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INCREASING CHILDREN'S VOLUME OF PHYSICAL ACTIVITY THROUGH WALK AND PLAY

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SUMMARY

This document looks at the contribution of walking and playing outside the home to children's volume of physical activity. The document draws on research carried out at University College London (UCL) in which 200 children were fitted with three-dimensional motion sensors and asked to keep travel and activity diaries over a period of four days. From these it is possible to establish what the children did, how they travelled and how much energy they used. Using these data, the contributions of unstructured out-of-home events (playing) and walking to children's volume of physical activity are demonstrated. It is also shown that these unstructured events tend to be associated with walking rather than use of the car, unlike structured out-of-home events. It is also shown that children who walk to events tend to be more active when they arrive than those who travel by car. The effect of an initiative to promote walking is considered. Conclusions are drawn about the need to remove various barriers to enable children to spend more time out of the home where they will be more active and so lead healthier lives, and the value of facilitating opportunities for walking.

Children's physical activity and travel

There is growing concern about decreasing volumes of physical activity in the whole population including children. There is considerable evidence that lack of physical activity can lead to a number of adverse health conditions including obesity (Department of Health, 2004). In Great Britain, the 2003 Annual Report of the Government's Chief Medical Officer (Donaldson, 2003) states that the growth in the proportion of overweight and obese children is a major concern. Quoting the Health Survey for England in 2001 (Department of Health, 2003), the report says 8.5% of 6 year olds and 15% of 15 year olds are obese. Between 1996 and 2001 the proportion of overweight children aged 6-15 years increased by 7% and obese children by 3.5%.

The evidence of the benefits and desirable amounts and type of physical activity is more limited for children than for adults (Riddoch, 1998). However, Biddle, Cavill and Sallis

(1998) argue that there are three main reasons for young people to take part in regular physical activity:

a) To optimise physical fitness, current health and well-being, and growth and development;
b) To develop active lifestyles that can be maintained throughout adult life;
c) To reduce the risk of chronic diseases of adulthood.

They acknowledge that neither the minimal nor the optimal amount of physical activity for children can be defined precisely. Notwithstanding this difficulty, they make the following recommendations:

a) All young people should participate in physical activity of at least moderate intensity for one hour per day;
b) Young people who currently do little activity should participate in physical activity of at least moderate intensity for at least half an hour per day.

Biddle, Cavill and Sallis (1998) state that moderate intensity activities for children may include brisk walking, cycling, swimming, most sports or dance, and that such activities may be carried out as part of transportation, physical activity, games, sport, recreation, work or structured exercise, and for younger children, as part of active play. Hence, the normal everyday events in which children participate, including travelling to and from school, can contribute to fulfilling their daily requirement for physical activity, which in turn, should lead to healthier lives. Most of these events take place outside the home, so there may be a good case for being outdoors more. Given that brisk walking is included on the list, this suggests that if children are travelling then walking or cycling is preferable from a health perspective to travelling by car. On the other hand, some of the events, such as organised sports require specialised facilities, which some children can only reach by car. In other words, it is important to consider two aspects of travel in terms of physical activity: firstly, the opportunity it provides to reach events that provide exercise such as organised sports; secondly, the physical activity it can provide in its own right, for example through walking and cycling.

An indicator of how active children are being is to see how often they leave the home, since it is easier to be active outside the home than in it. Table 1 uses data from the National Travel Survey to show the trends in trip making by children compared with the total population. It can be seen that over the period 1985/86 to 2002 there was a decline of about 4.7% in the number of trips made by children, while the whole population made 1.9% fewer trips over this period (in each case there was an increase in the total distance travelled). This suggests that children are leaving the home less in their free time, because they make the same number of trips to school and that is a significant proportion of their journeys.

Table 1 Number of trips per head each year in Great Britain

	1985/86	**2002**	**Change**	**% change**
Children	931	887	-44	-4.7
Whole population	1024	1008	-19	-1.9

Source: Department of Transport (1988), Department for Transport (2004)
Note: In 1985/86 children were defined as those aged under 16; in 1999/2001 they were those aged under 17

In Britain, children are walking less than they used to. As Table 2, shows 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 56%, 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. For trips to school, as shown in Table 3, the percentage of young children in Britain walking decreased from 67% to 51% from 1985/86 to 2002 while, for older children, the percentage dropped from 52% to 38% over this period. The net transfer has all been to the car.

Table 2 Percentage of children using various methods of travel

	1985/86	2002
Walk	47	32
Car	35	56
Bicycle	4	2
Other	14	11
Total	100	100

Source: Department for Transport (2004).

Table 3 Percentage of children using various methods of travel to school

	Age 5-10		Age 11-16	
	1985/86	2002	1985/86	2002
Walk	67	51	52	38
Car	22	41	10	24
Bicycle	1	1	6	2
Bus	9	6	29	32
Other	2	2	2	3
All	100	100	100	100

Source: 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 employment and childcare arrangements, and concerns about children's safety. For example, the number of children in Britain aged 5-10 years travelling to school alone fell from 21% in 1985/86 to 10% in 2002 (Department for Transport, 2004). Much of the increasing 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).

Another reason that children walk less may be that they are following the lead set by their parents. Fogelholm et al (1999) found that parental inactivity was a strong and positive predictor of child inactivity in a study of 129 obese children and 142 normal weight children plus their parents. It was found in surveys carried out as part of the project being discussed in this document, that children who went to school by car were more likely to have parents to use the car for going to many local services, but this may be partly due to their residential location (Mackett et al, 2002).

This evidence suggests that children are being discouraged from playing outside the home and travelling, and that when they do go out, they are more likely to go by car rather than walk or cycle than they used to. These trends are reducing their quantity of physical activity, with serious implications for their health. The purpose of this document is to demonstrate how

walking and playing contribute to children's levels of physical activity using results from a project entitled 'Reducing children's car use: the health and potential car dependency impacts'. The research 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 has been described in more detail elsewhere (Mackett et al, 2004). In the next section the key aspects of the methodology that underlie the findings in this document will be outlined. Then the results will be presented.

Methodology

A major main strand of the project was the assessment of the travel and activity patterns using portable motion sensors. The equipment used was the RT3 tri-axial accelerometer, manufactured by Stayhealthy, USA which measures movements in three directions. The RT3s combine all three acceleration vectors to produce an overall vector magnitude (VM) expressed in terms of activity counts. These can be converted into 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 events 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. Trost et al (2000) have shown that four days of monitoring of physical activity are required. 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. In presenting the results, the data for the weekdays have been multiplied by 2.5 and added to the weekend data to provide data for one week.

The children were asked to complete a travel and activity diary for the four days. An example extract from the diary is shown in Figure 2. The RT3 output was used as a visual aid to refine the times of specific events identifiable from the trace by the child and a researcher. The events recorded in the children's activity and travel diaries were classified, using the typology shown in Table 4 and put into an Access database. Because of the ambiguity of the word 'activity', which can mean either any event that a person carries out or imply the level of energy consumed in carrying out an event, the word 'event' will be used to describe activities such as being at school or an out-of-home activity. 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. The children's events outside home and school are divided into three categories: 'Structured out-of-home events', 'Unstructured out-of-home events' and 'Out-of-home events shared with parents'. Unstructured events include activities that are regarded as 'playing'. 'Active play' describes play where a specific energetic event, such as 'On the swings' was mentioned. 'Out-of-home events 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 include 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. One important event that is missing is swimming, because the RT3 monitors cannot function when wet. The overall mean amount of time spent swimming in a week was 22 minutes. 28 of the children recorded swimming as an event in their diaries. The data were collected in March and May in 2003 and 2003.

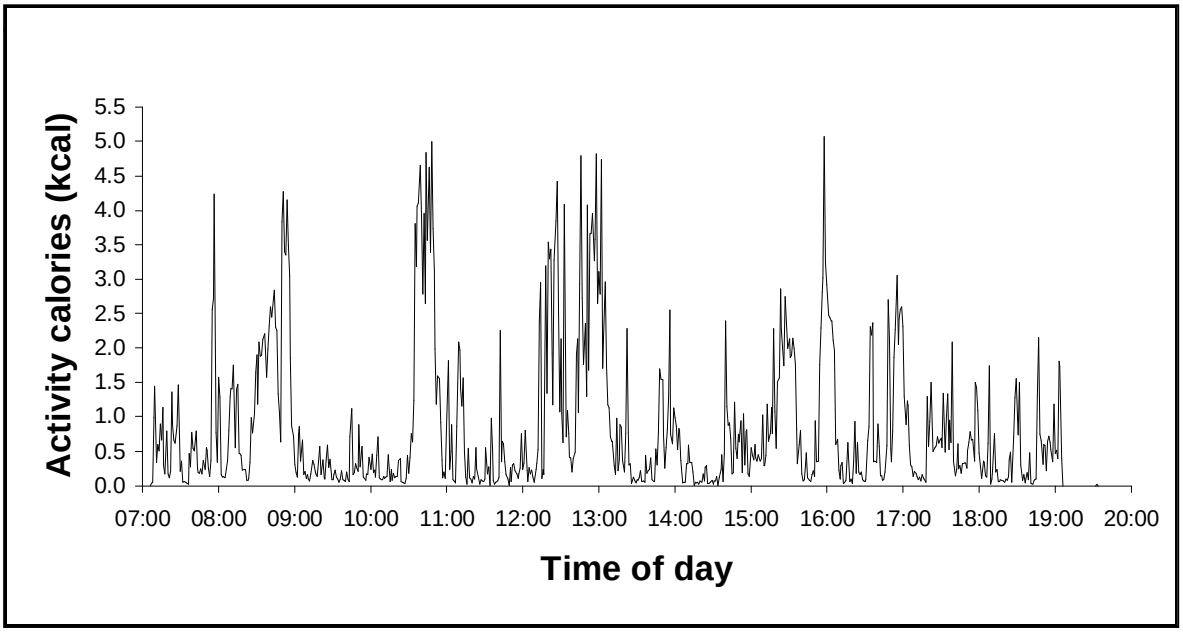

Figure 1 An example of the output from an RT3 motion sensor

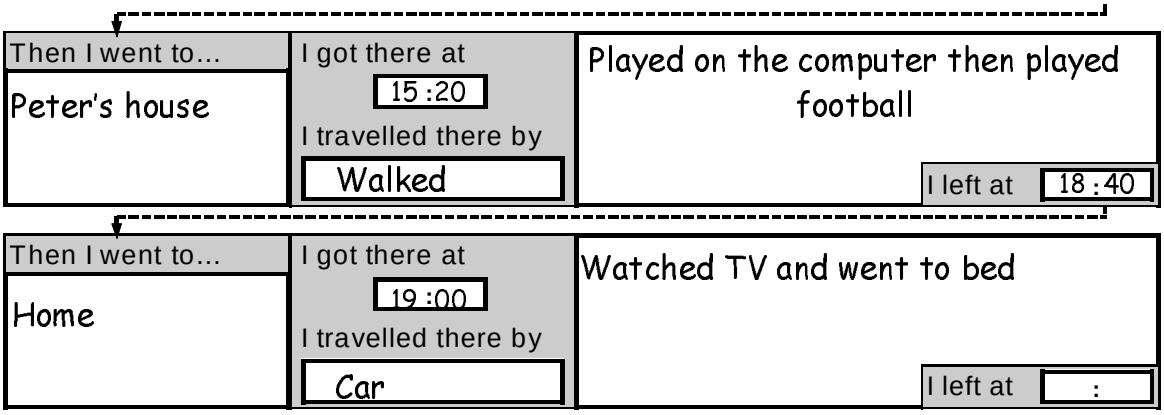

Figure 2 An example extract from a travel and activity diary

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, split fairly evenly between boys and girls. They were in two year groups: Year 6 (aged 10-11) (54 boys and 58 girls) and Year 8 (aged 12-13) (42 boys and 41 girls). The four age-gender groups were used to explore possible age-group and gender differences in travel and physical activity patterns.

Table 4 The classification system for events recorded in the children's diaries

Broad level	Middle level	Narrow level
School	PE or games lessons	PE or games lessons
	Other lessons	Other lessons
	Break	Break
Structured out-of-home events	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 events	Unstructured ball games	Badminton, basketball, cricket, football, rounders, tennis, and unclassified ball games
	Other unstructured events	Cycling, disco, dog walking, jogging, scootering, skateboarding, and walking
	Other outdoor play	Active play and general play
Out-of-home events shared with parents	Out-of-home events shared with parents	Appointment, event, fair/fete, meal out, and shopping
At own home	At own home	At own home
At other people's homes	At other people's homes	At other people's homes
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
Other	Physical work	Physical work
	Waiting	Waiting
Not monitored	Not monitored	Not monitored

Source: RT3s and activity and travel diaries.

Analysis

From the travel and activity diaries it is possible to establish which modes of travel are used to attend the various events. Table 5 shows the number of events of each type that the children attend, broken down by mode of travel to reach them. 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 events. The largest category of car use is to go on events shared with parents, 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 take children with them rather than letting children stay at home alone or go out to play alone because of concern about road safety and possible abduction. Car is used more for the structured out-of-home events, while walking is more popular for the unstructured out-of-home events. This supports the hypothesis that one reason for increasing car use by children is the switch from unstructured to structured sport and games. It can also be seen that modes other than walk and car are not used very much, and much of their use, particularly bus, is to school. It is interesting to note that one of the major uses of travel by children to reach other people's homes, which is split fairly evenly between walk and car.

Table 5 Number of events 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 events	0.3	0.8	0.0	0.0	0.0	1.2
Unstructured out-of-home events	0.7	0.4	0.0	0.0	0.0	1.2
Out-of-home events shared with parents	0.6	1.7	0.1	0.0	0.1	2.4
Other 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

Source: RT3s and activity and travel diaries.

From the travel and activity diaries, the time spent at various events has been calculated (Table 6). It can be seen that the children spend the largest amount of time at their own homes, followed by being at school. It should be noted that the 'At own home' figure refers only to the time when the RT3s were being worn. The time when they were not, for example when the children were in bed, have been classified as 'Uncoded' (hence this is the largest category). Travel takes 4% of their time, slightly more for the older children. The children do not spend very much time on out-of-home events, other than school. This suggests that travel does offer scope for physical activity, since the amount of time spent travelling is slightly more than that spent in structured and unstructured out-of-home events, which are conventionally regarded as the ones to provide physical activity for children. The large amount of time spent at home suggests that there is scope for more time to be spent elsewhere doing more active things.

Table 6 Time spent on various events by children in a week (%)

	Year 6		**Year 8**		**Overall**
	Boys	**Girls**	**Boys**	**Girls**	
At school	19	19	21	20	20
Structured out-of-home events	1	2	2	1	1
Unstructured out-of-home events	3	2	3	1	2
Out-of-home events shared with parents	2	3	2	3	2
At own home	21	20	20	24	21
At other people's homes	4	4	5	4	4
Travel	4	4	5	5	4
Other	0	0	1	1	0
Uncoded	46	47	43	41	45
Total	100	100	100	100	100

Source: RT3s and activity and travel diaries.

Using the matched diary and RT3 monitor data, it was possible to calculate total expenditure of energy on various events as shown in Table 7 which includes standard deviations so that the variation across the various categories can be seen. Travelling makes a substantial contribution, at 12% overall, particularly for older children. A similar contribution is made to the total for structured (5%) and unstructured (7%) out-of-home events. Being at school and at home use the greatest number of activity calories simply because so much of children's time is spent there.

Table 7 Percentage of activity calories expended by children in a week on various events

	Year 6		Year 8		Overall
	Boys	**Girls**	**Boys**	**Girls**	
At school	39	36	36	39	37
	10	*9*	*11*	*12*	*10*
Structured out-of-home events	2	7	6	3	5
	4	*7*	*10*	*5*	*7*
Unstructured out-of-home events	10	6	10	4	7
	10	*8*	*11*	*6*	*9*
Out-of-home events shared with parents	4	7	4	5	5
	5	*6*	*5*	*5*	*5*
At own home	25	24	20	25	24
	12	*9*	*12*	*11*	*11*
At other people's homes	6	7	7	6	7
	8	*8*	*9*	*7*	*8*
Travel	10	10	13	16	12
	6	*4*	*5*	*7*	*6*
Other	1	1	1	1	1
	3	*3*	*2*	*2*	*2*
Uncoded	3	4	1	1	3
	10	*8*	*3*	*2*	*7*
Total	100	100	100	100	100

Source: RT3s and activity and travel diaries.
Note: The figures in italics are the standard deviations for the mean values above.

The mean intensity (activity calories per minute) for each of the events in the classification system was calculated by dividing the total number of activity calories consumed on the various events by the time spent on them for each child. Table 8 shows the intensities at the middle level of the classification system. Examining travelling first, children consume over twice as many activity calories per minute walking than travelling in the car. Few young children travelled by bus and bicycling was not a common mode of travel for any group, so the intensity values for bus and bicycle have to be treated with caution. It can be seen that, overall, walking comes after PE or games lessons and ball games in intensity, and higher than all the other structured and unstructured out-of-home events. When walking is compared with all other the events in terms of intensity, taking into account the children's body weight, the difference is statistically significant (t=10.55, df=194, p=0.00, two-tailed). This suggests that walking offers great potential as a way for children to consume calories, being nearly as good as structured ball games. 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. Overall, it can be seen that structured and out-of-home events have an intensity of 1.7 while unstructured events are 2.2. This difference is statistically significant (t=2.56, df=206.55, p=0.011, two-tailed). Some of the children are heavier than others, and so will consume more activity calories simply moving their body weight. To correct for this factor, the intensities can be divided by the child's weight. When this is done the difference is still statistically significant (t=3.06, df=206.52, p=0.003, two-tailed, equal variances not assumed). When the 46 children who did both structured and unstructured out-of-home events are examined, the mean intensity for the former is 1.5 activity calories per minute and 2.3 for the latter. This difference is statistically significant (t=3.68, df = 45, p=0.001, two-tailed). If the intensities are divided by the child's weight to allow for the fact that some of the extra

activity calories will be due to carrying more weight around, the respective intensities become 0.034 and 0.052. This difference has even greater statistical significance (t=3.88, df=45, p<0.0005, two-tailed). The lowest intensity event is being at home, which uses 0.6 activity calories per minute. It should be borne in mind that this does not include sleeping because the children did not wear the monitors in bed. The overall intensity for all other events, outside the child's own home, is 1.1 (SD=0.5). This difference is statistically significant (t=17.80, df=194, p<0.0005). If the intensities are adjusted by body weight, the respective values become 0.013 and 0.026 (t = 19.47, df = 194, p< 0.005, two-tailed). This suggests that children are twice as active when away from their own homes as they are when they are there.

Table 8 Intensity of various events undertaken by children

		Year 6		Year 8		Overall
		Boys	**Girls**	**Boys**	**Girls**	
At school	PE or games lesson	2.7	2.6	3.2	4.2	3.1
		1.6	*1.4*	*1.4*	*3.7*	*2.2*
	Other lessons	0.6	0.5	0.7	0.7	0.6
		0.3	*0.2*	*0.2*	*0.4*	*0.3*
	Break	2.0	1.6	2.4	2.1	1.9
		0.9	*1.0*	*1.6*	*1.4*	*1.3*
	Overall	1.0	0.8	1.2	1.2	1.0
		0.4	*0.4*	*0.6*	*0.7*	*0.6*
Structured out-of-home events	Structured ball games	2.0	2.3	2.5	2.6	2.4
		0.5	*0.7*	*0.7*	*1.2*	*0.7*
	Other structured sport	2.0	1.4	2.7	1.9	1.8
		1.4	*0.6*	*3.1*	*0.7*	*1.4*
	Organisations	1.6	1.2	1.8	0.8	1.4
		0.6	*0.5*	*1.3*	*0.5*	*0.9*
	Tuition	0.7	0.9	0.4	0.5	0.7
		0.5	*0.5*	*0.6*	*0.3*	*0.5*
	Overall	1.5	1.4	2.3	1.8	1.7
		0.9	*0.5*	*1.8*	*1.0*	*1.1*
Unstructured out-of-home events	Unstructured ball games	1.9	1.1	3.4	3.2	2.8
		1.0	*0.5*	*1.3*	*2.2*	*1.6*
	Other unstructured events	1.6	1.9	2.1	3.2	2.1
		0.8	*1.1*	*1.2*	*2.9*	*1.6*
	Other outdoor play	1.5	1.6	1.5	2.1	1.6
		0.7	*1.3*	*1.0*	*2.1*	*1.2*
	Overall	1.6	1.7	2.8	2.8	2.2
		0.7	*1.2*	*1.3*	*2.1*	*1.5*
Out-of-home event shared with parents		1.1	1.1	1.3	1.2	1.1
		0.7	*0.5*	*1.1*	*0.7*	*0.8*
At own home		0.6	0.5	0.7	0.6	0.6
		0.3	*0.2*	*0.4*	*0.4*	*0.3*
At other people's homes		0.9	0.8	1.3	0.8	0.9
		0.7	*0.4*	*1.1*	*0.6*	*0.7*
Travel	Walking	1.8	1.9	2.7	3.0	2.3
		0.7	*0.8*	*1.3*	*1.6*	*1.2*
	Car	0.9	0.9	1.1	1.1	1.0
		0.5	*0.5*	*0.6*	*0.5*	*0.5*

	Bicycle	1.6 *0.8*	1.2 *0.9*	2.0 *0.4*	2.3 *1.1*	1.7 *0.9*
	Bus	- *-*	1.2 *0.7*	1.6 *0.9*	1.5 *0.6*	1.5 *0.7*
	Overall	1.3 *0.6*	1.3 *0.7*	1.9 *0.9*	2.0 *1.0*	1.6 *0.9*
Other	Physical work	0.7 *0.4*	1.7 *0.3*	1.3 *0.9*	1.0 *0.1*	1.1 *0.6*
	Waiting	1.0 *0.5*	0.9 *0.7*	1.0 *0.7*	1.3 *0.8*	1.1 *0.7*
	Overall	0.8 *0.5*	1.0 *0.7*	1.1 *0.7*	1.3 *0.8*	1.1 *0.7*
Overall		0.8 *0.4*	0.9 *0.3*	1.2 *0.5*	1.0 *0.5*	0.9 *0.4*

Source: RT3s and activity and travel diaries.
Note: The figures in italics are the standard deviations for the mean values above.

Another way to consider the merits of the various events in terms of their contribution to children's physical activity is to examine how much of the event involved physical activity at a moderate or greater level, using the definition of moderate level activity by Rowlands et al (1999) (Table 9). This shows that only 10% of children's time spent at their own home is of moderate or higher intensity, despite the fact that this includes playing in the garden. Nearly twice as much of the time spent at other people's homes is at the moderate or higher level. The exception to this is the older girls, which may reflect the different ways that girls of 12-13 spend their time when together. The average for all out-of-home events is 23%. Unstructured out-of-home events involve 50% of the time spent at a moderate or greater intensity level while structured events only involve 39%. Travelling is the next highest figure at 35%

Table 9 Percentage of time spent in moderate or higher intensity physical activity

	Year 6		**Year 8**		**Overall**
	Boys	**Girls**	**Boys**	**Girls**	
At school	21	16	21	19	19
Structured out-of-home events	40	35	46	37	39
Unstructured out-of-home events	46	40	65	49	50
Out-of-home events shared with parents	27	24	27	19	24
At own home	11	9	12	9	10
At other people's homes	23	17	26	13	19
Travel	32	30	42	39	35
Other	23	23	21	21	22
All events apart from 'At own home'	24	20	28	21	23
Overall	19	16	22	16	18

Source: RT3s and activity and travel diaries.

It has been shown that walking is not very far below PE and games lessons in intensity, but the durations are likely to be different. The number of minutes spent in PE or games lessons per week is 70 minutes while 153 minutes a week is spent walking, mainly to and from school. One way to make a comparison is to see how many calories would be consumed over a week. Table 10 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, obtained by scaling the figures given in the diaries and from the RT3 sensors. 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 travelled to school by bus, and no older girls cycled. The numbers cycling are very small and need to be treated with more caution than the other figures. 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 10 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	209	201	522	625	374
	130	*137*	*286*	*492*	*339*
Car to and from school	152	160	172	226	165
	94	*112*	*110*	*137*	*108*
Bicycle to and from school	433	365	411	-	414
	170	-	*170*	-	*135*
Bus to and from school	-	-	420	346	380
	-	-	*322*	*188*	*256*
Overall travel to and from school	193	183	455	472	305
	129	*127*	*293*	*409*	*285*
PE or games lessons for two hours	326	307	388	499	371
	196	*167*	*167*	*443*	*269*

Source: RT3s and activity and travel diaries.
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. The figures in italics are the standard deviations for the mean values above.

Walking to and from school consumes many more activity calories than two hours of PE or games for the older children. This difference is statistically significant for the boys (t=2.43, df=46, p=0.019, two-tailed, equal variances not assumed) but not for the girls (t=1.05, df=49, p=0.30, two-tailed). Younger children who walk to and from 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 (see Table 8) 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 overall. 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 and this raises the overall mean. 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.

Another way to compare walking with PE or games lessons is to examine the percentage of the time spent at a moderate or higher intensity (Table 11). The figures are fairly similar, particularly for the older children. This again shows how walking can help make a valuable contribution to children's volume of physical activity.

Table 11 Percentage of time spent in PE or games lessons and walking that is of moderate or higher intensity

	Year 6		Year 8		Overall
	Boys	Girls	Boys	Girls	
PE or games lesson	62	61	63	62	62
Walking	51	53	62	60	56

Source: RT3s and activity and travel diaries.

It may seem surprising that children are not more active in PE and games lessons than has been shown here, but this is quite possible. In the U.S. (U.S. Department of Health and Human Services, 1996) only 19% of all high school students report being physically active for 20 minutes or more in daily physical education classes. There was a decline from 81% to 70% in the percentage of American high school students who enrolled in PE and reported being physically active for at least 20 minutes during the first half of the 1990s.

Turning to the age and gender differences, boys and older children expend more calories per minute than girls and younger children respectively. For boys the mean intensity is 1.0 and for girls it is 0.8. This difference is statistically significant (t=2.11, df=193, p=0.036, two-tailed). If the values are adjusted for body weight the respective means are 0.023 and 0.019, which is a more significant difference (t=3.34, df=193, p=0.001, two-tailed). The older children have a greater intensity (1.1) than the younger ones (0.8), which is a statistically significant difference (t=5.04, df=124.38, p<0.0005, two-tailed, equal variances not assumed). When body weight is taken into account, the respective means are 0.022 and 0.019, which are significantly different, but the significance is reduced (t=1.39, df=132.13, p=0.019, two-tailed, equal variances not assumed). As children go through their teens they tend to become less energetic (U.S. Department of Health and Human Services, 1996) so it is possible that these children, who are aged 12-13, are at or near the peak of their childhood levels of physical activity. The differences across the age groups tend to be greater the more energetic the event, with the exception of structured out-of-home events for girls, which may reflect the nature of what they choose to do, or may reflect their earlier maturation than boys which means that they are starting the downward trend in physical activity earlier.

It is possible to examine the relationship between the intensity of various events and the mode of travel used to travel there, as shown in Table 12. For the events that occurred at school it is the mode used to travel to school. It can be seen that, overall, the children who walk use 1.7 activity calories per minute and those who go by car use 1.3. When individual events are examined, there are some larger differences, some of which are statistically significant (in each case equal variances are not assumed). For example, for PE and games lessons, the walkers used 3.5 activity calories a minute, compared to 2.4 for the car users (t=3.02, df=84.60, p=0.002, one-tailed), while for unstructured out-of-home events the walkers use 2.4 while the car-users consume 2.0 activity calories per minute (t=1.84, df=84.88, p=0.035, one-tailed), for out-of-home events shared with parents, the values are 1.5 and 1.0 respectively (t=3.09, df=86.61, p=0.002, one-tailed) and for being at another house the values are 1.1 and 0.8 respectively (t=2.37, df=122.41, p=0.01, one-tailed). It is quite clear that for most events, 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 12 Intensity of various events, 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	3.0	2.3	2.7	2.4	3.6	2.9	4.7	2.4	3.5	2.4
	1.9	*1.2*	*1.7*	*1.0*	*1.6*	*1.1*	*4.4*	*0.3*	*2.7*	*1.0*
Other school lesson	0.6	0.5	0.5	0.4	0.6	0.7	0.8	0.5	0.6	0.5
	0.4	*0.3*	*0.2*	*0.2*	*0.2*	*0.2*	*0.6*	*0.3*	*0.4*	*0.2*
School break	2.0	1.8	1.6	1.5	2.3	2.4	2.4	1.2	2.0	1.7
	1.2	*0.8*	*1.2*	*0.7*	*1.0*	*0.9*	*1.6*	*0.5*	*1.3*	*0.8*
Structured out-of-home Events	1.5	1.3	1.3	1.5	2.2	1.8	-	2.0	1.7	1.6
	0.9	*0.9*	*0.5*	*0.6*	*1.1*	*0.9*	-	*1.0*	*1.0*	*0.8*
Unstructured out-of-home events	1.7	1.6	1.4	1.8	3.4	2.5	2.7	2.3	2.4	2.0
	0.8	*0.8*	*0.4*	*1.3*	*1.6*	*1.0*	*2.0*	*1.1*	*1.6*	*1.1*
Out-of-home event with Parents	1.1	0.8	1.5	0.9	1.6	1.1	1.6	1.2	1.5	1.0
	0.6	*0.6*	*1.2*	*0.5*	*1.4*	*1.0*	*1.3*	*0.8*	*1.1*	*0.7*
At another home	1.0	0.8	0.8	0.7	1.9	1.0	0.9	0.8	1.1	0.8
	0.6	*0.6*	*0.5*	*0.4*	*1.5*	*0.7*	*0.7*	*0.7*	*0.9*	*0.6*
Overall	1.5	1.2	1.3	1.2	2.1	1.6	2.1	1.2	1.7	1.3
	1.3	*0.9*	*1.2*	*0.9*	*1.5*	*1.1*	*2.4*	*0.9*	*1.6*	*0.9*

Source: RT3s and activity and travel diaries.
Note: The figures in italics are the standard deviations for the mean values above.

It certainly seems that children who walk more will consume more calories not only in travelling, but also when they arrive at their destination. Cooper et al (2003) found that boys who walked to school were more active after school and in the evening, compared with those who travelled to school by car. This positive link between walking to an event and the quantity of physical activity used during the event is important because just walking to school may not make a large enough contribution to a child's total physical activity to produce health benefits. Sleap and Warburton (1993) looked at 1133 children aged 4 to 11 and drew that conclusion, but if children who walk to school are also more active when participating in events, then walking to school may lead to a very useful contribution to children's quantity of physical activity.

There is some limited evidence (Almond and McGeorge, 1998; California Department of Education, 2002) of a positive link between physical activity and academic achievement. Combined with the evidence here, it seems that children who perform more physical activity by walking to school may perform better academically than their colleagues who travel by car. This provides a very powerful message to parents – not only will walking improve their health, it may also promote enhanced academic performance.

Promoting walking to school

The results presented above suggest it may be useful to promote initiatives that encourage children to walk to school rather than be driven. One such intervention which is being 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. According to CAST (2000), the walking bus set up in 1998 at Wheatfields Junior School in St Albans was the first in Britain. By 2001, 50 out of 102 local authorities surveyed for the Department for Transport (2001) had implemented one or more walking buses, and a further 31 planned to do so. It was the most common planned initiative. This implies a very rapid rate of growth from the initial one in 1998.

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 overall reduction in traffic on the road because, in many cases, the car will still be used by the parent for other trips, usually to work.

Conclusions

A major objective of this document has been to show that walking and playing away from the homes can contribute significantly to children's health through physical activity. It is clear from the analysis presented here that the place where children tend to be least active is at their own home. When they do go out, unstructured events (playing) tend to be more active than structured ones.

Travel itself offers physical activity, but some modes are better than others. In particular walking and cycling are better than travelling by car. This means that, all other things being equal, it is better to walk or cycle to an event rather than go by car. However, if the choice is between going somewhere by car and staying at home, then the former will provide more physical activity than the latter. This means that a trip that would not normally be regarded as particularly good for children, such as going to the shops with parents, is better than staying in at home. It is not as good as going out to play with friends in the park, and effort needs to be put into making environments outside the home safe for children to be in, and to make parents and children aware of this. One trend in children's activity patterns that has contributed to the shift to more car use has been the move from unstructured to structured play: children tend walk to the former and go by car to the latter. Effort should be put into initiatives such as walking buses which get children into the habit of walking and helps to build up children's and parents' confidence that the children can be allowed out unescorted.

Children are shifting from walking to the car. Walking consumes more calories than travelling by car with important implications for their volume of physical activity and so for their health. In fact, walking compares very favourably with most events in terms of energy consumption. Walking to and from school for a week is much better than a week's worth of PE and games lessons for many children. Children who walk to events not only use more calories in travelling, but use more when they arrive. Evidence from elsewhere suggests that there may be a relationship between physical activity and academic achievement. If this is so, then

walking more will not only make children healthier, it may promote enhanced academic performance.

To sum up, this document has shown that encouraging children to walk and play away from home will have benefits in terms of physical activity in three ways: they both have high intensities compared with most events; they tend to be mutually reinforcing: children tend to walk to unstructured activities, and children who walk to events tend to be more active when they arrive than those who go by car, and this includes playing. Given the level of parental concern about decreasing physical activity levels of children and their health implications, this research helps to provide powerful arguments to help convince parents of the need to allow their children out to walk and play, and for Government to help provide suitable opportunities.

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