	42	41	83
Total	96	99	195

### *Children's activities and travel*

The data collected permits analysis of the number of activities that children undertake. Table 3 shows the number of activities of each type that the children attend over a week, broken down by mode of travel. School is the main activity, not surprisingly. The second most common activity is going to other people's homes, and then going on trips with parents. The children go on just over one structured and just over one unstructured activity a week, on average. This implies that they only go on just over two outdoor non-school activities a week that would be regarded as providing physical activity.

Table 3 Number of activities each week per child classified by mode of travel to the activity

	Walk	Car	Bicycle	Bus	Other	Total
At school	2.6	1.4	0.1	0.4	0.0	4.6
Structured out-of-home activities	0.3	0.8	0.0	0.0	0.0	1.2
Unstructured out-of-home activities	0.7	0.4	0.0	0.0	0.0	1.2
Out-of-home activities shared with parents	0.6	1.7	0.1	0.0	0.1	2.4
At other people's homes	1.5	1.4	0.1	0.1	0.0	3.1
Other	0.3	0.3	0.0	0.0	0.0	0.7
Total	5.9	6.1	0.4	0.6	0.1	13.1

It can be seen that car and walk are used almost equally, but there are some interesting differences. Much of the walking is to school, whereas car use is spread more evenly over various activities. The largest category of car use is to go on activities shared with parents, which is interesting because it suggests that quite a lot of children's car use may be spent meeting parental or household needs, such as shopping. It may well be that parents feel they have to take children with them rather than letting children out to play alone or with friends because of concern about road safety and possible abduction. A clear picture that emerges is the use of walking and car to reach the structured and unstructured out-of-home activities. Car is used more for the former while walk is more popular for the latter. This suggests that one reason for increasing car use by children is the switch from unstructured to structured sport and games. It can also be seen than modes other than walk and car are not used very much, and much of their use, particularly bus, is to school. One of the major uses of travel by children to reach other people's homes, which is split fairly evenly between walk and car. It is quite possible that walking is mainly to the homes of friends, while the car may be used to go on family visits to relatives.

### *Children's physical activity*

The RT3 monitors have been used to calculate the amount of physical activity undertaken by the children in the sample over four days. Using the classification system shown in Table 1, it is possible to calculate how much energy is used in the various activities, as

shown in Table 4. From the overall figures, it can be seen that structured and unstructured out-of-home activities both use about 1.9 activity calories each minute, and the least energetic activity is being at home, which uses 0.5 activity calories each minute. This shows that the time spent watching television, playing computer games and just sitting around uses very little energy. It should be borne in mind that this does not include sleeping because the children did not wear the monitors in bed.

Table 4 Intensity of various activities undertaken by children

		Year 6		Year 8		Overall
		Boys	Girls	Boys	Girls	
At school	PE or games lesson	2.7	2.6	3.2	4.1	3.1
	Other lessons	0.6	0.5	0.6	0.7	0.6
	Break	1.9	1.5	2.3	2.0	1.9
	Overall	0.9	0.8	1.1	1.2	1.0
Structured out-of-home activities	Structured ball games	2.0	2.3	2.4	1.9	2.2
	Other structured sport	1.9	1.4	3.6	1.9	2.2
	Organisations	1.8	1.2	1.7	0.8	1.3
	Tuition	0.7	0.9	0.3	0.5	0.7
	Overall	1.6	1.4	2.7	1.5	1.9
Unstructured out-of-home activities	Unstructured ball games	1.9	0.9	3.1	2.7	2.5
	Other unstructured activities	1.7	1.4	1.9	2.9	1.8
	Other outdoor play	1.5	1.6	1.6	1.5	1.5
	Overall	1.6	1.4	2.4	2.5	1.9
Out-of-home activity shared with parents		1.0	1.0	1.4	1.4	1.1
At own home		0.5	0.5	0.6	0.6	0.5
At other people's homes		0.9	0.8	0.9	0.7	0.8
Travel	Walking	2.1	1.9	2.6	3.2	2.5
	Car	0.8	0.8	1.0	1.1	0.9
	Bicycle	2.0	0.9	1.9	2.4	1.9
	Bus	-	1.2	1.5	1.6	1.5
	Overall	1.3	1.0	1.7	2.0	1.5
Other	Physical work	1.1	1.7	0.7	1.0	1.1
	Waiting	1.0	0.9	1.2	0.7	1.0
Overall		0.8	0.7	1.1	1.0	0.9

It can be seen that, overall, walking is second only to PE or games lessons in intensity, equal with unstructured ball games and higher than all the structured out-of-home activities. In the age-gender groups it is not lower than fourth. This suggests that walking offers great potential as a way for children to consume calories, being as good as ball games, whether in an organised class or self-organised. It has the advantage that it requires no preparation, special equipment or expenditure of money. This table also shows that break times at school are very important for children's energy consumption, and that reducing their length to provide more time for lessons has implications for their health.

Given that the children only do just over one structured and one unstructured activity each week, this analysis shows how important walking is as a form of exercise. It has been shown that walking is second to PE or games lessons in intensity, but the durations are likely to be different. One way to make a comparison is to see how many calories would be consumed over a week. Table 5 shows the number of calories that would be spent in five

journeys to and from school and in two hours of PE or games lessons. The travel to school is classified by the mode used for the greatest duration. For example, most bus trips include an element of walking to and from the bus stop. The activity calories spent in this walking are included in the bus trips. None of the younger children travel to school by bus, and no older girls cycle. Two hours of PE or games lessons has been used because the National Healthy School Standard Guidance (Department of Health, Department for Education and Employment, 2000) includes Standard 3.5 which says that schools can meet the requirements of the standard by offering all pupils, whatever their age and ability, two hours of physical activity a week within and outside the national curriculum.

Table 5 A comparison of the number of activity calories consumed in a week travelling to and from school with two hours of PE or games lessons

	Year 6		Year 8		Overall
	Boys	Girls	Boys	Girls	
Walk to and from school	211	206	530	658	388
Car to and from school	149	159	191	225	164
Bicycle to and from school	450	365	370	-	404
Bus to and from school	-	-	439	373	403
Overall travel to and from school	192	186	475	509	317
PE or games lessons for two hours	327	311	378	495	376

*Note: the journeys to and from school have been classified by the mode used for the greatest duration where more than one mode was used.*

It can be seen that walking to school consumes many more activity calories than two hours of PE or games for the older children. Younger children who walk to school use about 65% of the calories that they use in PE or games lessons in a week. This difference occurs for two reasons: the older children walk more intensively than the younger ones and they have longer journeys on average because most of them are at secondary schools of which there are fewer than primary schools, so they are located further from homes, on average.

It may be noticed that cycling and bus both use more calories even than walking. However, the number of cycling trips are very small and so need to be treated with caution, and only the older children use the bus. Children who travel by car to school consume quite a few calories, but many fewer than in two hours of PE or games. Calories are consumed travelling by car partly because many car trips involve some walking, either to and from the car, and partly because some journeys are in two stages, for example a child might be dropped off at the childminder's home by a parent who is driving to work, and then the childminder walks the child to school later. It should also be noted that, in the case of trips by car and bus, acceleration of the vehicle may have an effect on the RT3 reading, but experiments with the equipment suggested that this effect is very small.

It is possible to examine the relationship between the intensity of various activities and the mode of travel used to travel there, as shown in Table 6. It can be seen that, overall, the children who walk use 1.1 activity calories per minute and those who go by car use 1.0. This is an interesting but small difference. When the figures are compared before rounding the former is 16% higher. When individual activities are examined, there are some much larger differences. For example, for PE or games lessons, the walkers use 3.5 activity calories a minute, compared to 2.4 for car users. At break times the values are 2.0 and 1.7 respectively. Similarly, for unstructured out-of-home activities, the equivalent values are 2.2 and 1.8, and for out-of-home activities shared with parents, the values are 1.3 and 0.9.

For structured out-of-home activities, the values are 1.9 and 1.7 respectively. The difference is the same way round, but perhaps smaller than one might expect. This may be because the car has to be used to reach some very energetic, specialised activities. It is quite clear that for most activities, those who walk to them are more energetic when there than those who travel by car. The only group for whom the converse is sometimes true is the Year 6 girls, and this may reflect greater use of the car to escort them to some very energetic events, and parental reluctance to allow them out to walk much.

Table 6 Intensity of various activities, classified by the mode of travel used to arrive

	Year 6				Year 8				Overall	
	Boys		Girls		Boys		Girls		walk	car
	walk	car	walk	car	walk	car	walk	car		
PE or games lesson	3.2	2.1	2.7	2.4	3.5	2.9	4.7	2.4	3.5	2.4
Other school lesson	0.6	0.6	0.5	0.5	0.6	0.7	0.8	0.5	0.6	0.5
School break	1.9	1.8	1.6	1.5	2.3	2.2	2.2	1.2	2.0	1.7
Structured out-of-home activities	1.8	1.5	1.3	1.6	2.5	1.9	-	1.7	1.9	1.7
Unstructured out-of-home activities	1.5	1.5	1.2	1.6	3.2	2.5	2.5	2.1	2.2	1.8
Out-of-home activity with parents	1.0	0.8	1.3	0.8	1.7	1.1	1.0	1.1	1.3	0.9
At another home	0.9	0.7	0.9	0.8	1.3	0.9	0.8	0.7	1.0	0.8
Overall	1.0	0.9	0.9	0.9	1.4	1.3	1.3	0.9	1.1	1.0

This suggests it may be useful to promote initiatives that encourage children to walk to school rather than go by car. One such intervention which has been examined in the project on children's car use at UCL is the 'walking bus'. A walking bus is a group of children who walk to school along a set route, collecting other children along the way at 'bus stops', escorted by several adult volunteers, one of whom is at the front (the 'driver') and one is at the back (the 'conductor'). The concept of walking buses was proposed in 1993 in a book by David Engwicht (1993). Now there are walking buses in the USA, Canada, Great Britain, Australia, New Zealand, and Denmark.

Walking buses have been examined using both a postal survey of all the schools in Hertfordshire where a walking bus has or could be set up, plus an in depth study of five walking buses over a period of a year. The results have been used in an evaluation framework to establish the effectiveness of such interventions (Mackett et al, 2003a, b, c).

It was found that about 50% of the trips made on walking buses were previously made by car. Hence such initiatives can help to shift children from cars to walking, both directly, and, in the longer run, by building up children's and parents' confidence to allow children to walk unescorted by an adult. There may not be much reduction in traffic on the road because, in many cases, the car was still being used by the parent for other trips, usually to work.



## *Conclusions*

Most children's trips are walked or by car. Walking is mainly to school or to other people's houses. Trips by car tend to be on trips with their parents, rather than to school or to structured or unstructured outdoor children's activities. Children tend to walk to unstructured out-of-home activities, whereas they usually go to unstructured activities by car. This suggests that the shift from unstructured to structured out-of-home activities may be one of the factors leading to increasing car use by children.

Children are least active when they are at home. This implies that parents should encourage children to be out of the house. In fact, in terms of physical activity, taking them out by car is better than letting them stay at home, because they will be more active when they arrive at the activity than they would have been at home. However, walking is much better for them than travelling by car. As a source of physical activity it is second only to PE or games lessons in terms of intensity. Over a week, walking to and from school provides more exercise than two hours of PE or games lessons, which is the recommended standard in Britain. Walking is generally better than the various out-of-home activities that children do, probably because it is more likely to be continuous.

Break times at school are very opportunities for physical activity by children. Replacing them by indoor lessons has serious implications for their health in terms of physical activity.

Children who walk to activities tend to be more energetic when they arrive than those who travel by car, particularly in more energetic activities. This suggests walking brings considerable benefits, both direct and indirect. One way to encourage children to walk is to introduce initiatives such as walking buses, which can help to get children into the habit of walking. In this study it was found that about half of the trips made on walking buses had previously been made by car, but that there was not an equivalent reduction in the number of car trips because many of the children were being dropped by parents in the course of a longer trip.

This all suggests that increasing car use by children is causing a significant reduction in their levels of physical activity, with serious implications for their health. Hence there is a real need to introduce measures to reduce car use by children and encourage more walking.

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