

Paper presented at the WALK21 Conference, Melbourne, Australia, 23-25 October 2006

## **Where do children walk (and what do they do when they get there)?**

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### ***Abstract***

This paper contains findings from the project CAPABLE (Children's Activities, Perceptions And Behaviour in the Local Environment) currently being carried out at University College London (UCL). In the project about 200 children aged from 8 to 11 have been fitted with activity monitors, GPS (Global Positioning Satellite) monitors and asked to complete a travel and activity diary for four days. The children and their parents have also completed questionnaires which cover issues such as whether the children are allowed out without an adult. From the diaries it is known what the children are doing and how they are travelling, and by whom they are accompanied. From the activity monitors, their activity levels in terms of calories consumed per minute, are found. The GPS monitors allow the location to be established. From these three sources it is possible to establish which sort of places children are most active in, adding to previous research into the relative levels of energy consumption in various activities such as walking, playing and sports.

The paper presents some of the preliminary findings from the work. The main focus here is on walking, and covers issues such as the trip purposes associated with walking, the differences in walking trips when the child is accompanied by an adult compared with when he or she is not, and the level of intensity of walking under different circumstances. The paper is concluded with illustrations of the richness of the data from the combined tools of activity monitor, GPS monitor and diaries. Whilst the data are rather limited in quantity, they offer comprehensive information on a relatively small number of children. From this it should be possible to understand quite a lot about how children

walk, and play and how they use the local environment. This should contribute to the design of environments that encourage children to walk and play more, and so lead happier and healthier lives.

### ***Brief biography of the authors***

Roger Mackett is Professor of Transport Studies in the Department of Civil and Environmental Engineering at University College London. He is currently involved in projects examining 'Children's Activities, Perceptions and Behaviour in the Local Environment' (CAPABLE) and developing techniques to ensure that transport policies are more socially inclusive.

Yi Gong has a background in Information Engineering and Geography. Currently she is working at the Centre of Advanced Spatial Analysis at University College London where she is researching into simulation models.

Kay Kitazawa was a visitor to CASA during August 2002 and joined CASA as a PhD student in October 2003. She holds a BA in Social Psychology (Behavioral Science) from the University of Tokyo and an MSc in Environmental Science from the Graduate School of Frontier Science, University of Tokyo.

James Paskins is a Research Fellow in the Centre for Transport Studies at UCL. He is currently working on the CAPABLE project, examining children's behaviour in their local environments and studying part-time for a PhD. He has previously worked on projects investigating children's car use and transport-related social exclusion.

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## **1 Introduction**

Young children do not, unless forced, walk the shortest path between any two points: they explore anything that interests them, interacting with people, animals and objects that they come across; they show no sign of wishing to minimise effort or time in walking as adults do. In the middle school years, children, if given the opportunity, seek out other children, push, jostle and chase them. In short, children's trips are rather different from those made by adults; if children are alone, they often move in small groups, they play and move at the same time, they visit local shops, and often their trips are strongly distorted by other recreational activities.

Nowadays, in Britain, significantly fewer young children are allowed out alone and so they travel by car on many short trips. According to the National Travel Survey, in 1985/86 21% of children aged 5-10 travelled to school alone; in 1999/2001 it was 10%. This change has implications for children in terms of their physical activity, developing independent skills, active social play and for parents in terms of escorting their children (Hillman et al, 1990, Joshi et al, 1999).

The purpose of this paper is to present findings from a project that brings these ideas together. The project, entitled CAPABLE (Children's Activities, Perceptions and Behaviour in the Local Environment) is being carried out at University College London (see <http://www.casa.ucl.ac.uk/capableproject/>). CAPABLE followed on from a project to investigate the effects of the car on children's volume of physical activity and long-term car dependency (see <http://www.cts.ucl.ac.uk/research/chcaruse/>). The most innovative part of that was to fit about 200 children with activity monitors and asking them to keep diaries from which it was possible to establish the relative contribution of various activities, including walking, to children's energy consumption (Mackett et al, 2005).

CAPABLE involves staff from CASA, the Bartlett School of Planning and the Department of Psychology all at UCL. In this work, children are being fitted with GPS (global positioning system) monitors as well as using the activity monitors and diaries, so that it is possible to establish where children go for various activities. Another aspect of interest is whether or not children are allowed out without an adult. Questionnaire surveys have been conducted of children and their parents, and various drawing and mapping exercises carried out with the children. The fieldwork was carried out in Lewisham in

south-east London, and in Hertfordshire, the area immediately north of London.

## **2 Methodology**

In this paper results are presented from fieldwork carried in two schools in Cheshunt in Hertfordshire, using three research instruments: activity monitors, GPS monitors and diaries. The activity monitors are RT3 tri-axial accelerometers, manufactured by Stayhealthy, USA, which measures movements in three directions, as shown in Figure 1. 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 in order to facilitate comparison of the results of this work with other research (it is recognised that the formulae for converting the RT3 outputs to activity calories have not been fully validated for such young children). They were set to record movements on a minute-by-minute basis.

The GPS is a satellite-based positioning system. Twenty four GPS satellites are orbiting the earth at a very high altitude. By picking up signals from these satellites, a GPS receiver can tell the user position over the ground with relatively high accuracy of several metres. Several types of GPS equipment were tested, in order to decide the best in terms of precision, battery life and acceptability to the children. The GPS equipment used in the CAPABLE project is the Garmin Foretrex 201 which is small and light-weight so that children can easily wear it on their wrists all day long, as shown in Figure 2. It monitors children's locations at set intervals and records them in its memory in chronological order. These data can be superimposed subsequently on a map or input into a GIS (geographic information system) so that they can be linked with other spatial data and analysed.

Trost et al (2000) have shown that four days of monitoring of physical activity in children are required. In this study, the volunteers were asked to wear the monitors 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 complete a travel and activity diary for the four days. An example extract from the diary is shown in Figure 3. The RT3 output was used as a visual aid by the child and a researcher to identify high-activity events shown in the trace which had not been previously mentioned in the diary. The events recorded in the children's activity and travel diaries were classified, using a typology shown in Mackett et al (2005), and put into an Access database.

The results presented in this paper focus on the walking trips, considering them in terms of the purpose of the trip, whether or not they were accompanied by an adult, and how intensively they walk. There will also be some discussion about where they walk. These are all preliminary results as the project is not yet complete.



Figure 1 The RT3 activity monitor



Figure 2 The Garmin Foretrex 201 GPS monitor

Morning	Location			What did you do there?
	I began the day at Home <input type="checkbox"/> Somewhere else <input type="checkbox"/> Please say where	I woke up at : <input type="text"/>	I put my sensors on at : <input type="text"/>	
				I left at : <input type="text"/>
	Then I went to	I got there at : <input type="text"/>	I travelled by <input type="text"/>	
		I travelled: • by myself <input type="checkbox"/> • with an adult <input type="checkbox"/> • with other children <input type="checkbox"/>	I left at : <input type="text"/>	
	Then I went to	I got there at : <input type="text"/>	I travelled by <input type="text"/>	
		I travelled: • by myself <input type="checkbox"/> • with an adult <input type="checkbox"/> • with other children <input type="checkbox"/>	I left at : <input type="text"/>	

Figure 3 The activity and travel diary

### 3 Results

As shown in Table 1, 162 children in Cheshunt provided data that could be used for this part of the analysis. This is not a large number, but it should be borne in mind that the children were being asked to wear two pieces of equipment, one of which required charging every night, and keep a diary of their activities and travel, for four days. This was demanding of both child and researcher time. Not all the children provided complete data sets. Also, the data were collected in the period from October 2005 to March 2006, which includes winter in Britain and therefore not an ideal time to collect data on outdoor activities.

The children were in the top three years of primary school, that is, aged 8 to 11. More girls than boys supplied useable data and relatively fewer Year 6 children than the other two years.

Table 1 The children in the survey

	Boys	Girls	Total
Year 4 (aged 8-9)	25	32	57
Year 5 (aged 9-10)	33	36	69
Year 6 (aged 10-11)	16	20	36
Total	74	88	162

Analysing diaries to establish trip patterns, particularly diaries completed by children, is difficult, because many trips are complex, involving use of more than one mode. The unit that will be considered here is the activity that the children went to and how they travelled there. Because of the ambiguity of the word 'activity', the word 'event' will be used from now on. Four types of event will be considered: 'school', 'structured events', 'unstructured events', and 'shopping etc'. 'Structured events' are events such as football lessons and

youth clubs that are organized by adults to provide formal training or activities for children, often after school, and will be referred to as 'clubs'. 'Unstructured events' are events in which children decide what to do, and are essentially playing, and so will be referred to as 'playing'. 'Shopping etc' includes not only shopping but also meals out, visits to the doctor, and visits to the cinema. Generally such events are organized by adults, but some children do go shopping without an adult. Even this simple typology does not really capture the full complexity of children's behaviour: children walking round a shopping centre should probably be classified as taking part in an unstructured event, particularly if they do not buy anything, but they probably put it in their diary as 'shopping'; it could also be classified as a 'walk' and so should be put under 'travel'. Notwithstanding these difficulties it is interesting to examine the data to try to learn about children's lives.

There were 461 walking trips, compared with 959 by car and 49 by other modes of transport. Of the 461, 220 were to home, 11 to other forms of travel, such as a bus stop, and 2 other. This leaves 228 events that were walked to. These events and the walking journeys to them form the main basis of the analysis in this paper. Even though the number of journeys involved is small, it is useful to see what the results show, but they should be regarded as indicative rather than robust. The journeys being shown here are those to the event. The behaviour on the journey home may be different, for example because of greater tiredness or greater freedom from time constraints.

Table 2 shows the distribution of walking trips between the four types of event mentioned above. It can be seen that school is the main event that children walk to. Shopping and similar trips come next followed by playing. Shopping etc attracts more walking trips by girls whereas boys tend to walk to clubs. The differences between the sexes probably reflect the differences in what they like doing: girls tend to like shopping, boys are more likely to go to after school clubs.

Table 2 Distribution of events that children walk to (%)

	Boys	Girls	All
School	60	60	60
Clubs	16	6	10
Playing	10	16	14
Shopping etc	14	18	16
All	100	100	100

Table 3 shows the percentage of trips to each event that are walked. The majority of other trips are by car. Overall, 36% of the trips are by walked, with more girls walking than boys. Here playing can be seen to be the event that the children, particularly the girls, walk to. Perhaps rather surprisingly, more girls walk than boys to all types of event, except clubs.

Table 3 Percentage of all trips to events that were walked

	Boys	Girls	All
School	35	48	42
Clubs	37	27	32
Playing	35	60	49
Shopping etc	14	21	18
All	31	40	36

One topic that is being explored in the CAPABLE project is that of children's independent use of the local environment, since children out without an adult have to make decisions for themselves about crossing roads, risks of danger and so on. Table 4 shows the percentage of the walked trips that are not accompanied by an adult. The child may be alone or with other children. It can be seen that 34% of the walked trips are unaccompanied by an adult, with slightly more boys than girls doing so. The biggest difference is for clubs with a much higher percentage of boys walking unaccompanied (but based on pretty small numbers).

Table 4 Percentage of walked trips to various events that are not accompanied by an adult

	Boys	Girls	All
School	26	24	25
Clubs	64	44	57
Playing	78	77	77
Shopping etc	17	20	19
All	36	33	34

Another way of looking at the figures is to see what sort of walking trips the children make without an adult. Table 5 shows this. It can be seen that school is the main type of trip, but this is because this is the dominant walking trip for children. Playing is next in order. This is because children often play near their homes, and simply go out and play. It was found in previous work that walking is often associated with playing, and it was suggested that the shift from unstructured to structured events for children is one of the causes of their increasing car use (Mackett et al, 2005).

Table 5 Distribution of events that children walk to without an adult (%)

	Boys	Girls	All
School	44	43	44
Clubs	28	9	17
Playing	22	37	31
Shopping etc	6	11	9
All	100	100	100

The converse of Table 5 is shown in Table 6, that is the types of walking trip that children do with an adult. Here school is even more dominant, but second



comes shopping etc trips. This is because many of these trips are made for the benefit of the parent and the child has to go rather than being left alone at home.

Table 6 Distribution of events that children walk to with an adult (%)

	Boys	Girls	All
School	70	68	69
Clubs	9	5	7
Playing	4	5	5
Shopping etc	18	21	20
All	100	100	100

An obvious benefit of walking is the exercise that it gives children. They were wearing the RT3 activity monitors which can give outputs in terms of activity calories. These have been divided by the body weight of the child to allow for the fact that a heavier child will use more activity calories in carrying around his or her body fat than a thinner child involved in the same event such as walking. Table 7 shows the intensity of walking. It can be seen that boys use more energy when walking than girls, and that walking to school is the most intensive event overall, but boys walk even more intensively when on their way to clubs. The children walk least intensively when going out to play, perhaps reflecting the nature of the event.

Table 7 Intensity of walking (in  $10^{-2}$  activity calories per kg of body weight) to events

	Boys	Girls	All
School	50	52	52
Clubs	54	39	47
Playing	32	33	33
Shopping etc	38	34	35
All	42	39	40

Children may walk rather differently when with adults from when they are alone or with other children, as shown in Tables 8 and 9. Comparing the tables it can be seen that children walk more intensively when walking with an adult. This may be because much of their walking with adults tends to be to school, and time constraints in the morning may mean that the children (or their parents) are in a hurry, and so they work more energetically. The lowest intensity event is shopping by girls when unaccompanied by an adult, perhaps window shopping in a group, which may not involve being very active. Conversely, the most energetic walking is boys going to clubs accompanied by an adult, perhaps reflecting enthusiasm for football, possibly linked with limited time availability after school. The overall average is the same for the two sexes when they are accompanied by an adult, but boys tend to be more energetic than girls when not accompanied by an adult, perhaps reflecting differences in behaviour between the sexes, with boys more inclined to run around, and girls more inclined to sit and chat with their friends.

Table 8 Intensity of walking (in  $10^{-2}$  activity calories per kg of body weight) to events when not accompanied by an adult

	Boys	Girls	All
School	53	42	46
Clubs	43	23	37
Playing	27	30	29
Shopping etc	42	14	16
All	44	32	36

Table 9 Intensity of walking (in  $10^{-2}$  activity calories per kg of body weight) to events when accompanied by an adult

	Boys	Girls	All
School	49	55	53
Clubs	72	47	57
Playing	47	38	39
Shopping etc	37	43	41
All	42	42	42

Having considered the type of event that children walk to, whether or not they are accompanied by an adult, and how intensively they walk, the next issue to be considered is where they actually walk, and how this relates to the event. This is shown by analysing the results from the activity monitors, the GPS monitors and the diaries. At the time of writing, these have not been fully analysed. However, it is possible to show maps of the findings. It is clear however, that the data from the GPS monitors is less robust than that from the RT3 monitors. This is largely because of the more complex nature of the GPS equipment which has a variety of potential problems, including difficulty in finding a signal from three or more satellites, false readings, sometimes due to signals to the satellite bouncing off buildings or being distorted in other ways, failure by the children or their parents to recharge them, rather flimsy battery chargers, that broke on several occasions, and children, particularly boys, interfering with the monitors. In comparison, the RT3 monitors continue to record continuously for the four days with no need for intervention and very little to play with, apart from removing the battery. Only 63 children provided GPS data for all four days. A lot of data cleaning has been required because of rogue points, particularly the first point after leaving a building. Nonetheless the results are of interest and should be seen as experimental.

Figure 4 shows the level of intensity of children walking home from one of the schools divided into three levels of intensity: light, moderate and vigorous. The map also shows the location of the school and the homes of the children with the codes for each child. The more vigorous walking seems to be along more definite corridors, whilst some of the light physical activity seems to be more meandering. Clearly there needs to be much more detailed analysis of the patterns of trips from the school to the individuals' homes, but it may be possible to identify which type of environment children walk most vigorously in. This may help to design new environments which encourage physical activity.

Figure 5 shows the location of the unstructured activities by the children at one of the schools. This illustrates the range of activities covered, including dog walking, tennis, skating and having a disco on the playing field. Again, it will need much more detailed analysis to identify which areas play in, where they are most active, where they go with their friends and so on. The rather limited size of the data set is going to restrict the range of analysis that is possible, but potentially the opportunities are huge.

#### **4 Conclusions**

This paper has presented some preliminary results from an ambitious project to understand how children interact with the local environment. The focus in this paper has been on walking by children, considering the purpose of their walking trips, whether or not they are accompanied by an adult, and how intensively they walk.

It was shown that the main reason children walk is to go to school, but they also walk to go to play, to clubs and to go the shops, with boys tending to walk to clubs and girls to the shops. It was found that girls tend to walk more than boys, but that more boys tend to walk unaccompanied by an adult more than girls. Of the non-school events, playing is the event that children, particularly girls, tend to walk to. Boys tend to walk to clubs much more than the girls. On the other hand, apart from school, when children walk with an adult it tends to be to the shops.

Another dimension that has been considered is the intensity of walking, in terms of the number of activity calories consumed per minute. It was found that boys tend to walk slightly more vigorously than girls, and that children walk more vigorously when accompanied by an adult than when unaccompanied by an adult. The least vigorous walking was found to be girls going shopping unaccompanied by an adult whilst the most vigorous was boys going to clubs, accompanied by an adult.

The results from using the GPS monitors as well as the diaries and the activity monitors have yet to be analysed fully. It is clear that they are rather limited in quantity, but that they offer rich information on a relatively small number of children. From this it should be possible to understand quite a lot about how children walk, and play and how they use the local environment. This should then contribute to the design of environments that encourage children to walk and play more, and so lead happier and healthier lives.

#### **Acknowledgements**

This paper has been written as part of a project entitled 'Children's Activities Perceptions and Behaviour in the Local Environment (CAPABLE)' which is being funded by the UK Engineering and Physical Sciences Research Council (EPSRC) under grant GR/T09378/01 for 2 years and 5 months from August 2004. It is being carried out at UCL as a joint project between the Centre for Transport Studies, the Centre for Advanced Spatial Analysis, the Bartlett School of Planning and the Psychology Department. The co-operation of the

children who took part in this exercise and their teachers and parents is greatly appreciated, as is assistance from Hertfordshire County Council and the London Borough of Lewisham.

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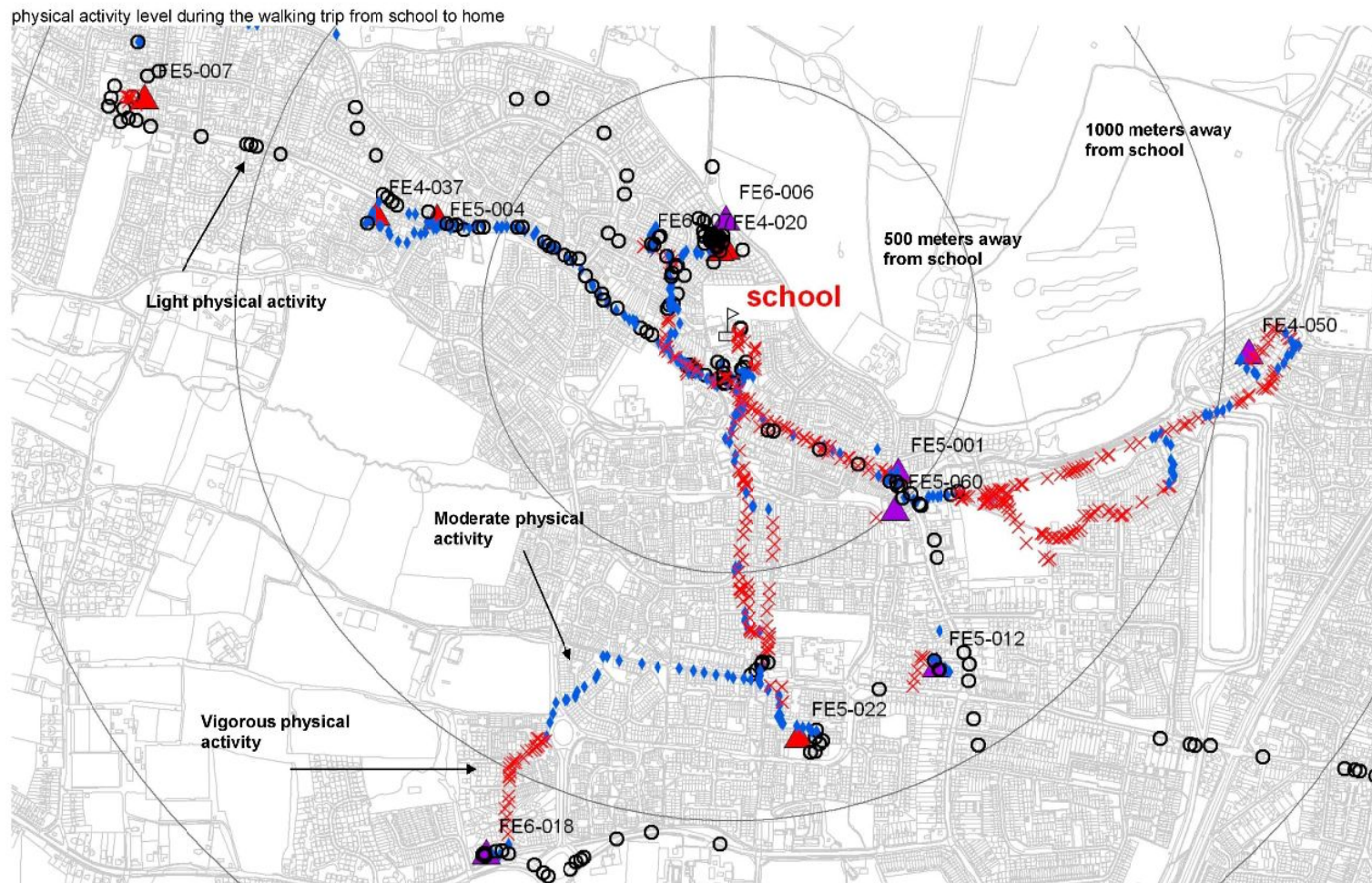


Figure 4 Physical activity levels during walking trips home from school

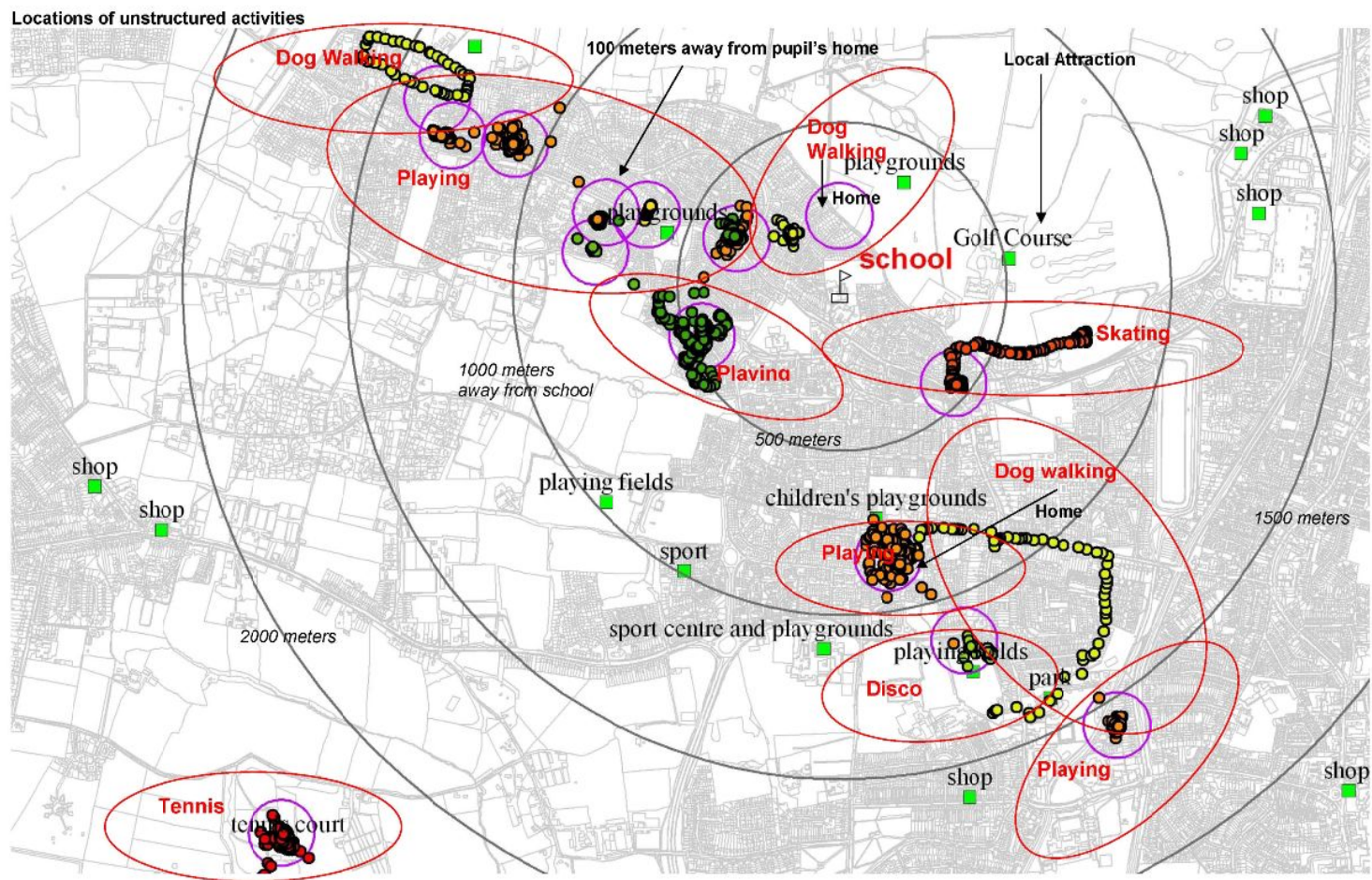


Figure 5 The location of unstructured activities