

## **1 INTRODUCTION**

The rationale of this research project was based on the recognition that car use by children was increasing, with consequent reductions in walking and cycling, with serious implications for their health, reflected in the current debate about childhood obesity. A related issue of interest was the extent to which children's current lifestyles are dependent on the car and the implications of this. One way to encourage children to use alternatives to the car is to introduce specific interventions to encourage use of the alternatives. However, there is no well-established methodology for evaluating the success of such interventions, so part of the project has involved the development of such a framework. Since the project started, the debate about children's lack of physical activity and the contribution of car use to it has grown, so this research has been very timely. Efforts have been made to ensure that the findings have contributed to the debate.

## **2 THE RESEARCH**

### **2.1 The research programme**

The research programme was divided into five strands, as indicated below. (The percentages are the approximate relative amounts of effort put into each strand.):

- a) Questionnaire distributed in schools to children and their parents and anthropometric measurements of the children (25%)
- b) Analysis of children's activity and travel patterns (40%)
- c) Evaluation of travel-to-school initiatives, focusing on walking buses (30%)
- d) Analysis of the attitudes of teenagers to the car (2%)
- e) Analysis of the effects of car use on children's cognitive and mental development (3%)

### **2.2 Methodology**

#### **a) The schools surveys**

Surveys were carried out in ten schools in Hertfordshire. All the schools were involved in Hertfordshire County Council's Safer Routes to Schools initiative. For a number of years, the transport consultancy Mouchel had carried out questionnaire surveys of children in schools and their parents on behalf of the County Council. It was agreed that there would be active co-operation between that work and the research on this project. This meant increasing the range of topics covered in the questionnaires to include questions on children's physical activity and parents' use of the car and their attitudes about their children's travel behaviour. Staff from the UCL project put effort into increasing the response rates, and ensuring that the questionnaires completed by the children could be linked with those from the parents at the individual level. Also, measurements were made of the children's weight, height and body-fat content. This information was all input into a database which included the anthropometric measurements, the children's patterns of travel and physical activity and parental attitudes to travel factors.

A total of 849 pupils in three year-group cohorts were covered by the surveys. The children were in Years 4, 5 and 7, with typical ages of 9, 10 and 12 respectively. Response rates of 95% were obtained in the pupil survey, 70% in the parent survey, and 88% for the anthropometric data exercise. Complete data from all three surveys were obtained for 65% of the children. Consistency checks were carried out on the data. Also the data were compared with sources such as the National Travel Survey to ensure that the data were representative of the population from which the sample came.

#### **b) Analysis of children's activity and travel patterns**

A major strand of the project was the assessment of the travel and activity patterns using RT3 portable motion sensors. The RT3 is a tri-axial accelerometer, manufactured by Stayhealthy, USA. The RT3s combine the movements in three directions to produce total activity counts in units of vector magnitude (VM). These were converted to activity calories using formula programmed into the equipment using data on the age, gender, weight and height of the child. 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 it wet. They were set to record movements on a minute-by-minute basis. 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. The children were asked to keep a travel and activity diary for the four days. The events from the diary were 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).

In order to classify the activity and travel patterns a suitable typology was developed. The typology has three levels so that analysis could be carried out using whichever level was most appropriate in terms of the trade-off between the number of cases and having sufficient detail to illustrate the point. Five modes of travel were represented including 'other'. For the school day, the only type of lesson that was differentiated was physical education (PE) or games

lessons, since these are likely to be significantly more active than other lessons. Periods not in class were classified as 'break', including the period before entering school, lunch time and morning break.

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.

### ***c) Evaluation of travel-to-school initiatives, focusing on walking buses***

One of the objectives of the project was to develop a framework for the systematic evaluation of interventions to improve children's welfare in the fields of travel and physical activity. To do this, a specific case had to be used so that the ideas can be tested in a practical context. The chosen case study was 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').

Five walking buses in Hertfordshire were studied in depth over a year in order to collect data to incorporate into the evaluation framework. Use of the evaluation framework involved the identification of all the parties that were active participants and then the collection of data from each of them about their roles and what they saw as the outcomes, both positive and negative. The participants involved were the headteacher, the walking bus co-ordinator, the parents, the children and the volunteers (who are usually parents of children using the walking bus). Children who had ceased to use the walking bus (and their parents) were interviewed as well as those still using it. Information was also collected about the walking bus route and where the children lived to see how far they walked. This was compared with their previous journeys in terms of mode used and distance travelled. This was all done in a table which summarised the information from which a judgement could be made about the success, or otherwise, of a walking bus.

To complement that work by providing evidence across a wider spectrum of situations, and to find out about schools which had not set up walking buses, a postal survey was conducted. This has covered all the schools in Hertfordshire which have, or could have, set up a walking bus. Questionnaires were sent to the 41 schools that had asked Hertfordshire County Council (HCC) to check potential walking bus routes for suitability and safety, as at January 2002. The questionnaires sent to the headteachers were in two parts: Part A to be completed by him or her, and Part B to be passed on to the co-ordinator of each walking bus. Twenty-six completed Part A's were received back, and Part B's for 26 walking buses at 23 schools (some schools had more than one walking bus). A fairly similar questionnaire was sent to the headteachers of the 464 schools in Hertfordshire that could have set up walking buses but had not done so. Responses were received from 213 schools, giving a response rate of 46%.

### ***d) Analysis of the attitudes of teenagers to the car***

Focus group interviews were carried out in three secondary schools in Hertfordshire, between December and April 2003. In each school, two group interviews were held, one with Year 12 pupils, one with Year 13 pupils. As far as possible, the groups contained equal numbers of males and females, and equal numbers of young people who lived in towns and the surrounding villages. Groups comprised between 8 and 14 participants and followed a checklist designed to explore the main research questions. Interviews typically lasted about one hour and all were tape-recorded and transcribed. At the beginning of each group interview pupils completed a short questionnaire to provide background information.

### ***e) The effects of car use on children's cognitive and mental development***

The work was conducted in primary schools with 88 children in Year 4 and Year 6, with ages ranging from 8 to 11 with a male to female ratio of 47:41. A travel questionnaire was used to gather information about the children and their travel patterns. Three tasks were used to measure children's spatial awareness, the first two of which involved sketching maps. The first sketch-map task was to draw the route the children took on their journeys from home to school and the second was to draw the area around the school. The third task was a landmark recognition task: the children were given a map of the local area with a number of landmarks indicated by arrows. The children then had to choose a photograph of the indicated landmark from a set of four photographs (the correct one and three distracters). The sketch map data were analysed for cartographic competence, the quality of the drawing of the map, and the placement of elements. A score was given for the number of correct responses on the landmark recognition task.

## **2.3 The research findings**

This project has generated a large number of findings which are described fully in the papers produced. As far as possible, the findings have been based on sound statistical analysis. The most significant findings are from the analysis of children's activity and travel patterns. From the RT3s the intensities (activity calories used per minute) were calculated (Table 1). It can be seen that PE and games lessons are the most intensive activities with an

intensity of 3.1, but not very far behind this come walking and unstructured ball games at 2.5, followed by structured sport at 2.2 and cycling and school break time at 1.9. At the bottom of the list come being at home at 0.5 and sitting in lessons at school at 0.6.

*Table 1 Intensity of various activities undertaken by children (activity calories per minute)*

School	PE or games lesson	3.1
	Other lessons	0.6
	Break	1.9
Clubs and tuition	Structured ball games	2.2
	Other structured sport	2.2
	Organisations	1.3
	Tuition	0.7
Playing	Unstructured ball games	2.5
	Other unstructured activities	1.8
	Other outdoor play	1.5
Out on trips		1.1
Physical work		1.1
Waiting		1.0
Own home		0.5
Other homes		0.8
Travel	Walking	2.5
	Car	0.9
	Bicycle	1.9
	Bus	1.5
Overall		0.9

*Table 2 Consumption of activity calories used in a week travelling to and from school and two hours of PE or games lessons*

Walk to and from school	388
Car to and from school	164
Two hours of PE or games	376

Whilst PE and games lessons are obviously good for children, the children in the sample only spent the equivalent of 70 minutes a week doing them. The benefits of walking relative to PE and games lessons are shown in Table 2. This shows that, on average, walking to and from school every day for a week uses more activity calories than two hours of PE and games lessons, the recommended standard. This also provides good evidence why travelling to and from school by car is bad for children in terms of physical activity. Not only does travelling to an activity by car use fewer calories than walking, as Table 3 shows, the children who walk use more calories when they arrive.

Children's lives are fairly dependent on the availability of a car, as Table 4 shows, with more events reached by car than walking. This shows that the main reasons the children go by car is to go on trips with parents, to go to other people's homes and to go to school. The trip to school is the main reason for walking. This suggests that trips other than walking to school need to be targeted in order to reduce children's car use significantly. Also it can be seen that going to clubs and tuition tends to be by car whereas children tend to walk when they go out to play. This suggests that the shift from unstructured to structured activities for children is one of the causes of their decrease in walking and that letting children go out to play is one of the best things that parents can do for their children's health. Outdoor play uses as many calories as organised activities and is more likely to be associated with walking.

The nature of the car trips to school was examined in the Schools Surveys. It was found that that only 28% of the 208 trips were being made to especially to take children to school. The majority were made as part of a longer trip: 47% of the parents were going on to work, 15% were involved in a complex trip taking two or more children to school or nursery, and 7% were going on to other destinations.

From the Schools Surveys it was also found that the significant factors determining modal choice were the distance to school, age and gender, with older boys the most likely to walk. It was found that a very high proportion (67%) of the

*Table 3 Intensity of various activities, classified by the method of travel used to arrive*

	Walk	Car
PE or games lesson	3.5	2.4
Other school lesson	0.6	0.5
School break	2.0	1.7
Clubs and tuition	1.9	1.7
Playing	2.2	1.8
Out on trips	1.3	0.9
Other homes	1.0	0.8
Overall	1.1	1.0

*Table 4 Number of activities each week classified by how the children travel*

	Walk	Car	Other	Total
At school	2.6	1.4	0.5	4.6
Clubs and tuition	0.3	0.8	0.0	1.2
Playing	0.7	0.4	0.0	1.2
Out on trips	0.6	1.7	0.2	2.4
Other homes	1.5	1.4	0.2	3.1
Other	0.3	0.3	0.0	0.7
Total	5.9	6.1	1.1	13.1

children never, or hardly ever, used public transport. 78 of the children (14%) were taken to school by car, always, or almost always, taken to out-of-school activities by car and never, or almost never, travelled by train or bus, suggesting that the car was a dominant aspect of their lives.

Another issue that was explored was the relationship between the child's car use and that of his or her parents. In order to try to establish this, the parents were asked whether or not the car was usually used to go to five activities: the main grocery shopping for the household, going swimming at the nearest pool, visiting the nearest town centre, visiting the nearest post office, and visiting the public library. The households were then classified into categories according to how many of the activities they used the car for. It was found that children from households where the parents did not use the car for travelling to any of these activities were much less likely to travel to school and after-school activities by car than other children, whereas those children whose parents used the car to go to all five activities were much more likely to go to school and after-school activities by car. Of course, this may be partly related to the location of the home relative to the various destinations, but for many of them, the choice of location would have been an explicit decision which made the household become car dependent.

From the focus group discussions with the teenagers it became clear that young adults saw the car as the mode of choice for most trips. The main exception was trips to London. They saw learning to drive as something they should do as soon as possible, as it is perceived as a means of obtaining independence from parents. Parents supported their children in becoming car users because it relieved their own concerns about their children's safety and responsibility to escort and collect their teenage children, often at very inconvenient times. This all suggests that young adults feel under no pressure or obligation not to drive cars as soon as they are able, and therefore that any education or training that they have had about the alternatives has had no long-lasting affect on their attitudes to car use.

As well as the effects of car use on the children physical activity and so on their physical health, some work was carried out into the effects on their cognitive and mental development. It was found that there was a small effect due to travel mode across the various measures; car users had lower scores on measures of map competence for the area-mapping task and for the landmark recognition task. It is possible that this effect is due to the distribution of travel modes for different ages and genders as older boys are more likely to walk to school and it is older boys who tend to do better on tasks of spatial awareness. The analysis of the placement of elements in the sketch map revealed that some groups are more accurate at placing, or are more likely to include, a particular element. For instance, a level crossing passed by, and probably waited at, by the majority of car users was more accurately placed by the car group than the walk group. Another instance was the inclusion of the local playground, a short walk from the school: this element was included by a large number of the younger children (Year 4), but hardly any of the older children (Year 6) included it. The analysis highlighted the influence that children's use of the environment and their mode of interaction with it (either as car passengers or walkers) can have on spatial representations. A larger sample would be needed to control fully for the effects of age and gender, and different instruments will be required to determine whether mode influences spatial awareness, or whether it is mode choice that is the function of cognitive skill level. This work will be continuing in the EPSRC-funded grant CAPABLE (GR/T09378/01).

One of the objectives of the project was to establish the effects of interventions on children's car use, and to develop a methodology for the systematic evaluation of such interventions. The 192 children in the schools surveys who had transferred from a primary or first school were asked about five different interventions which they might have had at that school including use of a walking bus at their previous school. Of the 192 children, 92 had class activities about exercise and activity, 90 had class activities about how people travel, 63 had a course on road safety or pedestrian training, 46 went on a cycle training course, and 15 used a walking bus to travel to school. Some of the children had been subject to more than one intervention, and some may have been subject to none. The first four interventions listed seemed to have had little impact on the choice of mode to school, in that the proportions walking and using car were close to the overall mean for all 192 children. Only one child cycled to school, and he or she did attend a cycle training course, so that might be a small, but useful, successful outcome. The most interesting result was for the 15 children who previously travelled to school by walking bus. None of them were travelling to school by car at the time of the survey and 11 of them walked, with the other four going by bus.

The framework to examine the impact of walking buses was used to examine five walking buses, with supporting information from the postal survey. From the postal survey it was found that the headteachers regarded the walking buses as successful, achieving the majority of their objectives, of which the two most popular were reducing congestion at the school entrance and giving the children more exercise. From the five walking buses studied in detail it was found that the main positive outcomes for the children were the social aspects, the pleasure of walking and the increase in exercise. The parents perceived similar benefits for their children, plus giving their children some independence. Many of the parents saw no benefits for themselves, but some recognised the benefits of increased exercise for themselves. The main disadvantages were the loss of flexibility for some parents, particularly those who acted as escorts, and for the children, the social aspects (having to walk with people they did not like) and having to

walk at all. The main cost of walking buses was the loss of time and the loss of flexibility for the parents who acted as escorts. The gains were for the children in terms of gaining exercise, pleasure and experience of walking and the time gains for parents who acted as escorts. The net transfer of time use from some parents to others caused some interpersonal friction.

A key issue was the impact of walking buses on car use. From the eleven walking buses that provided the data in the postal survey, it was found that between 32% and 100% of the children previously travelled by car, but many of them did not travel by car every day. On the five walking buses studied in depth, out of 73 children, 17 previously went by car and 14 sometimes did. Based on the evidence collected, it is estimated that about 50% of the trips on walking buses were previously by car. Given that there were 26 active walking buses in Hertfordshire at January 2003, it was estimated that the walking buses in Hertfordshire have led to 130 fewer trips to school by car by children. As mentioned above, it was also found that most trips to school by car are part of a longer journey, so the reduction in car the number of cars on the road is likely to be very small. This all suggests that walking buses are useful as ways of giving children more exercise and may lead to children walking to school more when they are older, but they do not have much impact on congestion except, perhaps, very locally.

### **3 Output of research staff**

The research staff were all actively involved in the development and testing of the various research instruments. They all made presentations to outside bodies and were involved in writing the various papers. James Paskins registered for a PhD part-time, based on the part of the project on analysis of the effects of car use on children's cognitive and mental development which he will continue at UCL as part of his work on the recently-awarded grant CAPABLE (Children's Activities, Perceptions and Beliefs in the Local Environment) (GR/T09378/01). The other researchers have gone to good positions elsewhere where they can use the experience gained in the course of this project.

### **4 Communication of research outputs**

Great emphasis has been put on disseminating the findings from this research. A list of papers and presentations is included at the end. A website was set up (<http://www.cts.ucl.ac.uk/research/chcaruse/>). There has been considerable interest in the findings, with information distributed through various media, information sent to four government departments (DfT, DfES, DCMS and DoH), appearance in the national press (e.g. The Times, 22 September 2003), and information provided for diverse outlets such as 'Take a Break' magazine and a Canadian TV programme about children. Interest in the results is being shown not only by transport professionals, but also by those in the fields of health, education and children's play. Presentations have or will be made at eight conferences outside the UK. The dissemination process is continuing, particularly in international refereed journals and in response to invitations to conferences and to present evidence. Currently a substantial report of the all the findings from the project is being prepared for dissemination via the Internet.

### **5 Potential benefits to society**

The findings of this research offer considerable benefits to society, for example, by producing sound evidence why children should walk rather than go by car, by showing that the shift for children from informal out-of-home activities to formal ones has led to an increase in car use, by showing that children who walk to activities are more active when they arrive than children who travel by car, and by showing that initiatives such as walking buses can be effective ways to attract children out of cars, although having little effect on traffic levels. All these and other findings are very valuable contributions to the current debates about childhood obesity and about travel to school, which lie at the interface between transport, education and health policy.

### **6 Cost-effectiveness**

The staff budget has been spent completely employing and training good research staff who have worked hard and effectively. There has been some underspend elsewhere for two reasons: the costs of the surveys in the schools were covered by Hertfordshire County Council by combining the surveys on this project with ones they were carrying out under their 'Safer Routes to School' programme, including printing, distribution and data processing, and the two researchers carrying out the fieldwork lived in Hertfordshire, which considerably reduced their travelling costs. Overall, this project has produced some very useful results, which have been disseminated widely and would seem to present very good value for money.

### **7 Papers and presentations (in order of being written)**

Mackett R L (2001) 'Are we making our children car dependent?' Invited lecture given at Trinity College Dublin, Ireland, 17 May 2001.

Mackett R L (2001) 'The effects of increasing car use by children', Paper written for presentation at the TRICS conference, The Britannia International Hotel, London, November 2001.

Mackett, R L (2002) 'Increasing car dependency of children: should we be worried?' *Proceedings of the Institution of Civil Engineers: Municipal Engineer*, 151, 29-38.

- Mackett R L and Paskins J (2002) 'Reducing children's car use: the health and potential car dependency impacts', Presentation to the North and South Thames Physical Activity Network Meeting, University of London Union, May 2002.
- Mackett R L, Lucas L, Paskins J and Turbin, J (2002) 'Understanding the car dependency impacts of children's car use', Paper presented at the Workshop on 'Children and Traffic' held in Copenhagen, May 2002.
- Mackett R L, Lucas L, Paskins J and Turbin, J (2002) 'Children's car use: the implications for health and sustainability', *Proceedings of the European Transport Conference*, held in Cambridge, September 2002 (PTRC, London).
- Turbin J, Lucas L, Mackett R L and Paskins J (2002) 'The effects of car use on children's physical activity patterns', Paper presented at the Symposium on Health Enhancing Physical Activity (HEPA) - Evidence-Based Promotion of Physical Activity, held in Helsinki, Finland, September 2002.
- Mackett R L, Lucas L, Paskins J and Turbin, J (2002) 'Health benefits of non-car travel by children', Paper presented at the Hertfordshire County Council Centre of Excellence Conference on 'School and Business Travel Plans' held in Hatfield, November 2002.
- McCarthy M, Mackett R, Turbin, J, Lucas L, Paskins J, and Edmunds L (2002) 'Health benefits of travel to school - evidence from a study of children's car use', paper presented at the European Public Health Association Conference, held in Dresden, Germany, November 2002.
- Mackett R L, Lucas L, Paskins J and Turbin, J (2003) 'A methodology for evaluating walking buses as an instrument of urban transport policy', *Transport Policy*, 10, 179-186, based on a paper presented at the First Annual Conference of SIG10 (Urban Transport Policy Instruments) of the World Conference on Transport Research Society, held in Leeds, July 2002.
- Edmunds L D, Mackett R L, Paskins J, Turbin J, Lucas L, and McCarthy M (2003) 'Does body status make a difference to physical activity patterns in two age groups?' Paper presented at the Satellite Symposium on Physical Activity and Weight Management, Tampere, Finland, May 2003.
- Mackett R L, Lucas L, Paskins J and Turbin, J (2003) 'The impact of walking buses', *Proceedings of the Transport Practitioners Meeting*, held at the University of Nottingham, July 2003 (PTRC, London).
- Mackett R L, Lucas L, Paskins J and Turbin, J (2003) 'The health benefits of walking to school', Proceedings of the SUSTRANS National Conference on 'Championing Safe Routes to School: Citizenship in Action', held at De Montfort Hall, Leicester, September 2003.
- Mackett R L, Lucas L, Paskins J and Turbin, J (2003) 'The effectiveness of initiatives to reduce children's car use', *Proceedings of the European Transport Conference*, held in Strasbourg, France, October 2003.
- Lucas L, Mackett R L, Paskins J and Turbin, J (2003) 'Walking buses – lessons and prospects', Paper presented at the LARSOA Plenary Meeting, Trumpington, Cambridge, October 2003.
- Paskins J, Mackett R L, Lucas L and Turbin J (2003) 'Walk of life', *Leisure Manager*, 21, 16-17 (2003).
- Mackett R L, Lucas L, Paskins J and Turbin, J (2003) 'Why do children travel by car so much, and does it matter?' Presentation at the EPSRC EQUAL Research Network Workshop on 'Inclusive Transport: today, tomorrow and the future: research challenges', held at the City Inn, Westminster, London, 20 November 2003 available at <http://www.fp.rdg.ac.uk/equal/>.
- Paskins J, Mackett R L, Lucas L and Turbin J (2003) 'Building physical activity into children's lives', Paper presented at the conference organised by HACO (Hertfordshire Association of Cultural Officers) 'Young people: the inactive generation: a time bomb ticking' at Hertfordshire University, Hatfield, 5 November 2003.
- Mackett R L, Lucas L, Paskins J and Turbin, J (2004) 'Increasing the amount of walking by children', Proceedings of the World Conference on Transport Research, Istanbul, Turkey, July 2004
- Mackett R L (2004) 'Evaluating school travel schemes', Briefing to the House of Commons Select Committee on Education and Skills, Portcullis House, Westminster, 17 March 2004.
- Mackett R L (2004) 'Making children's lives more active', Factsheet, Centre for Transport Studies, University College London, March 2004, also published in *Play Action: Fair Play for Children*, Spring 2004.
- Mackett R L (2004) 'Active children are healthier children', Presentation at the 51 Minute Challenge Conference, Church House Conference Centre, Westminster, London, 31 March 2004.
- Mackett R L, Lucas L, Paskins J and Turbin, J (2004) 'Cities for children: the effects of car use on their lives', Proceedings of the Walk21-V Cities for People Conference, Copenhagen, Denmark, 9-11 June 2004.
- Mackett R L, Lucas L, Paskins J and Turbin, J (2004) 'The therapeutic value of children's everyday travel', Paper submitted to the special issue of *Transportation Research A* on 'The Positive Utility of Travel'.
- Mackett R L, Lucas L, Paskins J and Turbin, J (2004) 'Making children healthier through walking', Paper to be presented at the Pro Walk/Pro Bike 2004 Conference, Victoria, British Columbia, Canada, September 2004 (paper being written).
- Paskins J (2004) 'Are differences in children's travel reflected in their cognitive maps?' Paper to be presented at the ICTTP 2004 - 3rd International Conference on Traffic & Transport Psychology, Albert Hall, Nottingham, September 2004 (paper being written).
- Paskins J (2004) 'Children's understanding of their local environments', Paper to be presented at the Open Space - People Space Conference, Edinburgh, October 2004 (paper being written).
- Plus four seminars to colleagues at UCL