ACCIDENT INVOLVEMENT OF CHILD PEDESTRIANS: A HOLISTIC STUDY OF RELATIVE RISK

by

Nicola Christie

ACCIDENT INVOLVEMENT OF CHILD PEDESTRIANS: A HOLISTIC STUDY OF RELATIVE RISK

by

Nicola Christie

A thesis submitted for the Degree of Doctor of Philosophy

Centre for Transport Studies
University College London

August 1998

Dedicated to my late father Derek Roberts

ABSTRACT

Mortality statistics show the need to investigate why children in the lowest socio-economic group are much more likely to be killed as pedestrians in road traffic accidents than their counterparts in the highest socio-economic groups. The objective of the present study is to assess the role of socio-economic and environmental factors in child pedestrians accidents.

The literature review was carried out which indicated that exposure, attitude of the parent or adult carer and environmental hazard may explain the high accident rate of children in low socio-economic groups. A survey comprising in-depth home interviews amongst 152 school children injured as pedestrians and a control sample of 484 school children was carried out. A parent or adult carer for each child was also interviewed. A survey of environmental features of the roads where the children lived was also undertaken carried out. The surveys took place in Bradford, Bristol, London, Merthyr Tydfil and Reading.

Data were collected about the child's exposure on the school journey and whilst playing in the street. The child's parent or adult carer was asked about their home environment and about personal characteristics such as ethnic origin, marital status and work situation. The parent's or adult carer's responses to statements about the accident risk of children in traffic and the responsibilities for safeguarding them were also recorded.

Logistic regression modelling was used to analyze the data to identify characteristics associated with accident group membership. A breakdown of these characteristics by socio-economic group was also carried out. The implications of the findings are discussed with reference to other studies. Potential countermeasures are offered and areas requiring further research identified.

CONTENTS

List of Tables

List of Figures

CHAPTER 1

INTRODUCTION

In road accident research there have been few studies focusing on the relationship between accident involvement and social economic group (SEG). However it is known that children (0-15 years) in the lowest socio-economic group are more than 4 times more likely to be killed as pedestrians than their counterparts in the highest socio-economic group (Townsend and Davidson,1982). To help improve our understanding of these high risk road users this study aimed to investigate socio-economic and environmental factors in child pedestrian accidents. In the first stage of this project a literature review was carried out and this identified two key areas where possible differences between socio-economic groups could be related to their differential accident involvement. These were 1) exposure defined as the quality and quantity of a child's experience in traffic; and 2) parental or carers perception of risk and attitude to the responsibilities for children's safety in traffic. This study presents a holistic approach to the problem of child road accident involvement in which socio-economic background and environment are regarded as possible influences on accident causation.

1.1 Background

The overall aim of the project was to investigate why children from low socio-economic groups are over represented in pedestrian accidents. The literature review suggests there are a number of social and environmental factors which may contribute to the relatively high accident involvement of children from low social groups. The picture which emerges is that high risk children live in overcrowded accommodation with limited play space, where the family has less access to a car and lives in an environment in which there is more traffic travelling at greater speeds. However, it is not clear how this syndrome affects accident involvement. The question is, are children from low income families more at risk because they spend more time in the streets, because the streets they use are more dangerous, because their parents or

adult carers are less adequate carers, because of some combination of these or because of some other factor.

Three hypotheses have been postulated to investigate whether there is a relationship between social and environmental factors and exposure and whether this relationship can account for the high accident involvement of child pedestrians from low socio-economic groups:

1. Children from low socio-economic groups are more exposed to traffic as pedestrians than children from higher socio-economic groups.

2. The parents or adult carers of children in low socio-economic groups are less able to be responsible for their children in traffic and less informed about risk compared to the parents or adult carers of children in higher socio-economic groups.

3. The traffic environments to which child pedestrians from low socio-economic groups are exposed are less safe than those to which children from higher socio-economic groups are exposed.

1.2 Objectives

The following objectives were set to test the research hypotheses:

1) To carry out a questionnaire based interview survey amongst a random sample of school children aged 5-16 years and also a sample of children aged 5-16 who, as pedestrians, had been injured by a motor vehicle and taken to a hospital Accident and Emergency Department.

2) To interview a parent or adult carer for each child interviewed.

3) To obtain measures of children's exposure on a school journey and during extra mural activities.

4) To obtain measures of the parents or adult carers attitudes to the responsibilities of safeguarding their children.

5) To obtain measures of the parents or adult carer's perception of the risks children face in traffic.

6) To obtain measures of the socio-economic situation of the interviewees household.

7) To develop a taxonomy of environmental variables to characterise individual roads.

8) To use the taxonomy to classify roads crossed by children and the roads in which they lived.

9) To obtain a full description of the circumstances of the accident from the experimental group.

10) To examine parents or adult carers perception of countermeasures

11) To examine the relationship between the aforementioned measures, socio-economic group and accident involvement.

1.3 Outline of the thesis

The first part of this study (Chapter 2) comprises a critical appraisal of literature which has investigated factors related to children's accident involvement as pedestrians. The aim of the literature review was to identify aspects of pedestrian accident risk that have been associated with socio-economic disadvantage to form a basis of further exploration. Chapter 3 begins with a discussion of various definitions of the concept of socio-economic status which is central to this study. This Chapter also comprises operational definitions of key variables devised to explore the relationship between socio-economic status and accident involvement. The aims and

objectives of the survey are stated and the survey methodology is outlined. Response rates and sampling is discussed and the sample demography given. Chapter 4 discusses the possibility of bias in the data arising from the sampling methodology. Chapter 5 provides a description of the accident circumstances and an insight into the child's and carer's perception of what caused the accident. Chapter 6 provides a breakdown of each variable by socio-economic group and accident involvement. Chapter 7 introduces the multivariate analysis model and Chapter 8 describes the results of applying the model to the data for the purposes of the thesis and for report for the Department of Transport. Chapter 9 explains the rationale for selecting one model as a focus for the discussion. The results of the selected model are discussed with reference to the findings of other studies and suggests potential countermeasures. This Chapter also examines the influence of sampling bias on the results. The final Chapter (10) identifies issues raised in the thesis which need further investigation.

CHAPTER 2

LITERATURE REVIEW

This literature review represents the first stage of a project aimed to investigate why children from low socio-economic groups are over represented in pedestrian accidents. The review covers six main areas:

* child pedestrian casualty statistics;
* developmental factors which make children vulnerable as road users at different ages;
* social factors which give rise to differential accident liability;
* exposure and how exposure measures have been used to indicate the quantity and quality of a child's experience in traffic;
* environmental factors are discussed with reference to the risks associated with the inner cities; and
* effectiveness of countermeasures are discussed indicating the level of provision for disadvantaged groups.

The review identifies a number of social and environmental factors which may contribute to the relatively high accident involvement of children from low social groups. These were exposure, parental attitude and environmental hazard.

2.1 Epidemiology

Epidemiology is 'The science that investigates the incidence and causative factors of diseases that are associated with a particular environment or way of life'. A major source of information about road traffic accident epidemiology is 'Road Accidents Great Britain: The Casualty Report' published yearly (Department of Environment, Transport and the Regions, annually). The casualty report is based on the STATS 19 database which is compiled from road traffic accidents involving injury which are reported to the police. It represents a 'broad brush' picture of

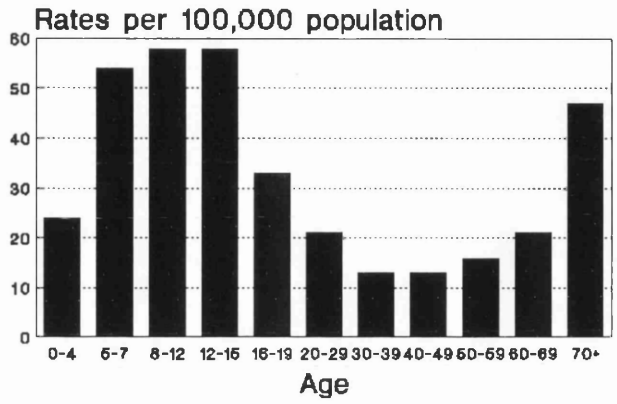
the incidence and circumstances of accidents. A fundamental problem with the database is that not all injury accidents are reported to the police. For example, injured pedestrians may well be taken directly to the hospital casualty department without involving the police or, particularly in the case of slight injuries be treated by local doctors. At TRL a sample of hospital casualty records were matched with STATS 19 data within clearly defined geographical areas and this has provided estimates of the level of under reporting for road accident casualties (Tunbridge et al 1988): this estimated that about a quarter of child pedestrian casualties are not recorded on STATS 19. However, as a national database of road accidents it contributes to our understanding of the epidemiology of road traffic accidents which will be discussed in this section.

2.1.1 Size of the problem

In 1991[1] over 5000 children (aged 0-15 years) were killed or seriously injured (KSI) on our roads in Great Britain. The rates per head of population for children aged between 5-15 are higher than those of any other age group (See Figure 1. Data source: STATS 19, DOT, 1992). Overall, pedestrians represent just over a quarter of all killed or seriously injured road users and of these just over a third are child pedestrians.

[1] 1991 casualty statistics are presented in this study because these were the only available statistics when the review began.

Figure 1: Killed and seriously injured pedestrians 1991

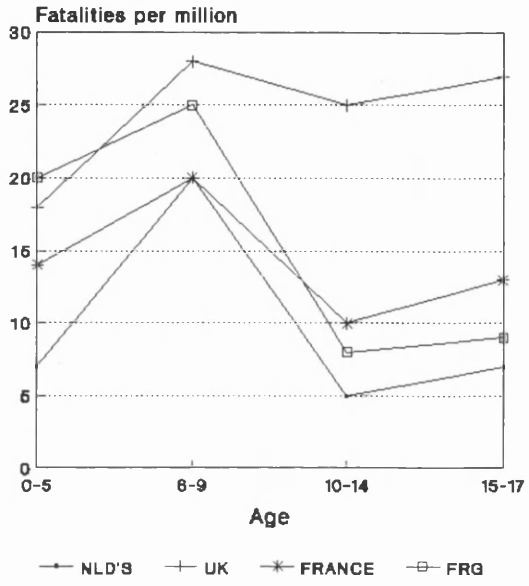


2.1.2 European comparison

Although there are some difficulties in comparing accident data sets from different countries (OECD 1983) the European picture shows a similar peak in casualties for children aged 5-7 years (Assailly 1992). However, in most other European countries the rates per capita are not as high as ours and the UK is the only country with a sustained high fatality rate for 10-14 year old pedestrians (See Figure 2). The fatality rate of 10-14 year old's in the UK increased in the early eighties but little is known of the causes (Tight 1992). A factor may be that UK adolescents travel more on foot than their counterparts elsewhere in Europe

(Lamm et al 1992) or, that they are more likely to live in extensive urbanized areas built before the motor age and less equipped to meets its demands (Lynam and Harland 1992). However, without comparative exposure data it is difficult to explain these differences in rates.

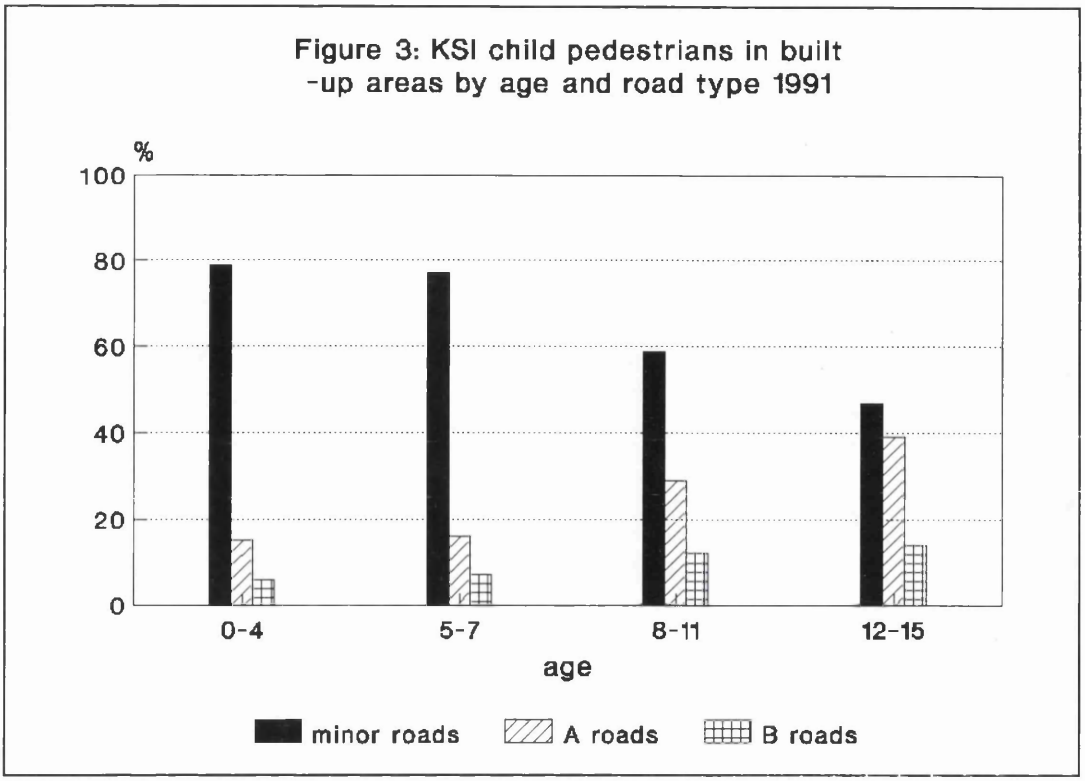
Figure 2: Pedestrian fatalities by age in northern Europe 1989



Economic Commission for Europe (1991)

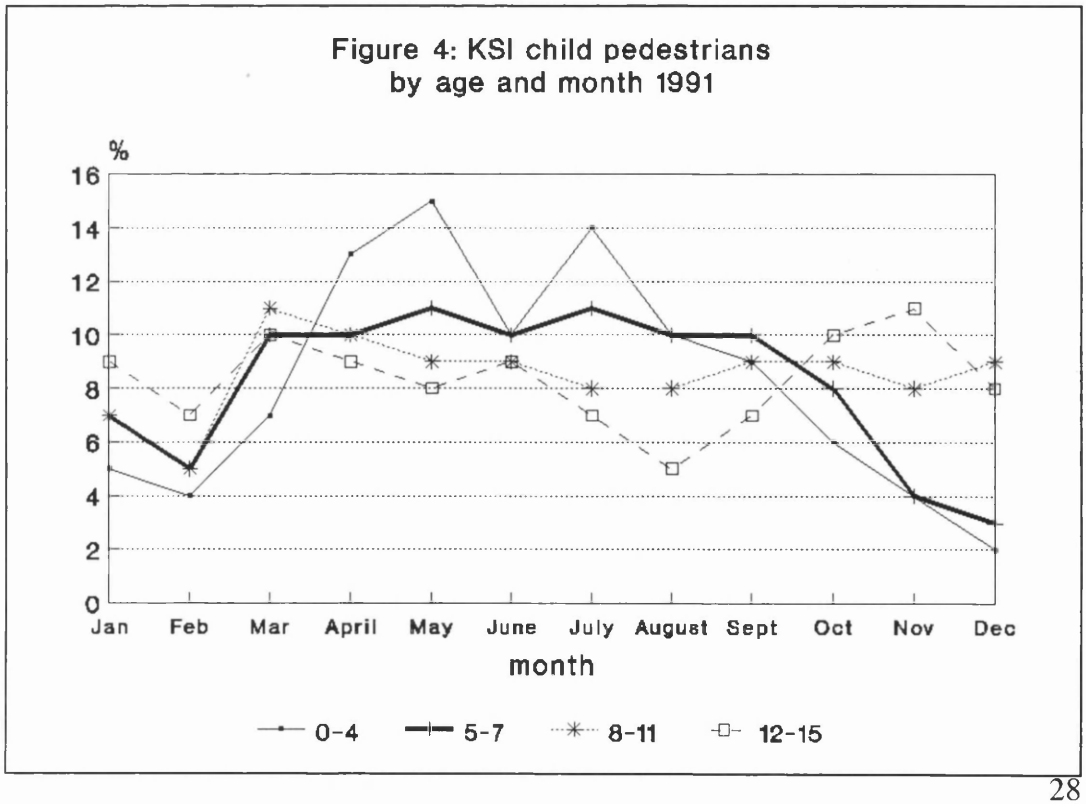
2.1.3 Type of area

Nearly all (95%) of the child pedestrian casualties in GB were killed or seriously injured in built-up areas (speed limit up to 40 mph). Up to the age of about 11 most of those accidents occur on minor roads (See Figure 3. Data source: STATS 19, DOT, 1992).

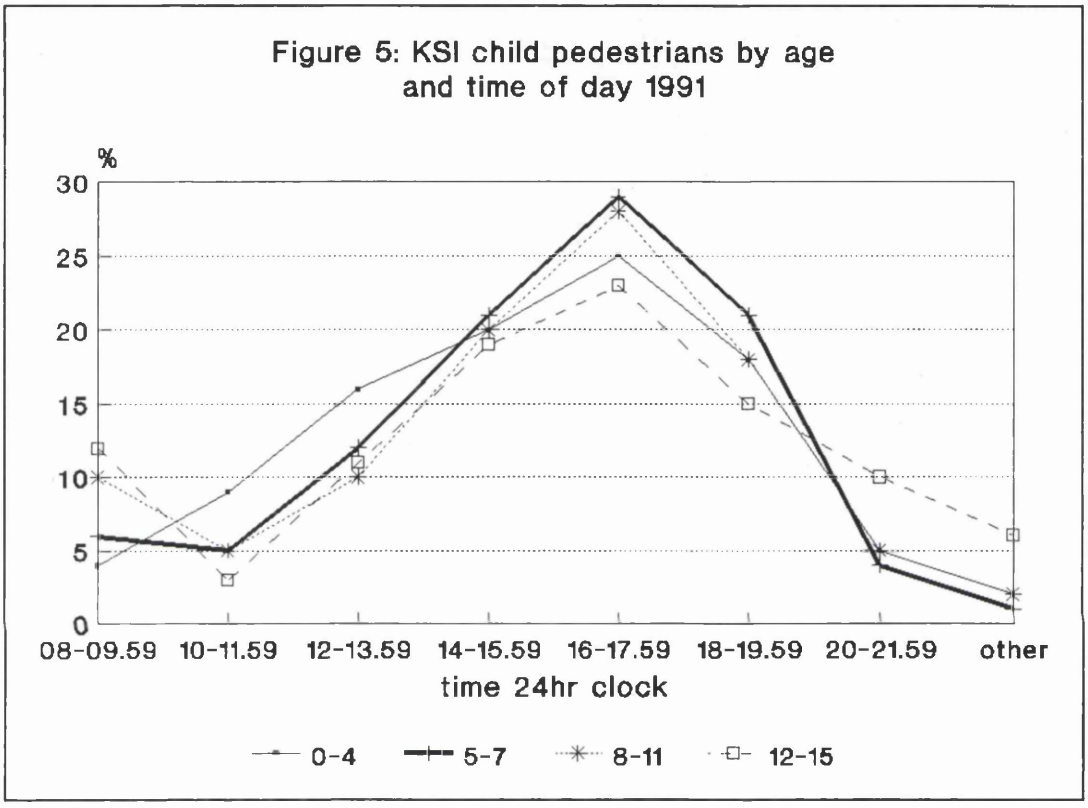


2.1.4 Seasonal and temporal variations

There are seasonal and temporal variations in casualty numbers as well, which also vary by age. There are spring and summer peaks for the under 11's, whilst autumn rather than summer has more casualties in the oldest age group (Figure 4. Data source: STATS 19, DOT, 1992).

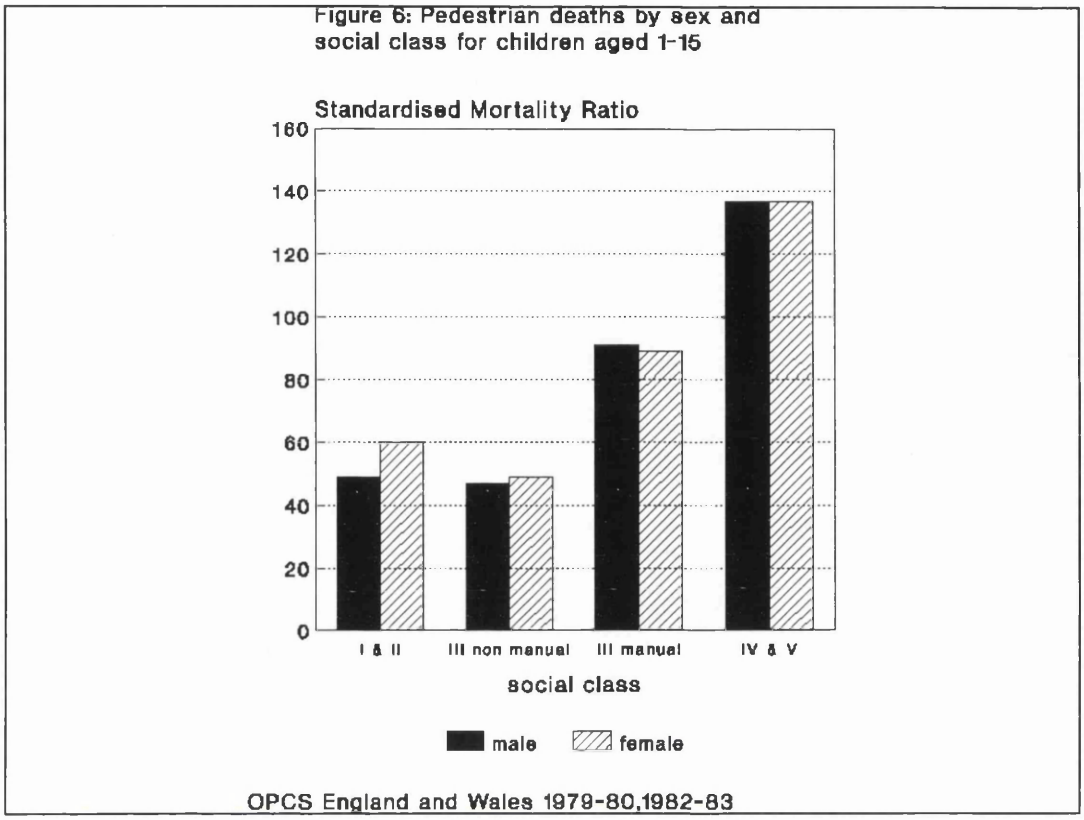


Most causalities occurred between 16.00 - 17.59 probably reflecting return journeys from school and children returning to the streets for leisure activities. There is also a noticeable morning peak for casualties aged between 12-15 years which may reflect the more independent journeys made by older children (Figure 5. Data source: STATS 19, DOT, 1992).



2.1.5 Socio-economic status

Data on the social-economic status of the casualty is not recorded on STATS 19. However, data from the Office of Population, Censuses and Surveys shows that road traffic deaths, like all accidental deaths are highly related to socio-economic group with a similar pattern for males and females (See Figure 6). A recent epidemiological study of fatal accidents involving head injury amongst children in the Northern region indicated that mortality was significantly related to social deprivation, and many of these children were playing, unsupervised at the time of the accident (Sharples et al 1990).



2.1.6 Ethnic origin

Several in-depth studies (eg. Lawson 1990; Lawson and Edwards 1991) have indicated that Asian children are over represented among pedestrian fatalities. Great Britain like most other European countries does not collect information on the ethnic origin of casualties, only in the USA is this type of data collected nationally (Division of Injury Control, 1990). In GB the coding of casualties by race on STATS 19 has been regarded as a politically sensitive issue by policy makers in the Department of Environment, Transport and the Regions, however given the high accident involvement of Asian children it would seem important to collect this information to help target remedial measures.

The remaining sections will attempt to review some of the main studies which have investigated the variables which underlie the statistical picture of accidents in Great Britain.

2.2 DEVELOPMENTAL LIMITATIONS

'A child is a psychotic dwarf with a good prognosis'

(in Klein 1980)

This comment by a paediatrician alludes to the fact that a child is not a miniature adult. Children inhabit a world constructed and controlled by adults but it is wrong to assume they possess adult capabilities in dealing with it. Any study of child pedestrians must start with a basic understanding of the developmental factors which make children vulnerable as road users. Certain features of children's development, in particular their limited ability to attend, search and detect, predispose them to accidents with vehicles which travel at speed and are difficult to see. Within the field of accident research, investigation of such behavioral features has provided a greater understanding of the aetiology of child pedestrian accidents. In this section, literature will be reviewed to show how the emphasis has changed from explaining developmental limitations in terms of physiological sensitivity to sensory cues, to the characterisation of development in terms of qualitatively maturing cognitive structures in which the development of attention is of critical importance. Also, this section will refer to the use of psychological models of development which have helped explain how experience, training and nervous integration contribute to more efficient information processing and attentional ability.

2.2.1 Visual and auditory perception

Many researchers have attempted to explain a child's poor capabilities in traffic in terms of sensitivity to sensory cues. Many studies of the sensitivities of children and adults indicate that the differences are not great (eg. Phinney et al 1985). Moreover, the ability to attend to relevant sensory stimuli seems a more important factor.

In her early pioneering work Sandels (1975) made observations of the spontaneous behaviour of Swedish kindergarten children (4-7 year old's) in traffic and argued that

they experience traffic differently from adults. Sandels observed that children do not appear capable of having an instantaneous appreciation of the total traffic environment. She argued that they cannot selectively attend to stimuli relevant to the task in hand over other, perhaps more interesting stimuli, to which they respond with 'the whole of their personality', and this makes their behaviour seem impulsive and erratic. Further experiments compared the ability of children (aged 6) to detect movement and localise complex sounds with the ability of adults (aged 20-40). Using a perimeter to measure movement detection in the peripheral visual field, adults proved to be more accurate than children. Again, subjects were instructed to point to one of 12 horizontally arranged loudspeakers which produced the complex noise of an approaching car. Children seemed to have difficulty in establishing the direction of the sound, and mixed up auditory sources to the right and left much more than adults.

A number of methodological problems arose from this research. The children were tested in unfamiliar laboratories (and not always the same unfamiliar laboratory), the tests were long and laborious and the instructions complicated. Such factors would inevitably discriminate against children in an experimental situation. Also, the tests were over-simplistic and did not investigate the masking effects of competing stimuli which would be present in a real life traffic environment. Sandels was aware of some of these criticisms and argued that the differences were too large to be accounted for by these factors. Sandels concluded that children's capabilities in traffic are best explained by their lack of long term training in attending to and judging traffic situations which make them less able to cope than experienced adults.

2.2.2 Movement and velocity perception

Kenchington et al (1977) attempted to assess the relative effect of movement prediction difficulties in the context of other contributory factors in an analysis of over 200 child pedestrian accidents. The analysis involved assigning 'indicators' to a number of accident variables (eg sex, age, lighting level, weather, presence of parked cars, etc) an 'A' = probably associated with inefficient movement prediction,

a 'B' = possibly and 'C' = probably not associated with it. For example, the environmental variable of 'presence of parked cars' may restrict a child's view of oncoming traffic and therefore would be assigned a 'B' indicator ' implying that 'masking' had possibly contributed more to the accident than movement prediction difficulties. The analysis suggested that inadequate movement prediction was a probable factor in 2% of accidents, a possible factor in 50% and probably not a factor in 16% of accidents (the remaining 32% of accidents were insufficiently well documented to be adequately classified in terms of 'A','B' or 'C' indicators).

The methodology is theoretical and makes many assumptions about individual accidents. Though the study makes a useful attempt at trying to identify the relative influence of developmental factors in accidents it does not successfully disentangle attentional effects from differences in movement perception.

Closely allied to the importance of movement detection is the perception of velocity. Accurate perception of velocity seems to be dependent on the assimilation of visual and auditory cues, distance judgement and spatial perception. Vinje (1978) argued that young children do not have the knowledge to determine the speeds of various vehicles. Salvatore (1974) argued that auditory cues and vehicle size affect velocity judgements. Forty children, two of each sex at each age from 5-14 years were asked to make 'slow', 'medium' or 'fast' judgements of vehicles from both 500 ft and 250 ft observation distances. Correct judgements of 'slow' and 'medium' speeds increased with age, while correct judgements of 'fast' were inversely related to age. (This last finding was explained in terms of younger children responding to parental road safety warnings).

2.2.3 Spatial relations, distance and depth perception

In Salvatore's study velocity discrimination became more difficult as the distance between observer and vehicle increased. Awareness of spatial relations and distance perception are also thought to affect a child's capability in traffic. Piaget and Inhelder (1956) characterised a child's viewpoint as being 'egocentric' in that until

the age of about 7 the child can only view the world from his perspective without considering the viewpoints of others. Gunther and Limbourg (1976) (cited by Phinney et al) also found that when using a small scale model, children aged 4 and 5 had more difficulty than older children in estimating the viewing possibilities of children and car drivers.

Studies reviewed by Phinney et al (1985) indicate that depth perception is well developed at an early age. 'Visual Cliff' experiments create a superficial illusion of depth which has been shown to deter infants from moving across the 'deep side' of the cliff despite encouragement from their mothers. However, the accurate perception of depth within a real life traffic situation seems to be more problematic for children. Zwahlen (1974; cited by Phinney) argued that 33% of pedestrian accidents involve errors of distance perception. He compared children (6-13 years) and adults (20-30 years) on their ability to estimate the position of a vehicle parked at 5 ft intervals between 180-210 ft. in relation to a standard vehicle parked at 200 ft. Adults and children did not differ in terms of their mean judgements, though children had larger variances in their judgements than adults. A further laboratory study indicated that children used less efficient head and eye movements, and although the basic strategies were the same, children took longer to make their judgements.

2.2.4 Attention

Efficient information processing in task oriented behaviour is essentially dependent upon the perception of whether stimuli are relevant or irrelevant, which is the problem of selective attention. Children's capabilities in traffic have been characterised in recent research as being limited by attentional ability which is regarded as a developmentally acquired skill. Conceptual models used by psychologists to explain maturation have been particularly useful in describing children's abilities in traffic.

Vinje (1978) discusses the developmental sequences proposed by Wright and Vlietstra (1975). A 4 year old is characterised by being easily distracted by novel stimuli and cannot control attention sufficiently to concentrate on relevant stimuli. A 5 year old has more control, but still attends to irrelevant stimuli which are salient in some way (in colour, form, novelty and surprise). Between 6 and 7 years old children are more

able to discriminate situations requiring playful curiosity and those requiring systematic search, but only by about the age of 11 can they attend to relevant information, ignoring what is irrelevant. Within this framework the development of attention is dependent on the amount of information gained from interacting with the environment and is therefore a function of the degree of exploratory and search behaviour of the child.

Phinney et al (1985) used Piaget's (1950) developmental framework to explain the limitations of a child's ability to pay attention in traffic situations. They argue that 'excessive centering' - a characteristic of the second stage of the pre-operational phase (2-7 years) - accounts for a child's tendency to focus on one or two interesting features of the environment which will prevent adequate search of all the traffic environment for other important features.

In summary developmental theories like that proposed by Wright and Vlietsra and Piaget are useful in helping to understand the ability of children to use the roads safely at different ages. In particular the development of attention is viewed as a critical aspect of developmental maturity. These theorists have argued that the control of attention is not fully achieved until the age of 11. The direct behavioural corollary of this attentional deficit, especially for the very young, is impulsiveness and the inability to attend to the appropriate aspects of the traffic environment making children under the age of 11 unreliable as safe road users. Clearly, this aspect of development has important implications about the feasibility of road traffic education and training objectives.

One of the main criticisms levelled at Piaget's theory of development is that it underplays the importance of the influence of explicit teaching and training upon intellectual development. However, Piaget recognised that education and a propitious social environment can influence the realization of the potential which maturation brings. Piaget was also criticized for his use of the concept of stages and for not being able to show empirically the limits of each stage. However, Piaget recognised that whilst the stages of the development were sequentially invariant the borderlines

between stages were blurred by intermediate steps thus allowing for individual differences between children.

Overall, Piaget's work provides a good theory to *describe* a child's development and what they are likely to be capable of at certain ages, though the range of causal mechanisms (eg.socialization, education and training) which may influence progress through these stages are not expounded in detail. Research has indicated that children may be trained to be safer pedestrians though the author feels that it is extremely difficult to substantially hasten developmental maturity for the average child, making them less impulsive and child like.

Attentional limitations have been more specifically studied in some accident studies. Grayson (1975) studied accidents involving child pedestrians (aged under 15) and concluded that lack of attention prior to crossing was a significant contributory factor. In conjunction with Hampshire Constabulary, information was gathered 'at-the-scene' of the accident from the child, a reliable witness and the reporting officer's description. Specific information on crossing accidents was gained from verbal reports from 2 questions: *'Did you look before you crossed?'* and *'Did you see the vehicle before it hit you?'* Data was coded in 3 main ways:

misjudgment - where a child reported that he/she both looked and had seen the striking vehicle before crossing in front of it.

partial lack of attention - where a child reported that he/she had looked before crossing but not seen the striking vehicle.

complete lack of attention - where the child reported that he/she had neither looked nor seen the striking vehicle.

Grayson concluded that few accidents were attributable to misjudgment, whilst over 90% (of 363 accidents) were due to partial or complete lack of attention.

Similarly Lawson (1990) carried out a retrospective analysis of accident data from over 2000 young pedestrians injured over a 3 year period in the Metropolitan districts of the West Midlands. The study included detailed reports from Coroners' data, supplementary postal interviews amongst 251 severely injured pedestrians, and additional information from police files on accidents involving over 400 seriously injured pedestrians. A fifth of all pedestrians admitted they looked neither right nor left before crossing and almost half said they had not seen the vehicle before the accident.

Such data relies heavily on information elicited from the recall of a child traumatised by accident involvement and therefore may not yield the most reliable data, especially from the very young. Also, these studies do not account for the influence of other factors like driver behaviour or the features of the environment where the accident occurred.

The central behavioural manifestation of inadequate control of attention seems to be impulsiveness. Sandels (1975) noted that children seem to have great difficulty in suppressing sudden impulses and are likely to run into the road without warning. Accident data suggest that 'dart-out' accidents are a prevalent type of accident amongst young children (see Malek et al 1990).

The significance of such behavioral factors in child pedestrian accidents is underlined by marked age differences in accident rates even when other factors are controlled. For example, Howarth et al (1974) noted that for the pre-school and infant child (5-7 years) exposure to traffic, defined in terms of number of roads crossed and number of vehicles encountered, is less than for older children though their representation in accident occurrence per unit of exposure is much higher.

2.2.5 Disabilities

A developing child does not then seem to have sufficient skills to adequately attend

to traffic. Given that even a normal, able child is disadvantaged in dealing independently with traffic, the presence of organic and cognitive disabilities seem likely to have profound effects upon a child's accident liability.

In a study of child pedestrian accidents and road crossing behaviour in Scotland (Scottish Development Department, 1989) 14%(53) of a sample of 380 children involved in accidents were reported by their parents as having some physical disability. The most common disability was defective eyesight but in all but 2 cases, children were wearing their glasses at the time of the accident. The incidence of hearing disabilities was 3.6% in the accident sample compared to the national level of 0.1% of school children who have some hearing impairment.

Sandels (1975) pre-selected children with normal vision for the motion test mentioned earlier and discovered a significant number of children with short-sightedness previously undetected.

2.2.6 Conclusion

The research reviewed in this section indicates the importance of a child's ability to attend to relevant information in the environment. The development of attention is in part a function of experience and interaction in the environment. In the next section studies of the influence of the social environment upon learning to survive in traffic will be reviewed, because this factor may have a substantial influence upon whether or not the child has a 'good prognosis'.

2.3. A SOCIAL PHENOMENON

> ***"While the death of an individual child may appear a random misfortune, the overall distribution indicates the social nature of the phenomena".***
>
> The Black Report
>
> (Townsend and Davidson 1982 p127)

The risk of death for child pedestrians is highly class-related. Mortality statistics indicate that children in the lowest socio-economic group are over 4 times more likely to be killed as pedestrians than their counterparts in the highest socio-economic group. Much of the risk to children in low socio-economic groups may be caused by

the interaction of social and environmental factors. This section will review some of the literature concerned with the interplay between social and environmental factors which may underlie the high mortality rates of children in low socio-economic groups.

2.3.1 Social factors

In the field of road safety research few studies have focused on socio-economic differences in child pedestrian accidents. However, there has been valuable work carried out by researchers involved with paediatric and community medicine. Early research into social factors in road accidents in Great Britain was carried out by Backett and Johnston (1959).

The study involved analysis of the social characteristics of 100 families in which a child aged 5-14 years had been involved in a non-fatal pedestrian accident compared with those of a control group of families matched in terms of sex, age, school and the 'social homogeneity' of the area in which they lived. The main areas of investigation were the relationship between accident involvement and the following social factors:-

a) family and maternal health: where illnesses were classified as 'trivial' or 'non trivial'
b) maternal preoccupation: where a mother's attention was described as taken up with younger siblings, pregnancy or outside work
c) family size and age structure
d) protected and unprotected play: measured by room to play in, gardens, yards, playrooms and by reported use of playgrounds, fields, etc.
e) crowding: defined as number of persons per bedroom.
f) poverty and property: defined as the ratio of dependents to earners in the household.

Backett and Johnston concluded that illness, maternal preoccupation, crowding and lower level of protection during play and play facilities were more strongly associated with the accident families, especially where younger children were involved.

Although Backett and Johnston investigated the social circumstances of the matched samples of accident victims and non-victims they did not attempt any formal classification of their subjects and so the study gives no indication of differences

between social groups. Given the way in which the samples were matched, the study may well reflect only differences within social groups.

Brown and Davidson (1978) interviewed a random sample of 458 mothers (with at least one child under 16) from inner London to investigate the relationship between social class, psychiatric disorder of the mother and accident risk to children. Accidents were more frequent for 'working class' children whose mothers presented some psychiatric disorder (determined by tests developed by the Institute of Psychiatry). Brown and Davidson argued that major housing problems were associated with the psychiatric disorder of the mother and the causal factors in the child's accident were less associated with the mothers ability to supervise and more to do with the change in the behaviour of the child due to atypical family life.

Similarly Husband and Hinton (1972) interviewed the mothers of 24 children aged 3-14 who had had at least 2 accidents in the previous 12 months, 4% of which were road traffic accidents. They found that in 50% of cases there were family problems associated with the psychiatric disturbance and/or organic illness in other members of the family and concluded that 'the child with repeated accidents may often be the presenting symptom of a family disturbance'.

Wadsworth et al (1983) investigated family type and accidents in pre-school children. The sample of children was taken from a national longitudinal cohort study whereby children born in one week in 1970 were followed up at set intervals. Of just under 13000 children available to interview at the age of 5, 6% were with one parent and 3% were living in step families, (described as 'atypical' families). A follow up interview was carried out with the child at 5 years of age by the health visitor who assessed parental responses to a wide range of medical, social and developmental topics. Accident history was recorded for all accidents for which the mother had sought medical attention. The study compared the accident history of children living in 'atypical' families to a randomly selected control group of children in the main sample who had always lived with two natural parents. They found that children in atypical families were more likely to suffer accidental injury compared to children living with two natural parents. Wadsworth et al also found that low maternal age, frequent house moves and the poor behaviour of the child were more associated with one parent or step family types than other family types and, unlike Husband and Hinton (op. cit.), argued that these factors affected the 'vigilance of parental

supervision' giving rise to the child's vulnerability to accidents.

More recently Sharples et al (1990) have put forward a similar argument to account for the relationship between accident involvement, deprivation and parental supervision. Sharples et al assessed the causes and circumstances of fatal accidents involving head injury occurring in children (aged under 16) between 1979-1986 in the Northern Region of England. The methodology involved identifying fatalities from OPCS records and the Hospital Activity Analysis. Inquest and necropsy reports were examined to identify causes and circumstances of the deaths and to assign an injury severity score to each case. A central part of the analysis was to investigate the relationship between fatal injury and social deprivation. To do this the 678 local authority wards were divided into 10 groups according to their overall score on the deprivation index devised by Townsend et al (1988), group 1 representing the least deprived wards and group 10 the most. Mortality rates per 100,000 could then be calculated from each group.

Pedestrian traffic accidents were the largest single cause of death accounting for 135 of the total of 255 fatalities. The mortality rate of pedestrians was significantly related to social deprivation: most of the accidents involved children living in deprived areas. Inquest reports indicated that of pedestrian fatalities most (53%) were playing unsupervised in the street at the time and nearly half of these children were aged under 7. The remainder of the children were injured whilst on a journey and these children were significantly older than those injured whilst playing; again the level of adult supervision was low. Sharples et al argued that the level of supervision afforded by deprived families is likely to be impaired and counter measures aimed at providing safe , supervised play near to home especially for the younger children could significantly reduce mortality.

Mueller et al (1990) aimed to measure the children's (aged less then 15 years) pedestrian accident risk in relation to the traffic environment. Data on 98 fatal and seriously injured child pedestrians were collected for King County, Washington in 1985-1986. The home address of the casualty and the address where the accident occurred were also recorded. Two control groups were used, one obtained from a random digit telephone sample and another from children who had been admitted to hospital for an appendectomy. The environmental characteristics recorded for each accident and control child included type of residence, play space availability, presence

of traffic calming or control measures, speed limit and presence of parked cars. The results indicated that children living in multi-family dwellings rather than single family dwellings was associated with increased accident risk as was absence of play space, low income, high traffic volume and higher speed limit.

In the USA Braddock et al (1991) investigated the role of demographic and socio-economic factors in the pattern of accident-involved child pedestrians (aged under 15) from police records in Hartford, Connecticut during 1986-1987. The 198 child pedestrian-vehicle collisions were assigned to 1 of 49 census 'tracts' in the city. The tracts were then classified in terms of collision frequency and characterised in terms of collision frequency: low, moderate and high. High collision frequency tracts were significantly different from lower frequency tracts in that they had a greater child population, more non-white residents and more households headed by women. The high collision tracts also had significantly more households with more than one person per room and more children per acre. Braddock et al argued that the value of this approach is that it can provide 'geographically focused prevention efforts': 'Local information about child pedestrian collisions can be a powerful incentive for mobilizing broad-based community support for prevention efforts. Community coalitions that include representatives from the city health department, traffic safety and engineering, police department, public schools, medical community, automobile and driver associations, housing authority, and community organizations can be motivated to address the problem through site specific community education and planning, and outreach.' (p1246)

Bagley (1992) looked at the relationship between juvenile crime - a correlate of social disadvantage - and pedestrian accidents among young people in Calgary, Western Canada. Juvenile (< 18 years) delinquency rates were calculated from data collected between 1981 and 1984 for 120 neighbourhoods for which there were social and demographic information. Pedestrian fatality and serious injury data between 1981 and 1987 were obtained from police records and classified by victim's address. Bagley found that a general crime factor score correlated with the child pedestrian accident rate across the 120 neighbourhoods. A number of high rate areas were identified. Crime rate and pedestrian accidents significantly correlated with public housing, population density, unemployment level,public play space and low birth weight.

Kendrick (1993) analyzed 573 child (aged under 12) pedestrian accidents which occurred between 1988 and 1990 by a deprivation score. The deprivation score was based on low income, unemployment, lack of skills, poor housing, poor health and family problems. Enumeration districts were then aggregated and categorised into areas of extreme, serious, moderate and below average disadvantage.The analysis showed that the accident rate (calculated using the estimated child population within each enumeration zone as the denominator and pedestrian casualties as the numerator) was significantly higher in deprived areas than in non-deprived areas.

2.3.2 Social and environmental factors

More recently, researchers have investigated what have been described as the 'socio-ecological' characteristics of child pedestrian accidents (Joly et al 1991). This conceptual model helps to identify characteristics of the social and physical environments which may be linked to the high accident rates of low socio-economic groups. The socio-ecological perspective stresses the importance of the individual's relationship to the social and physical environment (Bjorklid 1992). Socio-ecological factors may include employment levels, ethnicity, indices of deprivation, traffic flow, speed limits, and accessibility to parks. Therefore the socio-ecological perspective looks at the *relationship* between a pedestrian's social situation and the physical traffic environment in which they live, in the same way that an ecologist, in a broader sense, looks at the relationship between living things and their environment .

The socio-ecological perspective has been used by a number of workers in the field of child pedestrian research. In particular, research has suggested that social factors may give rise to increased exposure to intrinsically hazardous environments. Preston (1972, 1976) in her statistical analysis of child pedestrian accidents in Manchester and Salford postulated a link between overcrowding - an index of social deprivation - and the accident rate for young boys which was especially high. She argued that overcrowded houses were likely to be associated with lack of play space both inside and outside the home increasing the probability of children 'playing out' in situations where they were unprotected.

Motivated by this research King et al (1987) investigated the pattern of child pedestrian accidents in the inner urban areas of the metropolitan districts of the West Midlands. They found that high accident rates were associated with Victorian

terraced houses with little or no gardens, few garages and therefore a high level of on-street parking. The roads in these areas were long and straight and encouraged high traffic speeds; such residential areas tended to be inhabited by people in low socio-economic groups.

Urban deprivation has also been linked to the disproportionately high incidence of accidents involving children from ethnic minorities. Lawson and Edwards (1991) have shown that Asian children under 9 years old are twice as likely to be injured as their non-Asian counterparts especially in accidents where children have been 'masked' by parked cars. The study analyzed accident data for 51 fatalities aged 0-19 years and for nearly 5000 injury accidents: and also looked at data from a questionnaire survey amongst 423 injured pedestrians and the drivers of the striking vehicle. The main findings were that type of area and age of casualty and not ethnicity were important in explaining high accident rates. In particular, areas which were deemed 'priority for urban regeneration', where there was considerable on-street parking, seemed to pose a problem for young Asian pedestrians.

A similar picture has been reported in France by Tursz et al (1991) where in Paris immigrant children were disproportionately represented in accident figures. This was explained in terms of possible cultural factors which involved greater street use by many immigrant children who tended to inhabit homes which had less space to play in forcing children to 'play out' on the streets.

In Germany, Bocher (1978) stressed the importance of the social environment in the context of what he described as a 'systems approach' to the problem of children in traffic. From this perspective the road safety problem is viewed holistically: 'The traffic environment may be understood as a kind of super system incorporating natural, man-made material and man-made sociocultural influences.' From studies carried out in Essen the systems approach revealed that accident involvement was linked to socio-economic background and to households where there was a higher number of children living in less spacious living accommodation, with lower car ownership, in areas with relatively high traffic density travelling at higher speeds, and where houses opened directly onto the street. A similar interpretation was provided by Joly et al (1991) from their study of child pedestrian accidents on Montreal Island which showed that low socio-economic group, traffic flow, type of speed limit and the accessibility of parks were associated with accident involvement.

This raises a number of questions concerning the nature of accidents involving children from lower social-economic groups. It is clear that the urban environment provides endemic risk for the child pedestrian. Given this fact, are children in low social groups somehow more exposed to this risk, and if so why? Is it because in some way they behave differently, perhaps they take greater risks? Do the parents of these children perceive the risks in the environment, and what responsibility do they take for their child's unsupervised play? And, what are the social factors like overcrowding and maternal preoccupation with other siblings which mediate different levels of supervision ?

Few of these questions have been adequately explored in child pedestrian accident research. In fact, often research into the characteristics of the accident-liable child has taken place as if such accidents occur in a 'social vacuum' without any relationship to the social situation. Manheimer and Mellinger (1967) looked at the medical records of nearly 700 accident injured children in California and using intensive interviews with mothers and school records, classified children in terms of 'high', 'intermediate' and 'low' accident liability. They found a statistically significant relationship between high accident liability and indices of extraversion: daring, roughhousing and other traits which they argued facilitated a child exposing himself/herself to hazards and once exposed impair his/her ability to cope. In this study such traits or individual differences were characterised as 'pathological'; however, there was no consideration of whether there was a 'pathological' social environment behind the accident-liable child. Research which attempts to characterise children involved in accidents in terms of individual traits should control for their social environment.

2.3.3 Exposure, social factors and the environment

The link between social deprivation and the high accident rate of child pedestrians from lower socio-economic group families may be explained in terms of increased exposure to hazardous environments. From interviews conducted with parents Klein (1980) reported that the child rearing practices of lower socio-economic group families involved less supervision, less time spent in shared activities, children are left to their own devices during holidays and out of school and for longer periods of time. Often children are left in the care of older but immature siblings. Klein proposes a number of explanations for this lack of control and supervision:

> "It may be due simply to a lack of resources. Or it may stem from a feeling of powerlessness to control many aspects of life and hence to an abdication of any efforts at control. It may be due to a greater amount of stress, less ability to cope with problems, or simply a condition of overload produced by too many children in inadequate quarters. Or, as some investigators believe, it may stem from a style of perception and cognition that is focused on the immediate present and is rarely future oriented. Under such conditions, concern with child safety receives low priority". (pp 277-278).

He also argued that 'working class' children are more likely to be encouraged to take part in activities that involve greater physical risk, where competitive drives find an outlet in unsupervised activities in unprotected environments. In comparison, the competitive drives of 'middle class' children are channelled into carefully taught and supervised activities.

Parental child rearing is perhaps the most important social influence upon the child's road safety but there are many other social influences which may affect children's behaviour on the roads. Peer pressure, particularly amongst school children, may affect children's use of the road system, especially in relation to street recreation; however, there is little research in this area.

2.3.4 Methodology of data collection and analysis

Generally there two methodological approaches used to acquire data on child pedestrian accidents. One approach describes *retrospective* sampling methods and the other describes *prospective* sampling methods.

Retrospective sampling methods usually involve analysis of national or regional casualty data routinely collected by the police or registered in population statistics as is the case with fatalities. Further information on fatalities is also available from coroners necropsy reports. The advantage of this sampling method is that several years of data can be combined to provide large numbers of casualties for analysis. Also, such samples can be used as numerators to combine with other nationally or regionally held databases, like census data, which can be used as denominators to calculate risks for different demographic groups. The main disadvantages of this method are that the data are limited as they usually only describe circumstantial

characteristics. Also, a sizeable proportion of accidents, especially involving vulnerable road users, will not be reported to the police. The database is anonymous and therefore does not offer a route by which casualties can be followed up to seek greater information. Currently, there is no national collection of information from hospitals on road casualties.

The prospective approach aims to achieve a sample of pedestrian casualties so that the casualty can then be interviewed or followed up in some other way. The main advantage of this method is that it enables the researcher to set their own agenda for data collection. Studies that use prospective sampling methods often obtain a sample via hospital casualty departments. There is little information on the efficiency of this type of sampling. Study reports using samples obtained from hospitals tend to be results oriented and do not give detailed accounts of sampling problems. The relative infrequency of pedestrian casualties necessitates using a large number of hospitals and/or a long sampling period to ensure sufficient sample sizes. Furthermore, there may be biases in the sampling method aimed at trying to obtain consent from the casualty or their carer at a time of stress. Simpson (1997), in her analysis of the DTI's hospital based home and leisure accident surveys showed that only a third of road accident casualties were able to be interviewed with a bias against the more seriously injured and male casualties.

The analysis of child pedestrian data may also be divided into two types of approaches involving 1) the estimation of risks and rates of accident involvement and, 2) descriptions of accident circumstances. The most often used type of analysis is the use of numbers of casualties as numerators with other data as denominators to express child pedestrian accident risk as function of various characteristics (eg. per capita, per unit of exposure etc). The denominators are usually obtained from national databases (eg. census data) and are limited by the disadvantages described earlier. If the data are not available nationally, as is the case with exposure data for children, then additional surveys have to be carried out.

The other approach to the analysis of child pedestrian accidents is to describe the circumstances of the accidents. Whilst such accounts provide a useful insight into the circumstances of the accidents they cannot indicate the relative risk associated with different characteristics of the accident or casualty.

Both these types of approaches are limited by the nature of the data and provide limited control of confounding factors. One method of overcoming these problems is to collect both types of data and use a multivariate approach to predict accident involvement over a range of characteristics for accident involved and control (i.e. non accident involved) samples of children. This approach enables statistical control of confounding factors, provides descriptive data and allows relative risks to be estimated. At the time of writing this thesis few studies have examined child pedestrian accidents using a multivariate approach which predicts risk for a sample including accident and non accident involved children.

2.3.5 Conclusions

This section has reviewed studies which have examined child pedestrian accidents in a social context. The interplay of social and urban deprivation has been implicated in the causation of accidents involving young pedestrians. However, the nature of this interplay is not well understood. It would seem essential to investigate the interaction of social group and environmental factors especially in relation to exposure data. This approach may help to provide explicit behavioral measures of differential accident risk and it is this issue - the measurement of exposure - which will be addressed in the next section.

2.4. EXPOSURE

The high accident involvement of child pedestrians from low socio-economic groups may be explained in terms of the socio-ecological perspective which attempts to describe the problem in terms of inadequate social and physical environments. However, the interplay between social and environmental factors has not been systematically investigated. Research discussed in the previous section suggests that social and environmental factors may have contributed to accident involvement by increasing a child's exposure to risk. For example, a child living in a household which is overcrowded with limited play space both inside and out may be forced to 'play out' in a traffic environment where there are more vehicles travelling at greater speeds than are encountered by children living in more spacious surroundings.

Few studies of exposure have investigated social class differences. Nevertheless, to understand the role of exposure in differential accident involvement it is important to

clarify what exposure means and how it can be measured. An important methodological issue of any study of exposure is: 'What is exposure for?' (Grayson 1979). Exposure is a measure of a pedestrian's interaction with traffic which when related to accident statistics can be used to identify which aspects of this interaction are associated with the risk of having an accident and so help to target preventive measures. Clearly there are many aspects of a child's exposure which may influence accident risk for example, whether or not a child is accompanied by their parent, what type of traffic they encounter, how they behave whilst crossing etc. Therefore the choice of exposure measure by the accident researcher will vary according to which aspects of a child's interaction with traffic are thought to influence accident risk. Consequently, exposure studies have provided a number of different measures of a child's experience of traffic.

Broadly speaking, two main approaches to pedestrian exposure can be distinguished in the literature. Firstly, exposure has been conceptualized as a quantitative measure of 'risk exposed' experience in traffic. This viewpoint does not attempt to account for the role of the active behaviour of the road user. Secondly, exposure has been conceptualized as a measure of a road user's qualitative experience in traffic, this viewpoint attempts to account for the road user's active 'risk exposing' behaviour in traffic.

The aims of this section will be fourfold: 1) to describe some of the different conceptual definitions of exposure and the methodological questions they raise; 2) to review studies which have used exposure measures to indicate 'risk exposed' traffic interaction; and 3) those which measure 'risk exposing' interaction; and 4) to identify children's patterns of exposure. Throughout this section measures of exposure, useful in explaining the relationship between accident involvement and socio-economic group, will be highlighted.

2.4.1 Conceptual definition

Exposure has been defined in simple broad terms eg. opportunities for accidents or presence in the road system whether on carriageway or footpath, or in a complex , exhaustive, model-building way embracing variables of road usage through to social and individual variables.

Chapman (1973) discusses the concept of exposure at length and defines exposure as 'the number of opportunities for accidents of a certain type in a given time in a given area.' He argued that there is a need for measures of exposure to be highly specified to provide a composite measure based on data from a group of indices (eg. when, where, how much and under what conditions) reflecting a road user's experience of the road system. Such measures would not have absolute values because of the difficulties in gaining total knowledge of the road system, the road user and his or her 'style' of use.

Chapman's paper is a useful theoretical discussion in which he argued that exposure measures should describe aspects of a pedestrian's experience of the road system. Other researchers agree with this simple theoretical standpoint but have attempted to link the use of exposure measures more specifically to accident causation in attempting to explain differential accident occurrence.

Grayson (1979) argued that exposure measures are essentially implicit models of accident causation. He likens the concept of exposure to the principle of experimental control in the laboratory. In this conceptualization a researcher must control for factors which are thought to contribute to accident involvement to establish whether the observed differences in the accident involvement of various groups can be attributed to the characteristics of the groups themselves, or some other factor such as exposure. Such a concept of exposure implies a dichotomy of causal accident variables, those attributable to behaviour (of the groups themselves) and those attributable to exposure (the extent a group is exposed to risk). Accident frequencies can then be regarded as a function of the interaction of both behavioral and exposure variables. Indeed, Grayson maintained that exposure data can only be meaningful if related to accident rates and any study of exposure should satisfy 3 criteria:

"Firstly, we should advance a definition of exposure, secondly it should collect data relevant to that definition, and thirdly, it should attempt to relate these data to accident statistics".

Grayson cites a study by Knighting et al (1972) as a good example . These workers argued that children were exposed to risk if observed anywhere in the traffic system and carried out a count of children in the streets as a simple measure of exposure which they then related to accident data.

The concept of exposure has been treated with greater specificity by Van der Molen (1981). His definition of exposure represents a standpoint diametrically opposed to that of Knighting et al (1972): it is specific rather than global. His paper represents an exhaustive taxonomy of empirical data which he attempts to link in a complex theoretical model. The model represents a synthesis of the most important data concerning child pedestrian accidents and attempts to characterise the pedestrian task in terms of 5 factors.

1. personal parameters of the child: age, sex, personality, educational background, physical development.

2. social parameters: journey purpose, accompaniment.

3. Environment parameters: roadway situation, pedestrian facilities, type of neighbourhood, traffic regulations, weather conditions.

4. traffic: presence/behaviour of other road users.

5. Behaviour of the child: determined by other 4 factors.

Within the model exposure is defined as 'the frequency of a particular occurrence with reference to participation in traffic ....'. The parameter values of each factor could then be specified on the basis of empirical data. Van der Molen states that exposure studies have usually focused on global 'non-personal' factors for different ages or sex, eg. time spent out doors, number of roads crossed, number of cars encountered etc. and argued that such studies shed little light on the behaviour (factor 5) involved. The model also allows 'general predisposing factors' (eg. personal variables, family background, housing, etc.) which influence exposure to particular situations, though no clear connection is made in relation to the pedestrian task.

In Van der Molen's model the concept of exposure does not have a precise metric, but is a derivative of a range of variables which predispose a child to behave in a certain way under certain conditions. Apart from being cumbersome the main flaw of this approach is that it draws on a variety of studies which have defined and measured exposure in different ways.

The major methodological problem created by these different conceptual definitions of exposure concerns the role of behaviour in exposure. Broadly speaking the concept of exposure has been defined in two main ways: Firstly, exposure has been used quantitatively to describe 'risk exposed' experience of traffic; secondly, exposure has been used qualitatively to describe 'risk exposing' experience of traffic which, to a greater extent, reflects the role of the active behaviour of the road user. In practice the distinction between exposure and behaviour is by no means clear, pedestrians participate interactively with traffic and there are many aspects of behaviour which will influence exposure to risk for example participating in the road crossing game 'playing chicken'. Given this conceptual difficulty exposure must be defined in a way that reduces the level of uncertainty about its relationship to behaviour.

2.4.2 Risk exposed traffic experience

There are a number of studies which measure exposure as a quantitative 'risk exposed' aspect of traffic experience. Knighting et al (1972) defined a child to be exposed to risk if observed anywhere in the street whether on the pavement or road because the unpredictable nature of children's behaviour meant that crossing a road was only one aspect of exposure. The researchers used a moving observer technique to count numbers of children in the streets on an estate in Reading, 10 hours per day for 1 week in the summer holidays. Around 2,500 children were observed. When data from this study was compared with child pedestrian casualty figures in urban areas for the same month and times of day, a reasonably close relationship was found. However, cross analysis by age showed less agreement especially for the younger age groups. The use of exposure in this way helps to identify the relative importance of different factors in child pedestrian accidents. In this study exposure could not account for the accident rates of young children, leaving Knighting et al to infer that the behaviour of this group of children has more influence on accident involvement than length of time exposed.

These results have been repeated by researchers at Nottingham University (Howarth et al (1974), Routledge et al (1976)). However, these workers quantified exposure in two specific ways: as the average number of cars encountered daily and the average number of roads crossed daily. These workers also introduced the idea of the 'quality' of exposure, whereby a child's exposure score is weighted by level of accompaniment which is assumed to influence the degree of protection whilst crossing

the road. Many studies have shown that a high proportion of accident involved child pedestrians were unaccompanied at the time (Kloeckner et al 1989; Tight 1992). From observed data, exposure measures were weighted differently depending on how they were classified. Specifically, responsibility for road crossing was classified in three ways: 1) active/responsible - where the child is crossing unprotected, eg. without an adult, 2) partially active/partially responsible, eg. with an adult, not protected by them, and 3) passive/not responsible - clearly protected by an adult eg. holding hands. Howarth et al 1974, used a number of different methodologies (interviews with parents and children; random site studies of crossings traffic density and encounters; following studies eg. moving observers) to provide exposure data to compare with accident data to achieve estimates of risk for different pedestrian groups.

The results from these studies indicated that there is a marked increase in exposure between the ages of 5 and 11 years which when related to accident data show that pedestrians aged between 5-7 years old are 40 times more at risk than adults aged 20-50 years. Also, exposure was similar for boys and girls especially between the ages of 5-7, whereas there are marked differences in accident data: boys had more accidents suggesting that behaviour played has a role in accident causation.

The Nottingham studies provide a useful operational definition of exposure in terms of road crossings and traffic encountered. The specific methodologies used raise some problems about the compatibility of different data sets, because interview data and traffic density counts relate to different days (for practical reasons). In addition, the perception of the quality of accompaniment was very subjective and not validated by other observers. Moreover, road crossing behaviour was measured mainly for specific, purposive journeys (from school) and therefore underestimates the exposure of children when playing out. This factor may affect the differences in accident rates between socio-economic groups.

Tight's (1987) investigation of the accident involvement and exposure to risk for children as pedestrians on urban roads used a number of measures of exposure which reflect both the quantity and quality of a child's experience in traffic in terms of patterns of mobility. Information from a self-completion questionnaire survey amongst school children in selected areas of five towns in England (Bradford, Reading, Sheffield, Bristol and Nelson) was collected about several aspects of exposure to

provide a 'snapshot' view of their journeys to and from school. The aspects of exposure were:

1) mode of transport
2) accompaniment
3) time spent outside
4) distance travelled
5) number of roads crossed

Other personal characteristics like age and sex were also noted. Recreational use of the streets was studied by using the moving observer technique during school holidays and after school. Average daily accident data for the study areas based on accident data for several years were analyzed in relation to exposure data to indicate accident risk for different age and sex groups.

The exposure data alone showed that more children tend to walk on the journey home from school than they do in the morning. Girls were accompanied more than boys and infants/first school children had the highest level of accompaniment. Secondary school children crossed more roads and took longer than younger children. There were notable geographical differences in levels of street play and accompaniment with children in the northern towns and cities playing out more and with generally less accompaniment than those in the southern ones.

Exposure data were related to accident data to provide estimates of risk. Risk was higher on the journey home than to school and middle/junior school children had the highest accident risk. The accident risk of crossing a main road was 10 times that of crossing a side road , and three times higher when crossing a main road not at a crossing facility than when crossing a main road at a crossing facility. Accident risk was twice as high within 0.5 km of the school compared to distances greater than this. Exposure could account for differences in accidents with respect to use of the streets other than for school journeys for different age and sex groups, boys having a higher than average exposure in the school holidays and primary school girls having a lower than average exposure in the school holidays.

Tight's study describes exposure to risk in terms of readily quantifiable variables providing normative patterns of children's mobility in traffic which can then be related to accident statistics. Interesting differences in exposure existed especially between urban areas in the northern and southern towns and cities, but no explanation

is given of why such differences occurred and no data were collected about the socio-economic status of the children sampled or about environmental factors which may have contributed to the differential accident patterns amongst child pedestrians.

Ward et al (1994) have carried out one of the first studies of the relative risk of pedestrians of different age and gender walking in different types of road environment. The study was conducted amongst over 1000 people in Northampton and aimed to make a detailed picture of pedestrian activity including routes walked and walking associated with other activities. The main measures of exposure were distance walked alongside roads and other areas and number of roads crossed. Estimates of relative risk were made using pedestrian casualty data for Northampton as the numerator and exposure data as the denominator.

The findings indicated that even taking exposure data into account the casualty rate for children aged 5-15 is higher than that for all adults. Gender differences in relative risk showed that whilst boys and girls aged 5-9 had similar casualty rates per km walked boys were one and a half times more likely to be injured crossing the road. However, girls between the ages of 10-15 are less safe than boys walking alongside or crossing roads.

The study also found that for children aged 5-15 most of their walking is carried out within 1 km of home. For the 5-9 year group 80% of casualties occurred within 1km of their home, with over half being injured under 400m from home. For the 10-15 year group two thirds were injured under 1km from home and 40% were within 400m of home.

2.4.3 Risk exposing experience of traffic

Other studies have attempted to measure exposure as a 'risk exposing ' aspect of traffic experience. Manheimer and Mellinger (op.cit.) argued that certain individual traits like extraversion, daring etc predisposed a child to behave in ways that increased their exposure to risk. Similarly some types of play on the streets may be regarded as being 'risk exposing' aspects of traffic experience.

Play is an aspect of exposure which provides a great source of risk especially because it absorbs the attention needed to avoid hazards (Sadler 1972; Sandels 1975).

However, the measurement of exposure whilst playing out on the streets poses a methodological problem: play on the streets is dynamic, unstructured and often unsupervised and parent's reports of their children's whereabouts whilst playing are likely to underestimate their exposure. Indeed, it is difficult to track and codify recreational use of the road environment accurately, without encroaching upon, and perhaps changing the very nature of the activity under study.

A number of studies have attempted to investigate street play and have identified sex and age trends. Chapman et al (1980) used observers who systematically patrolled the streets before and during the summer holidays recording the behaviour of children up to 17 years old. The results showed that children between the ages of 8-10 yrs, and in particular boys, used the streets more than other age/sex groups. These results are similar to those of Knighting et al 1972 who report that the frequency of playing in the street increases with age up to about 9 years and decreases afterwards, and that girls are more likely to be accompanied than boys. These studies represent quantitative approaches to play but do not shed light on the nature of street play which may provide a source of risk.

In the USA Brower and Williamson (1974) studied patterns of outdoor space use in urban Baltimore (USA) in 1971. Using a number of methods (drive around/walk around censuses of outdoor activities, diaries kept by a sample of residents and interviewers) they concluded that street front recreation 'has a special quality of its own' and comprises a range of activities and games including bicycle riding, roller skating, ball chasing and jumping games. In the UK, research on the nature of street play is scant, it is most often studied by distant observers and they cannot provide insight into recreational games involving behaviours which increase exposure to risk.

Street play may be an important variable in explaining the link between accident involvement and socio-economic group though it seems only to have been studied quantitatively which does not give an insight into the role of 'risk exposing' behaviour.

2.4.4 Patterns of exposure

Despite the conceptual and methodological problems of exposure discussed in this section, exposure studies have produced a number of similar findings to provide a

general picture of the travel patterns of child pedestrians. However, most of the studies were carried out in the early 1970's and the trends may have changed over the last 20 years. There is some evidence (Hillman et al 1990) that children's independent mobility in traffic has reduced partly because of the increase in traffic and parent's fears concerning accident risk. In the UK, walking is the main form of transport for children and there is little use of public transport. Independent crossing of roads increases with age, whilst as expected, adult accompaniment decreases. Few 7 year-olds are allowed to cross roads on their own but about half of 9 year-olds and well over half of 11 year-olds are allowed this 'licence'. By the age of 12 (the age of transfer to secondary school) most children travel independently. This increased licence is associated with the greater distances travelled to senior school. Young males walk further than females: boys are more likely to travel unaccompanied and cross roads on their own. Minor roads tend to be crossed more than major roads. There is some evidence that the degree of accompaniment is particularly related to traffic density. There is little evidence concerning the relationship between exposure and socio-economic group (Knighting et al 1972; Hillman et al 1990; Ward et al 1994).

2.4.5 Conclusions

This section has involved a discussion of the conceptual definitions of exposure and how research undertaken in this field suggests that measures of exposure can reflect both the child's 'risk exposed' and 'risk exposing' experience on the roads, the former being used to quantify behaviour and the latter being used to indicate the quality of that behaviour. Given the difficulties of identifying the 'risk exposing' aspects of a child's behaviour discussed in this section the author believes that an exposure measure is most useful when it can reflect, in a quantitative way, the normative mobility patterns of pedestrians. Therefore useful exposure variables are those which measured the use of the roads for recreation and purposive journeys including number and type of roads crossed, distance travelled, time taken and level of accompaniment. The physical context of this exposure, in terms of the permanent and temporary features of the road environment, is discussed in the next section.

In 1976, Preston wrote:

> ***"Road accidents have reached epidemic proportions and blaming the parents is very similar to blaming parents fifty years ago if their child had diphtheria. If the child is kept in and isolated from other children contagion, or road accidents, are less likely. But the problem cannot be solved by individual parents - or motorists. The analogy with an epidemic is misleading, road deaths are endemic, it is not a question of keeping a child in for a few weeks until the epidemic is over." (p 4).***

Preston's analysis of child pedestrian casualties in the 'typical' UK towns of Salford and Manchester led her to postulate that whilst the traffic environment always provided a level of risk for the child, some environments provided a greater source of risk than others. In this section research on the material hazards in the traffic environment will be reviewed and particular reference will be made to engineering and planning measures which provide an insight into how changes in the physical environment can change the mortality rates of child pedestrians.

2.5.1 An urban problem

Most child pedestrian accidents occur in built-up areas. Preston (1972) analyzed data on over 900 child pedestrian injury accidents from police files for Manchester and Salford. She investigated interactions of area type and injury rates per head of population (determined from the 1966 sample census) for the under-8s, whose accidents are more likely to be near home. Results showed that in 'pleasant residential areas' the rate was 2:1000 population and 20:1000 in older residential areas where houses had very small or no gardens, with front doors leading straight onto roads, and there was no place for children to play safely, and also where there was a high level of through traffic. Using indices of socio-economic group and overcrowding, Preston argued that children who lived in overcrowded houses which were mostly in the poorest neighbourhoods, were more likely to 'play out' and that lack of space to play inside was analogous to lack of space to play outside: "The spacious house will have a garden and space around it for children to play. The overcrowded house is likely to be in an overcrowded street, without gardens or play spaces for children." The correlation between accident rate, socio-economic group and overcrowding was only significant for young boys, who were more likely to be 'playing out' and injured whilst doing so.

Motivated by the findings of Preston more recent research indicates that strategies for remedial engineering action can have a significant effect on accidents to vulnerable users in the urban traffic environment.

King et al (1987) investigated the pattern of child pedestrian accidents in inner urban areas in metropolitan districts of the West Midlands. Accident density for a three year period was examined in relation to the resident population, the area and nature of the highway system and the environment in these areas. The data set was enhanced by computer access to local census data and supplemented by visits to establish typical types of housing stock, roads and land use. They found that areas with high child pedestrian accident rates were those with Victorian terraced houses with little or no gardens, few garages and consequently much on-street parking - known to be a factor in accidents to the young pedestrian (Lawson 1990; Wallin 1979). The residential roads were long and straight 'rat-runs' which facilitated high vehicle speeds. King et al noted that in areas of urban redevelopment like Coventry the use of 'traffic severance techniques' reduced 'rat-run' traffic by 68% leading to a 50% reduction in accidents with particular benefits for child pedestrians and the effectiveness of such traffic engineering measures were viewed as an 'integral part of an improved environment.'

2.5.2 Environmental safeguarding

Environmental safeguarding for the vulnerable road user living in urban areas became an issue in the late 1960s when the use of engineering techniques aimed at segregating vulnerable road users from inappropriate through traffic led to 'improving the environment for pedestrians by introducing the idea that in residential districts vehicles should be seen as intruders rather than be accorded automatic priority ... ...' (Wade et al 1982. p256).

Schioldborg (1978) argued that in Norway the reduction of the mortality rate by some 30% for children under 15 years was achieved in part by the execution of the highway design principles laid down by SCAFT (Stadsbyggnad, Chalmers, Arbetsgruppen for Forskning om Trafiksakerhet. In 1968 SCAFT was responsible for developing a technical road design manual which laid down the principles of urban planning with respect to road safety). One of the main set of principles of this initiative was to change the physical environment to separate children from traffic and

adapt the environment to their needs. This involved attempts to separate different types of traffic in space and time to reduce conflicts between vehicles and vulnerable road users, and led to the development of improved public transit. The measures also included differentiation within each road system to control traffic flow by using one-way streets, pedestrian crossings, traffic lights etc to reduce vehicular speeds. Moreover, the SCAFT guidelines represent engineering measures which change the nature of the physical environment by diverting traffic away from urban areas, and reducing the speeds of existing flows.

In the UK these principles were explored by Bennett and Marland (1978). Accident records involving pedestrians over 3-4 years for over 9000 streets in some 257 residential estates relatively free from high levels of through traffic were analyzed in relation to the presence of the following attributes of the physical environment where the accidents occurred:

- number dwelling in street
- length of street; carriageway width; total highway width; curvature of street;
- number of 3-way and 4-way junctions; number of (highway) ends opening onto other streets; school access; shops; recreational facilities
- whether part of bus route
- number of children observed playing
- presence of parked vehicles
- passing vehicles
- other census data on the population.

Bennett and Marland concluded that low accident rates were associated with estates that were segregated within distributor roads, where the layout utilised culs-de-sacs and reduced traffic flow.

Following on the principles of the SCAFT initiative, the most major environmental improvement study undertaken in the UK was the Urban Safety Project which involved the implementation of low-cost engineering measures (at a budget of £250k per scheme) in selected parts of five towns: Reading, Bristol, Bradford, Sheffield and Nelson. The aims of the project were threefold: 1) To encourage traffic to use the main roads more safely; 2) to discourage use of local residential roads for through traffic, and 3) provide safer conditions for traffic which does need access to the

residential area. The schemes employed a number of low-cost engineering measures to help the vulnerable road user, these included:-

- reduction of through traffic in residential areas
- provision of extra crossing facilities
- banning of some right turns
- the creation of refuges and use of painted hatchings to help pedestrians in areas of moving traffic
- slowing down traffic by using various speed reducing measures
- providing better defined parking bays with pedestrian promontories in areas where there is on-street parking.

The target reduction in accidents was 10-15%. An overall evaluation of the area wide schemes (Mackie et al 1990) compared the accident trend for a 5 year pre-scheme period with the implementation period and a 2 year post-scheme period and showed a reduction of 13 per cent in all accidents. The results indicated that there were measurable savings in pedestrian accidents in 2 towns (Sheffield and Nelson) whilst general reductions were found for those involving 2-wheeled road users. Unfortunately no explanation was given concerning the lack of savings in other towns.

Proctor (1992) comments that the risk of being killed as a pedestrian increases significantly with the closing speed of the striking vehicle: at 20mph the risk is 5 per cent, at 30mph it is 37 per cent and at 45mph it is 83%. His paper looked at the benefits of creating self-enforcing 20mph zones in urban residential areas. A study area in Birmingham was chosen and the current pedestrian accident record analyzed for a 5 year period. A sub area was selected for treatment which had a particularly high concentration of child pedestrian accidents. The package of traffic calming measures included the closure of one of the 17 roads within the area and the introduction of road humps, speed cushions and designation as a 20mph zone. Preliminary evaluation of the speeds of vehicles within the treated area before and after treatment showed a significant reduction in the number of vehicles travelling over 25mph, which if sustained would be expected to produce accident and casualty reductions. Mackie et al (1993) have evaluated the initial impact of 20 mph zones and have found that accidents were reduced by up to 80% with particular reductions in accidents for pedestrians.

Roberts et al (1994) carried out a study to look at the environmental features of the locations of child pedestrian injuries. The study was based on data from 103 children aged under 15 years of age killed or hospitalised as a result of being in collision with a motor vehicle in Auckland in 1992-1993. Further information was collected on the time, date and location of the accident from an interview with the parent. The environmental characteristics of the accident location were recorded by a civil engineer who visited each site on the same time and day of the week. A 24 hour traffic flow profile was also taken for each site to provide measures of mean flow and mean speed. Type of road, number of lanes, speed limit, presence of traffic calming and distance between children's home and the accident location. Of 73 children injured on the roadway (as opposed to driveway) most were boys and the median age was 7 years. Sixteen per cent occurred on pedestrian crossings, 22 percent occurred at an intersection and 62 per cent mid-block. Twenty-seven per cent of children were injured immediately outside their homes, 60 per cent within 0.5 of a kilometre and 70 per cent within 1 kilometre. High traffic flows were associated with the accident locations and most occurred on residential roads. Given these findings Roberts et al argued that traffic calming measures should be given greater priority.

2.5.3 Conclusions

This section has attempted to show how the layout of the residential environment influences the safety of child pedestrians and that where there have been engineering interventions which have helped restrict vehicle access, speed and flow there has been a reduction in accident rates. Decisions on whether or not to intervene and modify the environment may then have a profound effect on safety and the location of power of this decision making process is an important factor. Wade et al (in Chapman et al 1982) in their discussion of pedestrian accidents and the physical environment argued that 'features of the environment for pedestrians are shaped to a large extent by those who design, construct and modify the central residential districts of cities and towns' and that there exists 'a degree of polarization between the professional engineer and the community politician'. Indeed, for ordinary citizens who wish to change their physical environment there is often '..a sense of powerlessness in the face of bureaucratic barriers' (Bjorklid 1992). This issue, and its relevance to countermeasures as a whole will be discussed in the next section.

Klein (1980) writing about societal influences in childhood accidents argued that "it seems essential to the design of countermeasures [to] take account of the perceptual differences, the value differences, and the lifestyle differences that exist among social classes" . Interventions on behalf of the child pedestrian have rarely taken into account such differences which exist between socio-economic groups or ethnic groups. This situation is hardly surprising as little is clearly understood about the effectiveness of countermeasures at any level, whether national or local, and resources rarely stretch to include evaluation as part of the remedial package (Christie and Coffey 1992). Broadly speaking, the responsibilities for protecting children fall to the parents and the governmental bodies like schools and local authorities which can control children's traffic exposure and modify the environment in which it takes place. This section will focus on the specific issue of remedial measures for the disadvantaged road user which will be discussed in the context of provision for children in government policy.

2.6.1 Department of Transport policy

In 1990 the government published a consultation document "Children and Roads: A Safer Way" (Department of Transport,1990) to focus attention on the vulnerable road user as part of a strategy to reduce road accident casualties by a third (with respect to the 1981/1985 average) by the year 2000 an objective identified in the policy review document "Road Safety: The Next Steps" (Department of Transport, 1987). The consultation document illustrated the scale of the problem and reports that road deaths like all accidental deaths are related to socio-economic group. A multi-agency approach is advocated involving central government especially the Department of Transport, the then Department of Education and Science, Local Authorities, police, private companies and voluntary organisations. Improvements in child safety would reflect the diverse responsibilities of these agencies and should include:

1. Implementing a range of engineering 'traffic calming' measures like road humps and 20 mph zones to reduce vehicle speeds and therefore severity of impact on pedestrians.

2. Enabling children to understand and cope with traffic by introducing

a range of education and training appropriate to all ages.

3. Seeking to create a 'climate of opinion' concerning the importance of child safety by strategic media campaigning.

The document ends with the prime responsibility for the child's safety being placed upon the parent: "Our aim is to educate parents so that they understand more fully the risks involved and therefore take responsibility for the safety of their children". However, recent national publicity campaigns run by the Department of Transport have targeted driver's attitudes and behaviour with messages like 'Kill your speed, not a child'.

2.6.2 Environmental measures

The previous section has attempted to show the effectiveness of engineering measures in reducing hazards for the vulnerable user. In particular, the implementation of traffic calming techniques which help divert, reduce and slow down traffic flows seem to benefit child pedestrians (Schioldborg 1978; Mackie et al 1990). However, the studies by Preston in the 1970's suggest that the provision of safe play spaces may be important in reducing the exposure of young children who she argued are forced to play in the street by confined, overcrowded living quarters. There has been some suggestion that play areas are diminishing and that it is important to provide safe play areas particularly for the disadvantaged child who is more likely to play in the street (National Playing Fields Association 1989; Chilton 1985; Sharples et al 1990). However, the author is not aware of any studies which have been undertaken to evaluate the road safety changes created by the provision of safe play areas, especially for the disadvantaged. However, countries like Holland who have traffic calmed 'woonerfs' which act as safe play areas tend to have a lower child pedestrian casualty rate than the UK.

2.6.3 Education, training and publicity measures

Although road safety does appear in the national curriculum it is not compulsory in the UK as it is in other European countries, teachers are inadequately prepared, there is lack of co-ordination between schools and outside road safety professionals and little time is afforded to its provision (Spear et al 1987). The TRL has attempted to

remedy this situation with the development of Good Practice Guidelines for establishment and support of road safety education within Schools. These are based on experience in two local areas Sheffield and Hertfordshire in developing a multi-agency approach to the provision and support of road safety education (Harland et al 1991). Pedestrian skills training on real-life road situations and using table-top simulations seem to offer some progress forward improving behaviour, superseding the rule-based Green Cross Code, though there are still strong developmental factors limiting a child's ability to be trained (Ampofo-Boateng and Thomson 1990). Publicity activities at a national and local level rarely have an identifiable significant short term impact on accident numbers or on behaviour. It is very difficult to establish a causal relationship as the data are intrinsically 'noisy' (Christie and Coffey 1992).

2.6.4 The effectiveness of remedial measures for disadvantaged groups

Few countermeasures have been specifically targeted at disadvantaged groups: there is a simple reason for this - very little is known about the characteristics of child pedestrians in low socio-economic groups, other than the environments they tend to inhabit, which influence their accident involvement. Even if such characteristics were established it may be inappropriate to tackle the accident problem with 'top-down' processes: Lawson (1990) in his study of accidents to young pedestrians in the West Midlands argued 'Many of those at risk are the disadvantaged in society, who attach little priority to traffic safety before an accident occurs, and are least able to make use of a sophisticated road safety message' . Road safety messages are rarely translated in the languages of the ethnic minorities which may represent groups particularly at risk in traffic.

This is supported by recent research carried out by RoSPA (1993) which looked at the safety information needs of ethnic minority groups in the UK. The document states that community groups which do not have English as their first language will have different information needs compared to the majority population and this is important because: 'For any health issue an essential element of need is a requirement for information: about risk factors and about available health promotion measures. This is equally true of safety issues.' The community consultation meetings carried out in that study suggest that the need for these information services is not being met, with the majority population being perceived by minority groups as insensitive to their

special information needs and language difficulties.

Laungani (1989) argued that there are clear cultural differences between ethnic groups which should be taken into account in the design of countermeasures: 'Adopting a uniform advertising strategy (notwithstanding the translation of the material into several Indian languages) will be of limited use. People of different cultures construe their private and social environments differently, identify danger and hazards differently, alert their children to dangers differently, and take different prophylactic measures to avoid situations likely to result in accidents.'

The location of power is important in determining the effectiveness of a preventive measure. It has long been known that the very process of consultation alone can have a positive, empowering effect upon people which helps facilitate greater co-operation (Roethlisberger and Dickson 1939). Both adults and children should be consulted, as countermeasures need to be sensitive to both sets of needs, a factor which has been important in the design of safe play areas (Chilton 1985). Moreover, countermeasures emanating from professionals may not be sensitive to the needs of local disadvantaged families and any multi-agency approach must involve members of the local community.

In her review of the role of the National Health Service in preventing road accidents to children Ward (1991) reported that road accidents are now in part seen as a case for preventive medicine falling under the remit of the Health Service and she proposes a number of ways in which the health service could interface with the local community. She argued that within the health service there exists a number of opportunities to provide greater information about the accident epidemiology of high risk groups and many possibilities to increase the networking of information and advice between the health service, road safety officers, planners and police to help set objectives for action. The action of these professionals is seen as a catalyst, enabling the community to identify its own road safety needs, indeed Ward argued that local remedial measures can only be effective if local communities are consulted:

> "local area safety schemes only work effectively if the help and co-operation of local people have been enlisted in setting the agenda for problem specification, design, implementation and use' .

The review hints at a more serious issue underlying the effectiveness of countermeasures, that local schemes aimed at improving the traffic environment are unlikely to be accepted by people whose home environment is inadequate. This viewpoint in many ways, represents a radical structuralist approach, whereby inequalities in health are seen to be caused by adverse social circumstances which arise from the structure of society. Within this context, health education is required to raise consciousness concerning the social origins of ill health and the health promoter concerned with morbidity and mortality associated with road vehicle trauma should help politicize communities to create collective action to improve the health status of the community. (see Tones, in David and Williams 1987).

Countermeasures for pedestrians based on the principles of health promotion have not been well documented or evaluated but given the over-representation of child pedestrians from low socio-economic and ethnic minority groups it is relevant that a view central to current thinking in health promotion is that it is important to understand the social origins of ill health. As Dunn et al (1993) comment: "The current wisdom in health promotion holds that targeting the behaviour of individuals, without also intervening at these other social levels that shape behaviour, will not have as great an impact on health status.".

Because of their vulnerable developmental status high risk pedestrians have often been seen as blameworthy when they become involved in accidents - a view that is sustained in a car oriented society. Roberts and Coggan (1994) comment on the 'ideology of victim blaming in child pedestrian injuries' and the 'structural contributors' to accidents. From a case study of the legal proceedings arising from child pedestrian vehicle collisions, Roberts and Coggan comment that 'Poverty, the volume of traffic, the lack of a safe place to cross and particularly.. the state's inability to enforce its own speed limits are ignored' . They argued that there is little evidence that prevention strategies focusing on the child are effective: 'Even with the most rigorous evaluative efforts it has been concluded that even large efforts to improve child pedestrian behaviour are rewarded with only small gains'. In another paper Roberts et al (1994) comment that '... past and current transport policies have encouraged car use. In particular, the high capital investment in roads compared with other transportation modes, cheap car parking and running costs and cuts in public transport subsidies have exacerbated the trend towards increasing car travel.' From

this standpoint countermeasures to protect the child pedestrian should not be focused on changing the behaviour of the child but on changing the behaviour of car traffic.

2.6.5 Conclusions

This section has attempted to give an overview of the varied types of countermeasures which have been designed to help protect the child pedestrian. It is difficult to ascertain the size and nature of the benefits afforded by such preventive measures. Child pedestrian accidents are relatively infrequent occurrences to be used as a meaningful criterion of the success of a countermeasure especially in the short term. Studies looking for improvements in safe behaviour rarely systematically control for exposure. What is clear, is that few countermeasures are specifically targeted at disadvantaged road users probably because little basic knowledge exists about the lifestyles and exposure of such groups from which to develop actionable objectives. Finally, how these objectives are achieved may depend on involving the local community to help set the agenda for action.

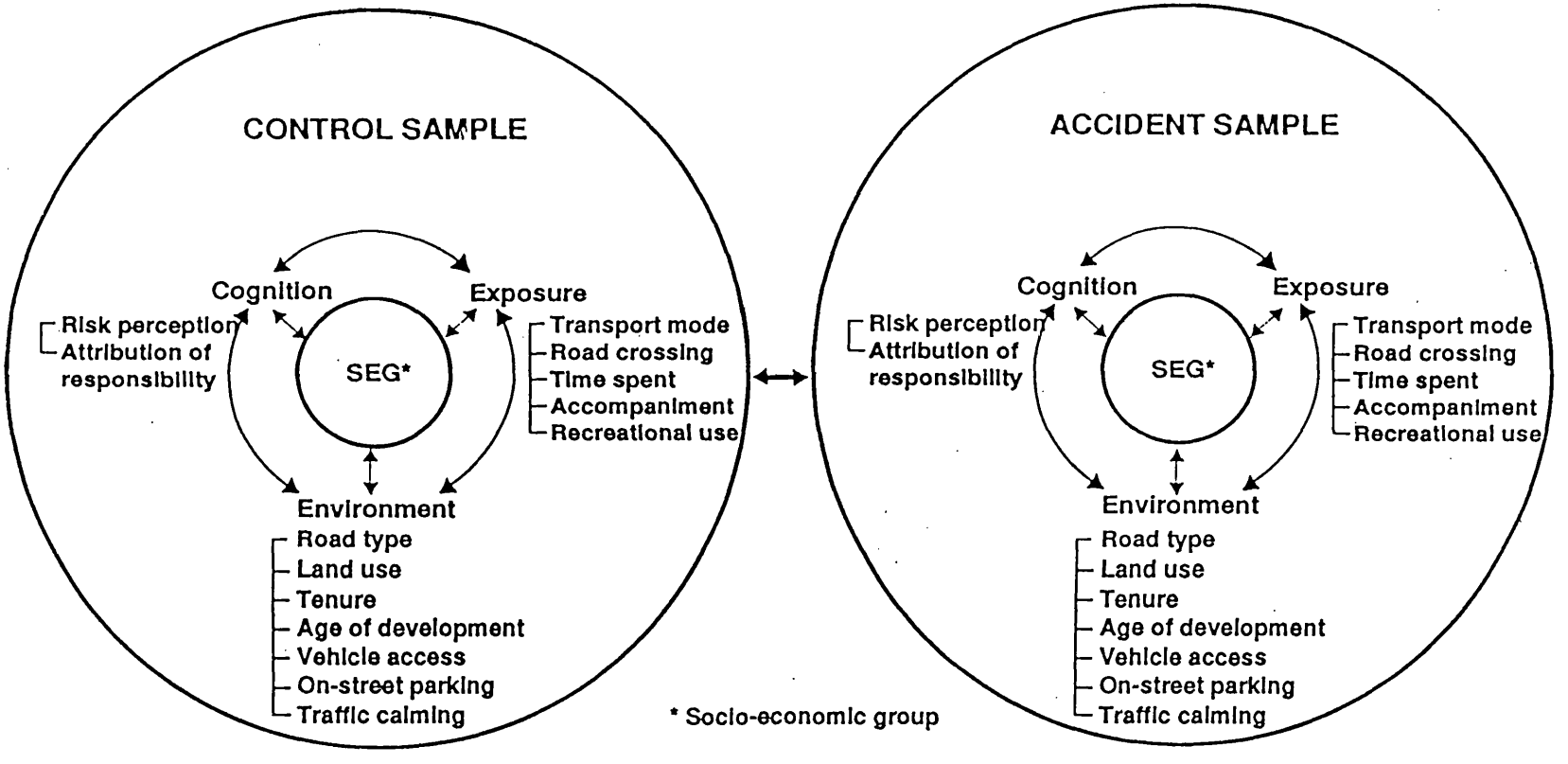
2.7. Conceptual model

The conceptual model developed for the empirical study is shown in Figure 7. The model shows socio-economic status as the central concept. The schematic model shows that other factors such as the environment in which the child lives, the attitudes of the carer (the cognitive component) and the experience of the child in traffic (exposure) can be understood in relation to the central concept of socio-economic status. These factors are seen to be interrelated (hence the two headed arrows). In terms of experimental design, measures of each factor (cognition, exposure, environment and socio-economic status) must be recorded for a sample of children who have been involved in a pedestrian accident for comparison with a sample of children who have not had an accident. The measures of each factor must be operationally designed in such a way as to reflect a child's typical exposure, the predominant characteristic of their local environment and measures of their carers perception of risks children face in traffic and the responsibilities for safeguarding them. Where possible these measures need to be similar to those used in previous research as indicators of pedestrian risk. For pragmatic reasons (cost, timescale, staff

Figure 7:

Accident involvement of child pedestrians: a holistic study of relative risk

Conceptual model



resources) the measures were selected to be readily obtainable in an interview survey or directly observable in the environment, A more detailed account of the individual measures is given in Chapter 3.

2.8. SUMMARY AND CONCLUSIONS

The research reviewed in this report suggests there are a number of social and environmental or 'socio-ecological' factors which may contribute to the accident involvement of children from low social groups. The main conclusions from critical appraisal of this research are listed below.

(1) According to empirical and theoretical research concerning cognitive and sensory abilities at different developmental stages, the ability of children to attend to relevant stimuli in the traffic environment is regarded as one of the most important differences between children and adults. No evidence was found to suggest that the differences in accident risk of children from different socio-economic groups are related to developmental factors.

(2) Social factors like family size and structure, over-crowding, and maternal preoccupation have been linked to the accident risk of child pedestrians in low socio-economic groups, especially in relation to the parents ability to supervise children. Little work has been carried out in the UK focusing on social factors in child pedestrian accidents.

(3) Few studies have investigated the role of exposure in explaining the over-representation of child pedestrians from low socio-economic groups in accidents. Some researchers have argued a link between frequent street play and overcrowding - an indicator of disadvantage. This concept has been discussed and measures of exposure assessed in terms of usefulness in quantifying children's experience in traffic.

(4)The physical environment is reported as an important factor in child pedestrian accidents. In particular the inner cities and areas of urban deprivation are linked to high accident risk for pedestrians and are areas more likely to be inhabited by low socio-economic groups.

(5) Few road safety campaigns have been specifically targeted at disadvantaged road users as little is known about what remedial measures may be most appropriate for these road users.

However, it is not clear how these factors or some combination of them affect accident involvement. It may be that the children of these families are more exposed to risk because limited play space, less car access and less disposable income - to spend on activities after school - mean that these children use the streets for school journeys or recreation more than children in higher social groups. Such a situation may well be compounded by parental attitudes less able to be responsible for safeguard their children in traffic and less informed about the risks they face there. The literature review shows that whilst these areas have been investigated in isolation they have not been drawn together in a single approach to the study of accident involvement of young pedestrians.

CHAPTER 3
METHODOLOGY

The aim of this Chapter is to describe the development and implementation of the fieldwork for the interview and environmental surveys and describes the ways in which data has been coded to give operational measures of social, economic and environmental factors in preparation for the analyses.

At the outset of developing the survey methodology a central conceptual issue was the definition of socio-economic status, which is by no means standardised and is complicated by concerns for political correctness. Therefore this Chapter begins with a discussion of different definitions of socio-economic status and the rationale for selecting a particular operational definition for this study. Most of the social, economic and environmental variables were selected because previous research suggests a link between them and child accident involvement. Composite scores of parents' or carers' risk perception and perceived ability to safeguard children were based on attitudinal scales devised mainly from statistical, situational and attitudinal factors identified in the literature review.

The surveys were carried out in urban areas of Reading, Bradford, London, Bristol and South Wales amongst a control sample of school children and an experimental group of accident involved child pedestrians. This Chapter describes the sampling procedure and problems which arose in achieving adequate sample size. A detailed discussion of sampling bias is presented in the first section of Chapter 4.

3.1 Definition of socio-economic status

Definitions of socio-economic status differ and the way they differ seems to depend on two factors: how occupations are classified and which adult in a household is used to classify the household's socio-economic status. These factors will be discussed briefly because the definition of socio-economic status is important in this study.

The Registrar General's classification of socio-economic groups was introduced in 1951 and was designed to classify together people with occupations which have similar social and economic status. Five broad social classes can be derived from this classification system: professional and managerial workers (I,II), skilled non-manual workers (IIINM), skilled manual workers (IIIM), and semi-skilled and unskilled manual workers and others inadequately described (IV,V). Analogous to this system are the occupational gradings: A,B,C1,C2 and DE used by the Market Research Society (1991). Groups AB are equivalent to social classes I and II, group C1 equivalent to IIINM, group C2 equivalent to IIIM and groups DE equivalent to IV and V. The accuracy of such classificatory systems is dependent on how occupations and the pattern of employment change; therefore these systems have to be revised regularly. It is worth noting that actual income is not measured by any of these schemes.

The second important issue is which adult in a household should be classified. There is by no means a standard convention and it may also depend on the type of interview. In interview surveys, the Market Research Society uses the convention of determining the occupational grade of the Head of Household which is assumed to be the husband or resident male partner or 'father of the family unit' . The man always takes precedence over the woman even if they share joint financial responsibility for that household. In the event that the Head of the Household is not earning, the Chief Wage Earner categorisation is used. Again this is based on the oldest related male, or if there is no male the oldest related female in full or part time employment. The Chief Wage Earner does not always reflect the status of the person earning the most money.

Arguably this way of grading a household is value-laden and anachronistic given the changing economic climate and apparent equality of opportunity for women workers. A less value-laden method is used by the Office of Population Censuses and Surveys (OPCS) in the decennial census survey which involves a self-completion questionnaire where occupational grading is based on the first named adult on the census form. Research similar to this study has graded households according to who the respondent perceives to be the 'main breadwinner' (Ward 1994).

Particularly pertinent to this study is the method used by OPCS to show the

relationship between childhood mortality and social class (OPCS 1988) - the figures which prompted this study. Registrars of child deaths are instructed to take the father's latest occupation to indicate the socio-economic group of a household, and the occupation of the woman is not recorded unless she has been in full time employment most of her adult life. Women's part-time work status is not taken into account and if a woman is a single parent the family socio-economic status is classified inadequately described, thus the socio-economic status of the members of this group could be heterogenous. Therefore the grading of a household in terms of the occupation of one of its adult occupants does not always yield directly comparable data because it depends on which person in a household is graded. Despite these different ways of computing socio-economic status, in around three quarters of households the socio-economic status of the household is based on the occupation of the male (OPCS 1994).

Given these different ways of estimating socio-economic status it was felt to be important to take into account a number of factors when grading the household because the survey involved family units in which there were children aged between 5 and 16, the adult respondent is assumed to be the primary carer for the child and the partner the primary source of income. The socio-economic status of the household was based on the occupation of the partner of the adult respondent with the expectation that the respondent would usually be the mother. The occupations of the respondents were classified using the Registrar General's classification of socio-economic group. If there was no partner, the socio-economic group of the respondent was taken. For additional information and to investigate the influence of sources of income from employment the working situation of both adult carers if available was taken into account. This method avoided the use of value laden questions and enabled the estimation of the levels of income in the household.

For this study it seemed important to classify socio-economic status in a way that reflects the differences in standard mortality ratios for child pedestrians (referred to in Figure 6 Chapter 2). This points to a tri-partite classification : group 1 (called ABC1) representing professional,managerial and skilled non-manual workers; group 2 (called C2) representing skilled manual workers and group 3 (called DE/OTHER) representing semi- and unskilled workers and non-earners.

3.2 Aims and objectives of the interview survey

The hypotheses postulated in the previous chapter provide a rationale to investigate whether the relationship between exposure and social and environmental factors can explain the high accident involvement of child pedestrians from low socio-economic groups compared to children from higher socio-economic groups. To test the hypotheses the following objectives were set for questionnaire design to provide:

1) a detailed picture of the children's exposure in terms of patterns of mobility;

2) information about school children's recent accidents and accident history; and

3) detailed information about the socio-economic status of the household including descriptors of deprivation;

4) information about the parent's or adult carer's perception of children's risk in traffic as pedestrians and their attribution of responsibility for safeguarding them.

To achieve these objectives the following specific data were to be collected by the questionnaires (see Appendix A):

Exposure:

- i) Types of journeys and road use (purposes) including non-journey activities like playing, recreation
- ii) Mode of transport
- iii) Accompaniment
- iv) Number of roads crossed (exact route where possible)
- v) Time taken
- vi) Spare time activities: extent of supervised and unsupervised leisure activities and consequent exposure.

Accident details:

- i) Description of accident
- ii) Cause of accident as perceived by child and parent or adult carer
- iii) Reported exposure of child on day of the accident (ie the time

leading up to the accident)

iv) 'Typical' exposure of the child on a school journey and during extra-mural activities prior to the accident

v) Post accident changes in exposure pattern (if any) and reasons why change has occurred.

vi) Factors which may have prevented the accident as perceived by the child and parent or adult carer

vii) Present exposure pattern of school age siblings on school journeys and during extra-mural activities.

Socio-economic profile:

i) Type of housing

ii) Number in household

iii) Car ownership/access

iv) Sickness/disability

v) Marital status

vi) Education

vii) Ethnic origin

viii) Work situation

Parent or adult carer's perception of risk and attribution of responsibility:

i) Responses to pre-determined statements about children's exposure to risk at different developmental stages.

ii) Responses to pre-determined statements about responsibility for maintaining children's safety.

These measures should provide data to explore relationships between socio-economic factors and exposure.

3.3 Aims and objectives of the environmental survey

The aim of the survey was to identify physical variables which would help to identify the types of environment associated with greater risk for child pedestrians and which were readily measurable. There are many environmental variables (housing and road

design) which may affect the accident risk of child pedestrians. For example, the presence of on-street parking in long straight roads, which encourages high vehicle speeds and masks pedestrians crossing, has been identified as a hazardous element of the environment for the young child pedestrian (eg.Preston 1976; King et al 1987 and Lawson 1990). Main roads have been estimated to be 10 times more risky for a child pedestrian to cross compared to other roads (Tight 1987). The land use adjacent to a road may also be important: research indicates that accident rates are higher on roads which have adjacent shops compared to those with residential use, especially for pedestrians because of the greater activity of pedestrians and car drivers on such roads (Lawson 1989).

Age of development and housing tenure when built are also important as these factors reflect differences in road layout and in provision for cars and parking: tenure is also a proxy for socio-economic group. Early research into housing development found few differences in accident rates between housing classified pre-1919, 1919-1939 and post-1945 (Transport and Road Research Laboratory 1977). However, many researchers have linked the high accident involvement of children in the inner cities to the old types of development (Preston 1976; King et al 1987): and Lawson (1985a, reported in Lawson 1989) in his analysis of radial routes in cities in the West Midlands indicated that the overall accident rate from single carriageways becomes higher the older the housing.

For this survey four categories of age of development were used because each represents developments which provide qualitatively different traffic environments. These were: pre-war(1914), inter-war (1918 -1939), post- war but pre-1960 and post-1960 which are described in more detail below:

1) The pre-war (pre 1914) development is characterised by long straight roads with terraced housing and little provision for car parking. It is therefore associated with a high level of on- street parking and there is virtually no public or social housing.

2) Inter-war development (1918-1939): private housing with some provision for car parking many long linear roads, few culs-de-sac. In this age category there is some public housing, with no provision for car parking, and the estates are characterised by long road loops.

3)The post- war age category (1945-1960) is characterised by predominantly public development of estates with long road loops and few culs-de-sac.

4) The post-1960 category reflects new traffic safety standards incorporated into the development of housing. Modern development has been influenced by the Parker Morris Central Housing Advisory Committee which reported in 1961 and set new standards for house building to include a space for a car per dwelling, to provide safe play space, and to maximise the segregation of pedestrians and vehicles, which helps to protect the pedestrian in a car owning community: 'Safety considerations also suggest the importance of arranging for cul-de-sac vehicular approach to residential development, so that vehicles adopt low speeds in the vicinity of homes and so that through traffic does not approach them at all.'(Parker Morris 1961 p44).

In addition a fifth category was provided for dwellings whose age of development was unclassifiable in the categories described above.

Little work has been done on the relationship between housing built under public or private ownership and accident rates. However, early public housing had less provision for car ownership and thus greater on-street parking compared to private housing of the same age. The design of most public housing estates, at least up to about 1960, tends to have long road loops which encourage high vehicle speeds. The coding frames used in the environmental survey are shown in Appendix B.

The first stage of the survey was to form a list of all the road names of the home addresses of children in the two samples, the roads crossed on the school route and the location of the accident. Although recall of road names seemed very good some respondents could not recall the names of all the roads crossed so the sample of roads slightly underestimates the road types involved. This information was then plotted on street maps for each area. The road safety officers for each area were contacted and were asked if they could help the author to visit the roads identified in the survey from which the author could then collect the data.

There was a positive response from the road safety officers and their co-operation was invaluable: they were usually local people who knew the areas well and were able to provide guided visits to each area.

The survey was carried out in a car with one person driving and another person coding each road in terms of the presence or absence of environmental features on a chart containing road names and each environmental variable. Numeric codes were assigned to each item of data after the data had been collected. The author coded the road environment data for all sampled children throughout the survey.

For each road visited the predominant characteristics of the road were classified as follows:

(i) Type of road (arterial or non-arterial)

(ii) Type of access (through or closed)

(iii) Age of housing (pre-1914, 1918-1939, 1945-1960, 1960+)

(iv) Tenure of housing when built (private or local authority)

(v) Level of on-street parking (obstructive or not obstructive)

(vi) Adjacent land use on road (commercial,mixed, residential)

The measurement of on-street parking was usually carried out after 14.00 hours to indicate the level of parking when children were likely to be walking home from school and returning to the streets for recreation or to carry out errands.

3.4 Key variables

A detailed specification of the socio-economic variables used in the survey is given in Table:1. The specification of variables relating to the social and work situation are shown in Table:2, the environmental variables used to describe the home location are shown in Table:3. Variables used to describe the environmental features of road crossings on the school journey are shown in Table:4 and exposure variables associated with the school journey are shown in Table:5. Where possible and meaningful the cell counts for multi level variables were combined to create dichotomous variables to simplify interpretation of the results. Additional information is included where the specification of a variable was not straight forward and/or involved some statistical analysis.

3.4.1 Socio-economic group categorisation.

For those adult respondents who had a partner, the FSEG represented the father's SEG in about 85% of cases, and the mother's SEG in about 12% of cases, in 3% of cases the SEG was based on someone else, usually because the child was living with another relative. The FSEG variable has three categories. The first category is equivalent to the "ABC1" socio-economic group comprising higher professional and managerial workers and other 'white collar' workers. The second category is equivalent to the "C2" socio-economic group comprising skilled workers and the "DE/other" group comprises semi-skilled and unskilled manual workers and others which could not be classified.

Table: 1
Classification of Socio-Economic Group (SEG)

Variable name and specification	Response levels
"FSEG" Socio-Economic Group. Response level (1) comprises: SEG 3 - Professional workers - self-employed SEG 4 - Professional workers - employees SEG 1 - Employers/managers in central and local government, industry, commerce etc (large establishments, SEG 2 - Employers and managers in industry, commerce etc (small establishments) SEG 13 - Farmers - employers and managers SEG 5 - Intermediate non-manual workers SEG 6 - Junior non-manual workers	(1) ABC1
Response level (2) comprises: SEG 8 - Foremen and supervisors (manual) SEG 9 - Skilled manual workers SEG 12 - Own account workers (other than professional, SEG 14 - farmers (own account)	(2) C2
Response level (3) comprises: SEG 7 - Personal service workers SEG 10 - Semi-skilled manual workers SEG 15 - Agricultural workers SEG 11 - Unskilled manual workers SEG 16 - Armed Forces SEG 17 - Inadequately described and not stated occupations including students, housewives etc	(3) DE/other

Table:2

Social and economic variables

Variable name and specification	Response levels
1."AGENV" Age of child.	(1) Under 11 (2) Over 11
2."NSEX" Sex of child.	(1) Male (2) Female
3."FSEG" Socio-economic group.	(1) ABC1 (2) C2 (3) DE/OTHERS
4."RESPSCOR" Carers composite responsibility score.	(1) Good (2) Poor
5."RISKSCOR" Carers composite risk perception score.	(1) Good (2) Poor
6."ETHNIC" The ethnic origin of the adult respondent Ethnic origin has been recoded from the data into 'white' and 'non-white' adult respondents. The 'non-white' category is predominantly Asian.	(1) White (2) Non-white
7."CROWDING" The level of crowding in household. Crowding level was computed by dividing the total number of people in a household by the number of living rooms and bedrooms.	(1) Not crowded (2) Crowded
8."DISAB" Family with disabled member.	(1) Disabled family member (2) No disabled family member
9."MARITAL" The marital status of the adult respondent. Marital status was recorded to indicate a 'typical' marital status where the adult respondent was married once only. 'Atypical' status represented an adult respondent who was either not married, widowed, separated or married for the 2nd or 3rd time.	(1) Atypical (2) Typical

10."STREETP" The reported frequency of playing in the street. The street play variable indicates whether or not a child plays in the Street and how often. Code (1) comprises those who 'never' play, who plays 'once a week or less' and 'more than weekly'. Code (2) comprises those who play in the street everyday	(1) Infrequently (2) Frequently
11."FAM" Number of children aged under 16 years.	(1) 2 or less (2) 3 or more
12."FAMSIZE" Total family members.	(1) 4 or less (2) 5 or more
13."TWORK" Number of working parents.	(1) 2 (2) 1 (3) 0
14."CARUSE" Reported access to use of a car.	(1) Yes (2) No

Table: 3

Environmental variables used to describe the home location

Variable name and specification	Response levels
1. "ADDTYP" Type of road in which child lives.	1. Arterial 2. Non-arterial
2. "ADDUSE" Predominant type of adjacent land use on road which child lives.	1. Residential 2. Mixed 3. Commercial
3. "ADDTEN" Predominant tenure of housing (when built) on road in which child lives.	1. Public 2. Private
4. "ADDAGE" Predominant age of development on road in which child lives.	1. Pre-war (1914) 2. Inter-war (1918-1945) 3. Post-war/pre 1960 4. Post 1960
5. "ADDACC" Vehicle access on road in which child lives.	1. Through 2. Closed
6. "ADDOBS" Level of on-street parking on street in which child lives.	1. Obstructive 2. Not obstructive

Table: 4

Environmental variables used to describe road crossings on the journeys to and from school

Variable name and specification	Response levels
1."TROAD1" Total number of crossings on arterial roads.	Continuous
2."TROAD2" Total number of crossings on non-arterial roads.	Continuous
3."TLAND1" Total number of crossings on roads with residential land use.	Continuous
4."TLAND2" Total number of crossings on roads with mixed residential/commercial land use.	Continuous
5."TLAND3" Total number of crossings on roads with commercial land use.	Continuous
6."TTEN1" Total number of crossings on roads where the housing tenure is public.	Continuous
7. "TTEN2" Total number of crossings on roads where the housing tenure is private.	Continuous
8. "TAGE1" Total number of crossings on roads where the age of development is pre-war (1914).	Continuous
9. "TAGE2" Total number of crossings on roads where the age of development is aged between 1918 and 1939.	Continuous
10."TAGE3" Total number of crossings on roads where the age of development is post war (1945) but pre-1960.	Continuous
11."TAGE4" Total number of crossings on roads where the age of development is post 1960, modern.	Continuous
12."TACC1" Total number of crossings on through roads.	Continuous
13."TACC2" Total number of crossings on closed roads.	Continuous
14."TOBS1" Total number of crossings on roads where there is obstructive on-street parking.	Continuous
15."TOBS2" Total number of crossings on roads where there is no obstructive on-street parking.	Continuous

Table:5

Exposure variables used to describe the school journey

Variable name and specification	Response levels
1."TIMETO" Time taken to get to school.	1. Up to 20 mins 2. Over 20 mins
2."TIMEFRO" Time taken to get back from school.	1. Up to 20 mins 2. Over 20 mins
3."PARENT" Accompanied by adult on journey to school.	1. Accompanied by adult 2. Unaccompanied by adult
4."FPARENT" Accompanied by adult on journey back from school.	1. Accompanied by adult 2. Unaccompanied by adult
5."TRAVTO" Mode of transport to school.	1. Walked 2. Other
6."TRAVFRO" Mode of transport from school.	1. Walked 2. Other
7."CROSSTO" Number of roads crossed to school.	1. None 2. 1-2 3. 3 or over
8. "CROSSFRO" Number of roads crossed from school.	1. None 2. 1-2 3. 3 or over

3.4.2 Perceptions of risk and responsibility

The questionnaire measures included 12 statements which were designed to measure a parent's or adult carer's perception of the risks children face in traffic and their own attitudes to the responsibilities for safeguarding them. The measures of these two dimensions were developed in the light of the literature review described in Chapter 2 which allowed the carers' responses to be evaluated in terms of how they compared to current knowledge about the accident situation of children.

Twelve statements were included on the questionnaire. Six of the statements were developed to assess the carer's perception of the risks children face in traffic and six were developed to look at the carer's attitudes to their responsibilities for

safeguarding children in traffic.

The statements designed to measure perceived risk dimension were:

"Young children are as good as adults at seeing how fast and close cars are coming towards them"

"Often young children forget to stop at the kerb and can easily dart out"

"Children are just as likely to have an accident on roads they use everyday as they are on roads they hardly use"

"As children get to the age of about 11 or 12 years they are less likely to be involved in a road accident"

"Older children have as many accidents as young children because they take risks"

"When children start secondary school they are old enough to get there on their own"

The statements designed to measure the responsibility dimension were:

"It's hard to know what to say to children to make them safe on the roads"

"It's hard to keep an eye on children playing outside near roads because there is always lots to do"

"These days parents don't have enough time to teach children how to cross roads safely"

"It is difficult to make sure that young children never cross roads on their own"

"It's nearly always the driver's fault when a child gets knocked down"

roads safely"

Carers were asked to indicate on a four point scale how much they agreed which each statement. The 4 point scale was used to avoid the ambiguity associated with the use of a central value. This was justified as the respondents were not expected to have impartial attitudes to children's traffic risk or the responsibilities for safeguarding them as they were all carers of school age children.

The rating scale was:

agree a lot
agree a little
disagree a little
disagree a lot

The carer's response was represented by a numeric score. To determine a respondent's value of the variable corresponding to each statement the level of agreement with each statement was scored to indicate a response which was beneficial or not beneficial to children's safety. The scoring scheme comprised four values: two positive values to indicate responses which would be beneficial to a child's safety in traffic and two negative values to indicate responses not so beneficial to children's safety.

Different weighting of agreeing or disagreeing a lot relative to doing so a little were considered. A number of weighting schemes were experimented with to see which scheme separated the distribution in such a way as to identify groups of scores with reasonable numbers of respondents to be used in the modelling analysis. The weighting schemes experimented with were :

-2, -1, 1, 2
-4, -1, 1, 4
-8, -1, 1, 8

The cumulative distribution bar charts for each type of weighting are shown below for the risk score (Figures 8-10) and responsibility score (Figures 11-13). The last

weighting scheme (-8, -1, 1, 8) allowed the best discrimination of scores and was used in all subsequent analyses. The criterion for choosing the 8,1 scoring of the data was that it allowed a much greater range of scores and a greater variability of scores within the range which enabled groups of scores to be distinguished.

Figure:8 Cumulative distribution: weighted risk score using values 1,2

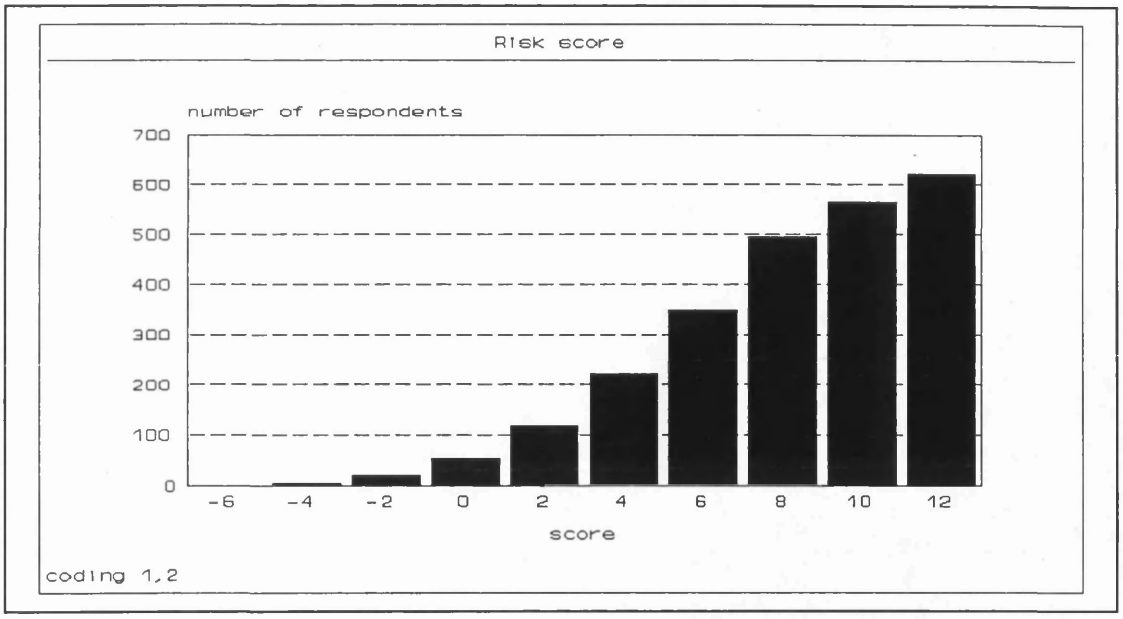


Figure:9 Cumulative distribution: weighted risk score using values 1,4

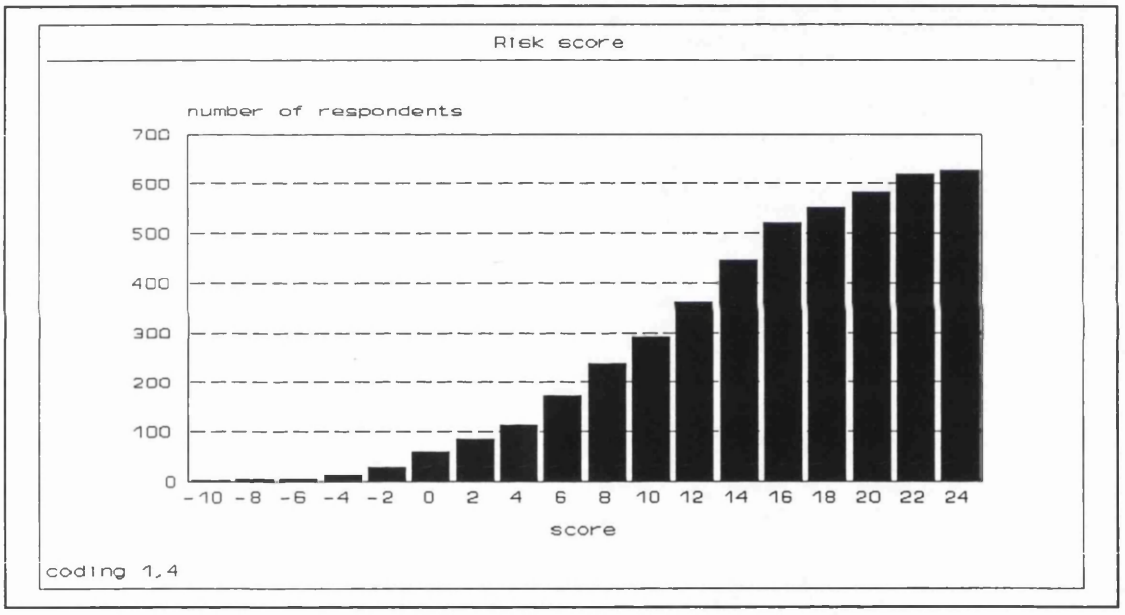


Figure:10 Cumulative distribution: weighted risk score using values 1,8

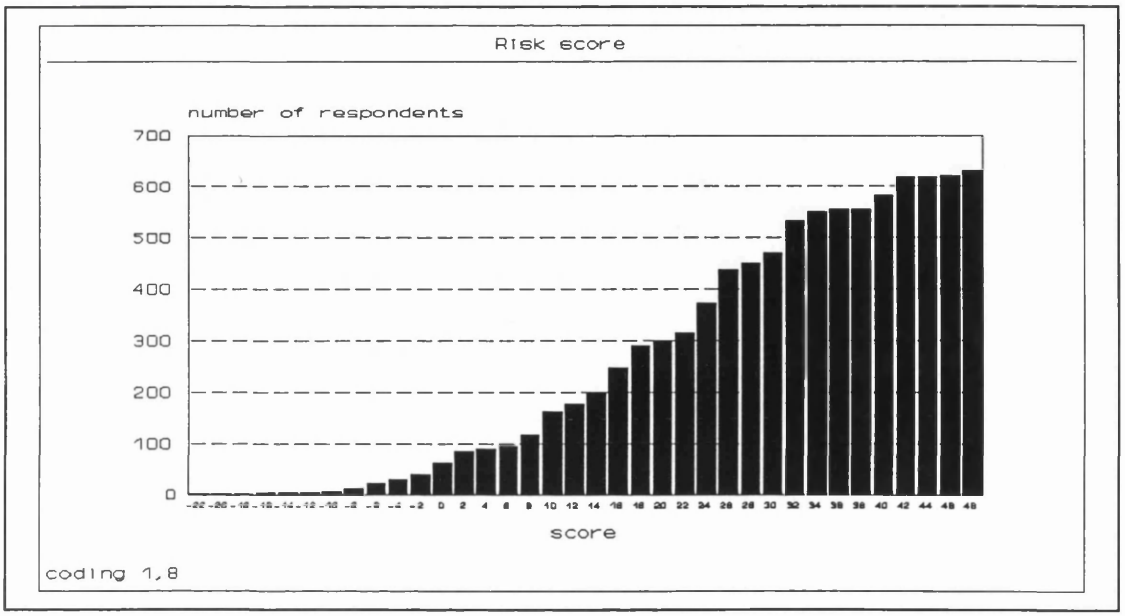


Figure:11 Cumulative distribution: weighted responsibility score using values 1,2

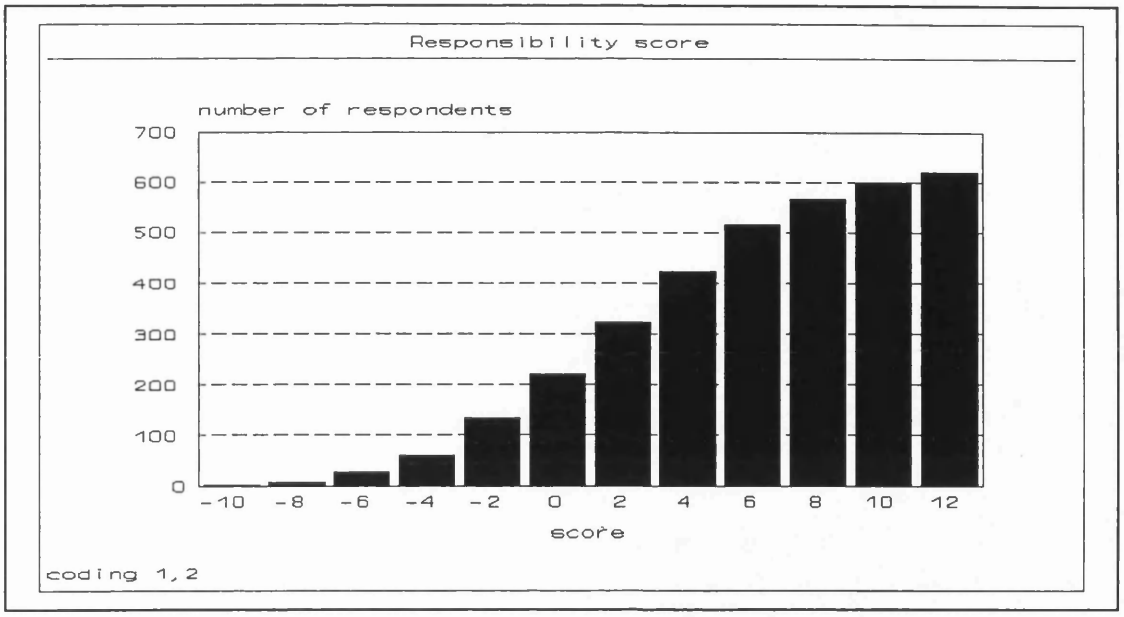


Figure:12 Cumulative distribution: weighted responsibility score using values 1,4

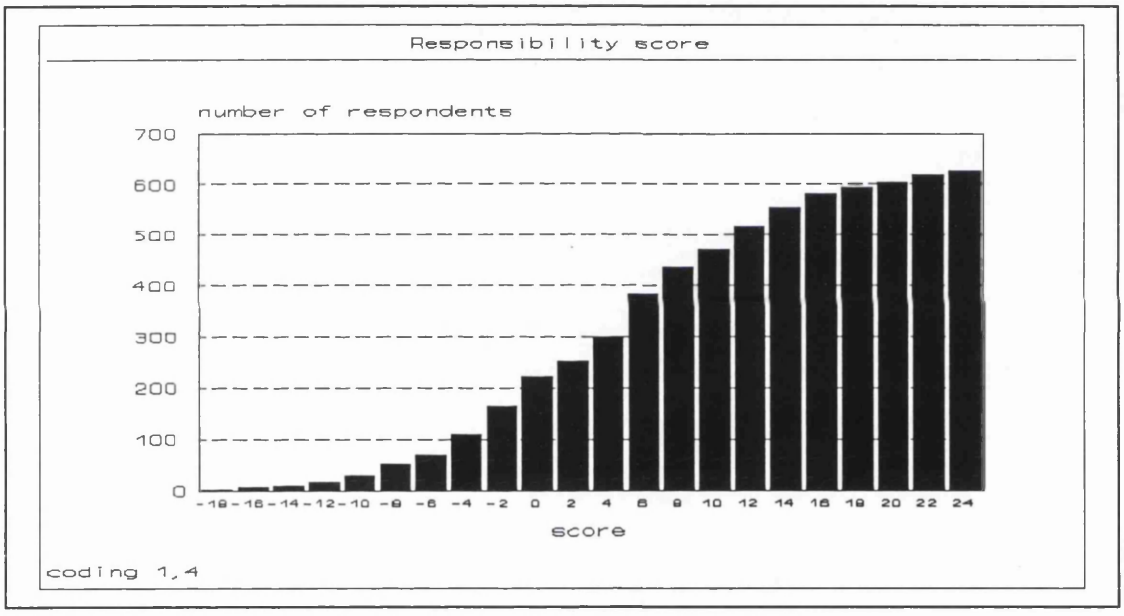
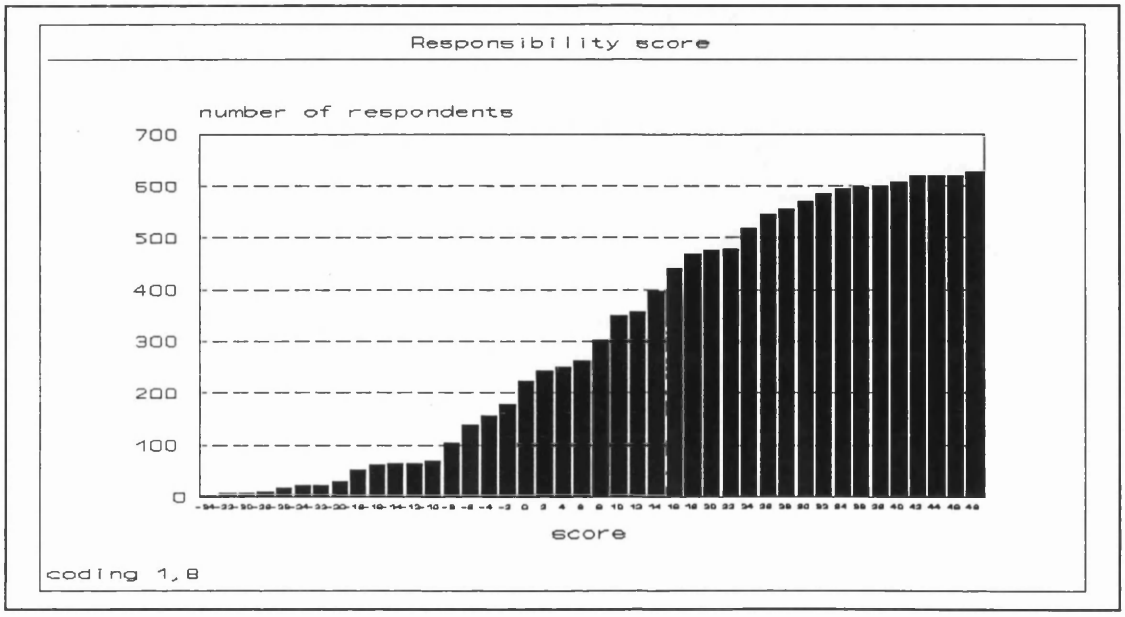


Figure:13 Cumulative distribution: weighted responsibility score using values 1,8



The statements were designed to obtain measures of risk perception and attitudes to responsibility as is evident from their face validity. However, a more reliable measure can be obtained by combining the responses from several statements as long as they seem to be measuring the same underlying latent trait, i.e. either risk perception or responsibility. Factor analysis is a statistical technique for data reduction which can be used to identify the number and form of underlying factors which best represent the information contained in sets of corresponding values of interrelated variables. Generally, as in this work, it is not possible to directly measure a trait of interest in a reliable way but by asking several questions about the same trait a 'factor' can be derived which is a relevant linear combination of variables and which provides a measure of the trait(s) of interest.

The method involves analysis of observed correlations between variables. The variables used in the factor analysis were the scores representing the rating given by each adult carer to the 12 statements.

It is first necessary to decide how many factors are needed to represent information contained in the data (Norusis 1990). The analysis can estimate in terms of the eigenvalues of the dispersion matrix of the 12 variables the percentage of total variance that can be explained by each factor, with the first factor explaining the most, the next factor the next most and so on. This provides a method to decide on the number of factors which have been measured by the original statements. These are tabulated in Table 6 and the scree plot of the eigenvalues shown in Figure 14 was then examined. If a factor has an associated eigenvalue clearly greater than one then it represents useful information. The scree plot indicates where in the sequence of eigenvalues this ceases to be the case: the scree represents the 'noise' in the data and corresponds to a natural looking fairly steady slope. Only factors corresponding to eigenvalues prior to the start of the scree are informative. Using these criteria indicated that there are two informative factors in this case. These two factors account for only just over 30% of the variance.

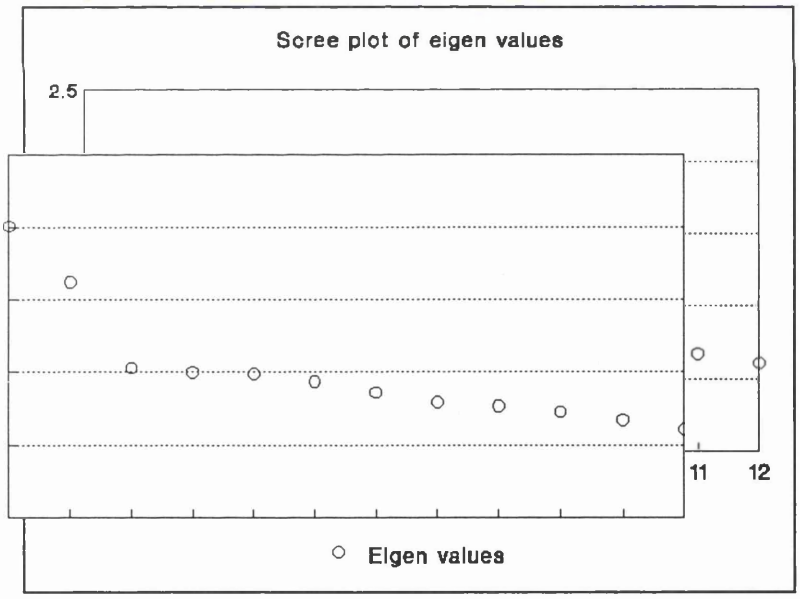
Table:6

Percentage of variance explained by each factor

Factor	Eigen value	% of variance	cumulative variance %
1	2.00508	16.7	16.7
2	1.62042	13.5	30.2
3	1.02706	8.6	38.8
4	.99963	8.3	47.1
5	.99047	8.3	55.4
6	.93649	7.8	63.2
7	.86029	7.2	70.3
8	.79228	6.6	76.9
9	.76529	6.4	83.3
10	.72535	6.0	89.4
11	.67136	5.6	94.9
12	.60629	5.1	100.0

Figure:14

Scree plot of normalized variance explained by each factor



The initial factor matrix obtained in the Principal Component extraction phase (Table 7) gives the associated correlations between the factors and the individual variables. It is unlikely to identify meaningful factors as it simply provides the solution which maximises the variation accounted for by factor 1, then maximises the remaining variation accounted for by factor 2 and so on. The resulting factors are un-correlated because the axes on to which the original scores are being projected are at right-angles to each other. It is usually then necessary to rotate the axes (about the origin), to obtain a solution which is easier to interpret.

Table:7

Factor matrix (unrotated):

Risk statements	factor 1	factor 2
"Young children are as good as adults at seeing how fast and close cars are coming towards them"	.47204	.01760
"Often young children forget to stop at the kerb and can easily dart out"	.41604	-.52723
"Children are just as likely to have an accident on roads they use everyday as they are on roads they hardly use"	.33464	-.41712
"As children get to the age of about 11 or 12 years they are less likely to be involved in a road accident"	.52618	-.13472
"Older children have as many accidents as young children because they take risks"	.41257	-.46539
"When children start secondary school they are old enough to get there on their own"	.28651	-.06919
Responsibility statements	factor 1	factor 2
"It's hard to know what to say to children to make them safe on the roads"	.25282	.53351
"It's hard to keep an eye on children playing outside near roads because there is always lots to do"	.39578	.47905
"These days parents don't have enough time to teach children how to cross roads safely"	.44862	.29673
"It is difficult to make sure that young children never cross roads on their own"	.38967	.56569
"Its nearly always the drivers fault when a child gets knocked down"	.35392	-.00924
"Its the parents responsibility to make sure their children know how to cross roads safely"	.51875	-.07985

The factor matrix indicates the relationship between the factors and the individual variables and can be difficult to interpret because both factors are correlated with many variables. Rotation of the initial solution can be used to transform the variables in a way that makes the factors more meaningful and easier to interpret (Norusis 1990). In the rotation phase the total variance explained does not change. However the percentage of variance accounted for by each of the factors does change. Rotation re-distributes the explained variance for the individual factors. The purpose of

rotation is to differentiate the factors so that on any one factor only some of the variables have high loadings. An algorithm is used which attempts to minimise the number of variables that have high loadings on any one factor. There are two types of rotation orthogonal and oblique rotation. Orthogonal rotation results in factors that are uncorrelated as factor axes are maintained at right angles. Oblique rotation allows for some correlation between factors that is the factor axes are no longer maintained at right angles. Oblique rotation is the preferred method as influences in this kind of context are likely to be correlated. The rotated solution should result ideally for any one factor in clusters of variables with high factor loadings and with low factor loadings so that there should be few if any variables which have a high loading on more than one factor. This is achieved by an objective algorithmic procedure driven by the data without preconceived selection of variables to have high loadings in either factor. In practice the result is usually less clear than this, but rotation nevertheless usually leads to a simpler structure of factors than the initial one. The resulting simplified structure of the factors is shown in Table 8.

Table: 8
Simplified structure of rotated factors

Risk statements	factor 1	factor 2
"Young children are as good as adults at seeing how fast and close cars are coming towards them"	.37057	.24561
"Often young children forget to stop at the kerb and can easily dart out"	.65571	-.26363
"Children are just as likely to have an accident on roads they use everyday as they are on roads they hardly use"	.52320	-.20589
"As children get to the age of about 11 or 12 years they are less likely to be involved in a road accident"	.50666	.13726
"Older children have as many accidents as young children because they take risks"	.61541	-.21062
"When children start secondary school they are old enough to get there on their own"	.27336	.07843
Responsibility statements	factor 1	factor 2
"It's hard to know what to say to children to make them safe on the roads"	-.11931	59514
"It's hard to keep an eye on children playing outside near roads because there is always lots to do"	.02918	.61664

"These days parents don't have enough time to teach children how to cross roads safely"	.18240	.48111
"It is difficult to make sure that young children never cross roads on their own"	-.02829	.69030
"Its nearly always the drivers fault when a child gets knocked down"	.29145	.16431
"Its the parents responsibility to make sure their children know how to cross roads safely"	.46739	.18217

It was decided that only those variables whose scores had coefficients in the factor exceeding .4 in absolute value would be included in the further analysis. All of the risk statements had strong positive correlation coefficients in factor 1 and four of the six responsibility statements had strong positive correlation in factor 2. The analysis was therefore confirmatory that most of the variable scores contributed to their respective factors in the expected way. However, one variable about responsibility which correlated with the risk factor was excluded. There was only one variable with a coefficient which was almost as large as .4 which meant that there was only one difficult judgement to be made about which variable to include. It was decided, exceptionally , to include this variable. As can be seen from Table 8 many of the variables had coefficients greater than .5 in one or other factor. The statements the responses to which were included in the responsibility factor were:

"It's hard to know what to say to children to make them safe on the roads"

"It's hard to keep an eye on children playing outside near roads because there is always lots to do"

"These days parents don't have enough time to teach children how to cross roads safely"

"It is difficult to make sure that young children never cross roads on their own"

Those statements excluded from the responsibility factor were:

"Its nearly always the drivers fault when a child gets knocked down"

"Its the parents responsibility to make sure their children know how to cross roads safely"

Those statements included in the risk factor were:

"Young children are as good as adults at seeing how fast and close cars are coming towards them"

"Often young children forget to stop at the kerb and can easily dart out"

"Children are just as likely to have an accident on roads they use everyday as they are on roads they hardly use"

"As children get to the age of about 11 or 12 years they are less likely to be involved in a road accident"

"Older children have as many accidents as young children because they take risks"

The statement excluded from the risk factor was:

"When children start secondary school they are old enough to get there on their own"

3.4.3 Composite scores of risk and responsibility

To evaluate the responses and enable categorical variables to be used in the analysis, the scores for the included statements were added together to provide a composite risk or responsibility variable. The scores were not weighted by the coefficients from the factor analysis because the coefficients of the included variables lay within quite a narrow range. Cumulative frequency bar charts were created for each composite variable to see if the distribution could be divided into two groups to indicate a relatively 'good' or 'poor' response range.

The scores for the composite risk variable ranged between -15 and 40 (Figure 15). The distribution of scores indicated that two groups could be distinguished: a score greater than 23 indicating a relatively 'good' group and a score of 23 or less indicating a relatively 'poor' score. The scores for the composite responsibility variable ranged between -32 and 32 (Figure 16). The distribution of scores indicated that two groups could be distinguished: a score of 7 or more indicating a relatively 'good' group and a score below 7 indicating a relatively 'poor' group.

Figure:15 Cumulative distribution: composite risk score

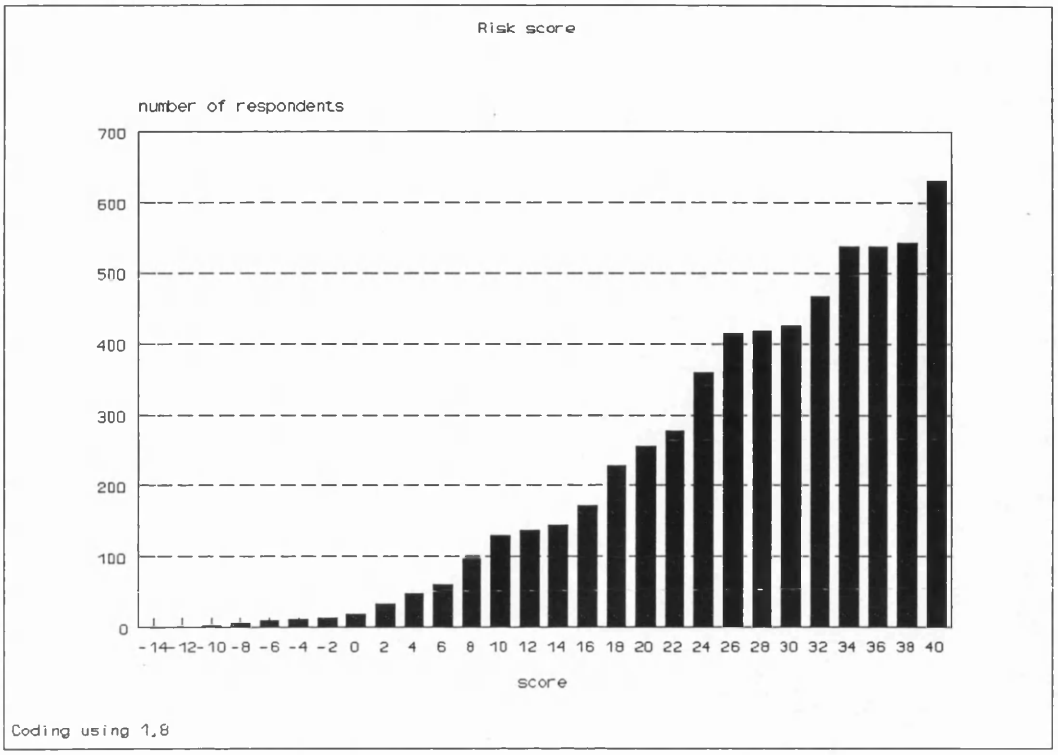
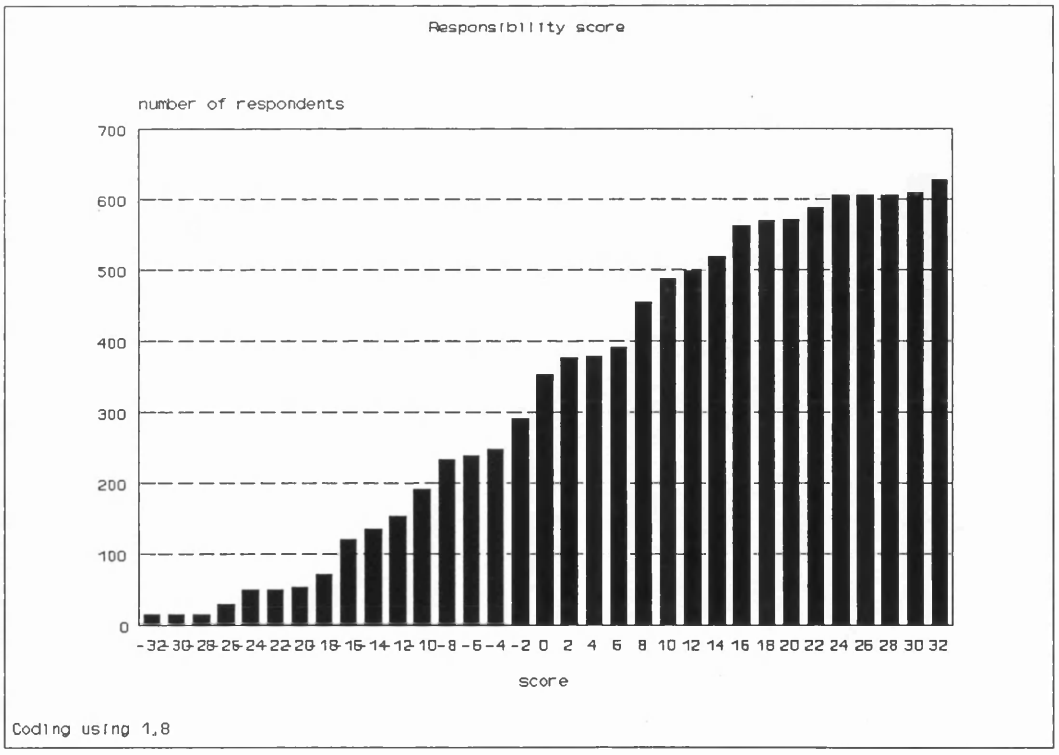


Figure:16 Cumulative distribution: composite responsibility score



3.5.1 Accident involved children

This part of the survey aimed to interview children aged 5-16 who had been recently involved in an accident as a pedestrian and attended a hospital casualty department. One of the parents (usually the mother) or adult carer and a school age sibling (preferably nearest in age to the accident-involved child) if available, were also interviewed as a 'proxy' for 'normal' exposure patterns in case the exposure of the accident-involved child had changed substantially as a result of the accident. The accident-involved child pedestrians were selected from the road accident casualties in the Department of Trade and Industry's (DTI's) Home and Leisure Accident Surveillance Surveys (HASS/LASS).

A pilot test of the sampling procedure was carried out using hospitals in Merthyr Tydfil, Reading and south east London: an additional hospital in Bradford was also included to represent northern inner city accident problems.

An introductory questionnaire (Appendix C) was administered by the hospital to the casualty's guardian and they were asked if they were prepared to be interviewed at home. Medical details and information about several accident variables was also collected. A computerised database was developed and TRL was given the names and addresses of hospital casualties who had agreed to follow-up interviews. A letter (Appendix D:1) was sent to these casualties preparing them to expect a TRL interviewer to call, indicating the types of questions, and assuring them of the confidentiality of their responses.

3.5.2 Control children

The aim of this part of the study was to interview children (aged 5-16) who had not recently been injured in a road accident and their parent or adult carer. Primary and secondary schools within the catchment areas of the hospitals used in the accident-involved child survey were approached to provide a random sample of school children within the appropriate age bands. The catchment areas were determined by contacting the hospital information officer,if available, or the A&E consultant. The schools were

selected from the Education Authorities Directory: they were mixed sex and fairly large in size. Several schools were contacted (Appendix D:2) and for the survey around 2 primary and 2 secondary schools participated in each area. The school's head teacher was asked to supply a list of names, randomly selected from the appropriate age bands. The list of names from the register was achieved by taking every third name until 20 names were given for each specified age group. A letter (Appendix D:3) was issued via 'pupil post' at each school requesting participation on an 'opt out' basis ie if the parent or adult carer did not want to be involved in the survey they were asked to return a slip to the Head Teacher.

3.5.3 Administration of the questionnaire

The time burden on respondents was 10 minutes for control children and siblings, around 30 minutes for accident-involved children and around 25 minutes for the parent or adult carer. In households where parents or adult carers were not fluent English speakers other members of the household who spoke English helped translate but this lengthened the interview.

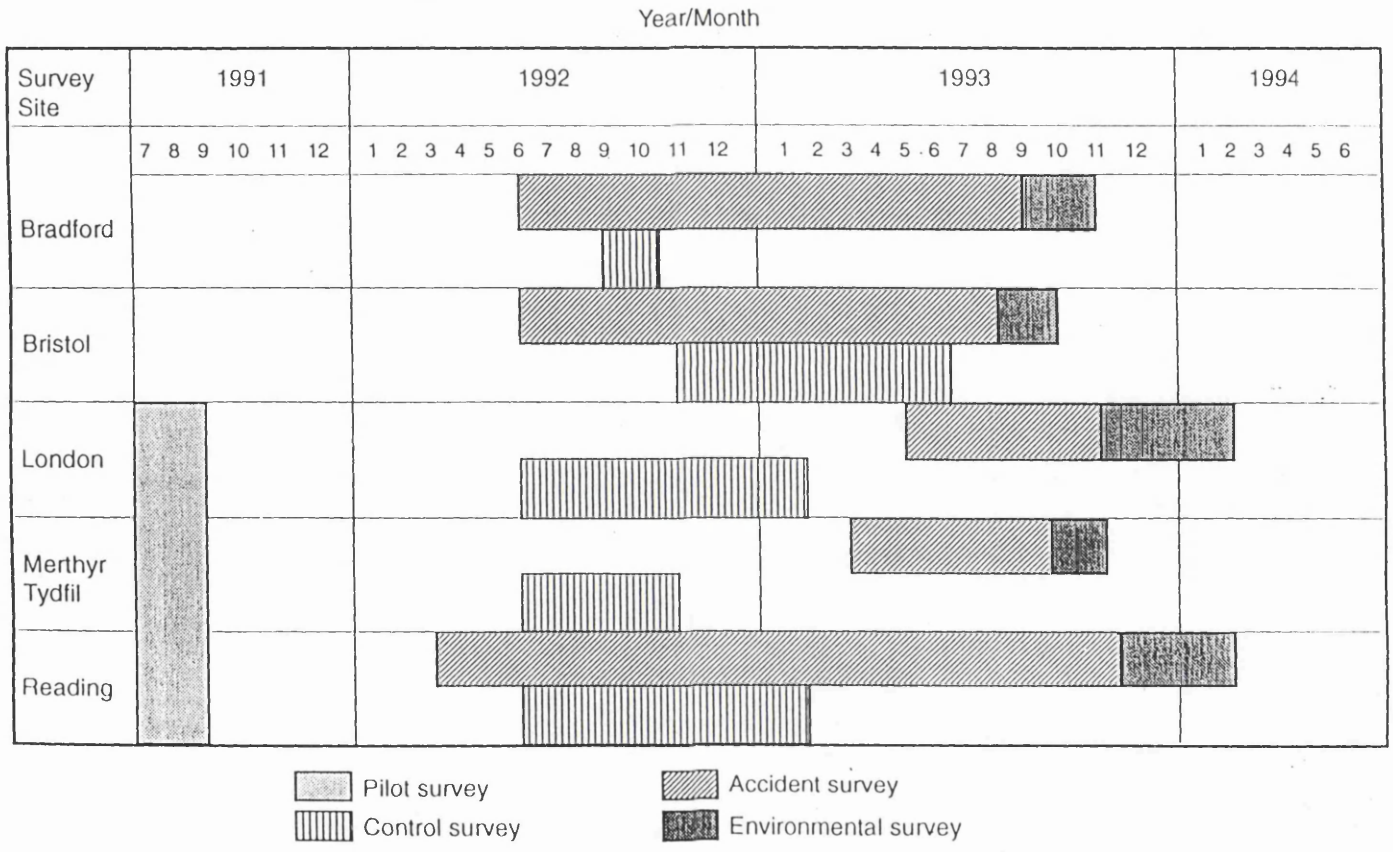
3.5.4 Sampling schedule

The timescale for the survey sampling is shown in Figure 17.

3.5.5 Response rates

The target sample size was 500 control children and 500 accident involved children. The sampling method for the control children was highly successful: less than 2% of parents or adult carers returned the refusal slips and of the remainder 98% were interviewed, giving an overall response rate of 96%. Achieving a sample of accident-involved children was more difficult. The pilot study had indicated that the guardians of around 25 casualties per month per hospital would agree to participate in follow-up survey. However, a major source of difficulty in collecting the accident sample was that when the HASS/LASS survey clerks were unable to establish the casualty's guardian's willingness to participate in a home interview. The level of non response increased during the sampling period. In the event, therefore, the expected rate was not achieved and other methods were implemented to obtain a sufficient sample to enable the study to proceed.

Figure 17: Survey sampling schedule



3.5.6 Methods used to enhance the sample of accident-involved children

Independent sampling systems were set up involving the casualty nursing staff in the HASS/LASS hospitals . They helped to identify relevant casualties and then issued an 'opt out' letter (Appendix D:4) either by post or upon registration. This asked the patient's guardian to return a slip only if they did not wish to be involved in the survey. This method is much more effective than requesting patients to 'opt in' by returning a slip if they want to participate as shown in the pilot survey and was adjudged to be ethically acceptable in several hospitals in the context of this study. Refusal slips were sent back to the hospital who then sent TRL details of those assumed willing to be involved in the follow-up survey. This strategy was more effective than the DTI method, producing a greater number of children and parents or adult carers who could be interviewed.

To further enhance the small sample size independent contacts by letter (Appendix D:5) were made with Accident and Emergency consultants in hospitals in London and Bristol. A simplified version of the DTI's road accident form was designed to be used by the duty nurse in their casualty departments. A piece rate was offered for each completed form or casualty name where willingness to participate had been established .

In each case the alternative sampling procedure to using the HASS/LASS clerks proved more effective in ascertaining willingness to participate. The most effective method was the issue of the 'opt out' letter which placed few demands on busy nursing staff and avoided the problem of the accessibility of the patient and their guardian. For one hospital it was possible to determine the relative efficacy of the DTI 'interview' method and the TRL 'opt out' for achieving contact. For a similar time period the DTI system established willingness to be involved in 28% of cases compared to 77% of cases in the TRL system. At another hospital's reception desk, staff routinely interview patients or patients' guardians about the accident and inserted a further question to establish willingness to participate in the TRL survey: forms indicating 'willingness' and 'unwillingness' were then returned to TRL with a printout of the personal details of those 'willing'.The relative effectiveness of these methods is shown in Table:9 .

Table:9

Hospital sampling: Patient contact status by sampling method with estimated response rates expressed as a percentage of total available sample* where known.

		CONTACT STATUS				
HOSPITAL LOCATION	SAMPLING METHOD	Not known	negative	positive	home refusal	Total
BRADFORD	1. First contact: contact established in routine questioning at casualty reception	92 (47%)	20 (10%)	82 (42%)	none	82
	2. Follow up of non-contacts: 'opt in' letter	0	0	0		
READING	1. First contact: DTI method	55 (82%)	0	12 (18%)	none	12
	2. Follow-up of non-contacts (introduced April 1993): casualties identified daily from records by RTA clerks and sent 'opt out' letter		13 (33%)	26 (67%)	1	25
MERTHYR TYDFIL	1. First contact: DTI method	18 (58%)	7 (23%)	6 (19%)	none	6
BRISTOL	1. First contact: TRL version of DTI questionnaire carried out by duty nurse	not known	3	16	none	16
LONDON	1. First contact: 'Opt out' letter issued at casualty reception	not known	not known	13	none (2 non-contacts)	11

*** The percentages shown in this table have been rounded so may not always sum to 100.**

3.6 The environmental survey

The aim of the environmental survey was to collect data for every child in the interview survey about the environmental features of each road crossed on a school journey, for the road in which the child lived and for each accident involved child the road on which the child had the accident. The survey was carried out after the interview survey had been completed. A database was formed in which the frequency of each environmental feature encountered by the child was represented.

Around 13% of the relevant roads could not be classified because they could not be identified on the maps or had not been visited due to the time and cost of carrying out this type of survey work. There was no reason to suspect that the roads not classified

were not proportionately distributed amongst the different kinds of road in the sample.

3.7 Data management

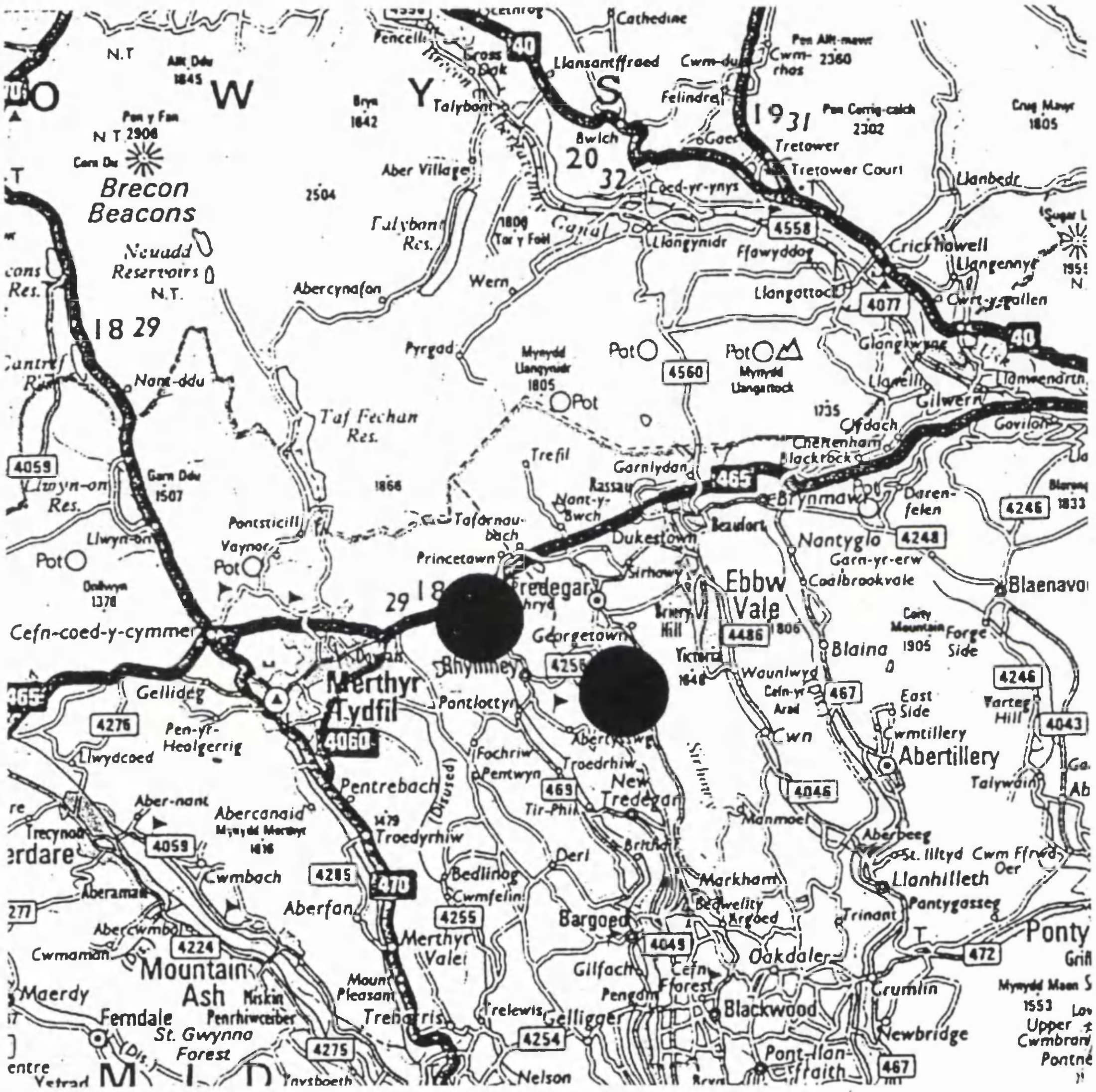
Most of the questions in the survey were designed to elicit discrete responses from a predetermined set which were suitable to be pre-coded on the questionnaire. A few open-response questions were used in the accident section of the questionnaire. A coding frame was developed for these questions by inspecting a sample of completed questionnaires and noting the range of responses. Most responses could be accounted for in five codes. Completed questionnaires were coded by a survey assistant and then input on to a computer database. An SPSS (Statistical Package for the Social Sciences) command file was written to interrogate the data. One data management assistant was used to minimize coding error variability. A one in ten verification of the survey questionnaires was carried out against the computer database as a means of checking coding accuracy.

3.8 Location of the sampling areas

Maps of the areas where the accident and control children were sampled are shown in figures 18-22.

Figure 18: Map of Merthyr Tydfil

The black circles show the approximate locations from where the control sample was drawn. The hospital was based in Merthyr Tydfil and the accident sample was drawn from the hospital catchment area which included the locations of control samples.

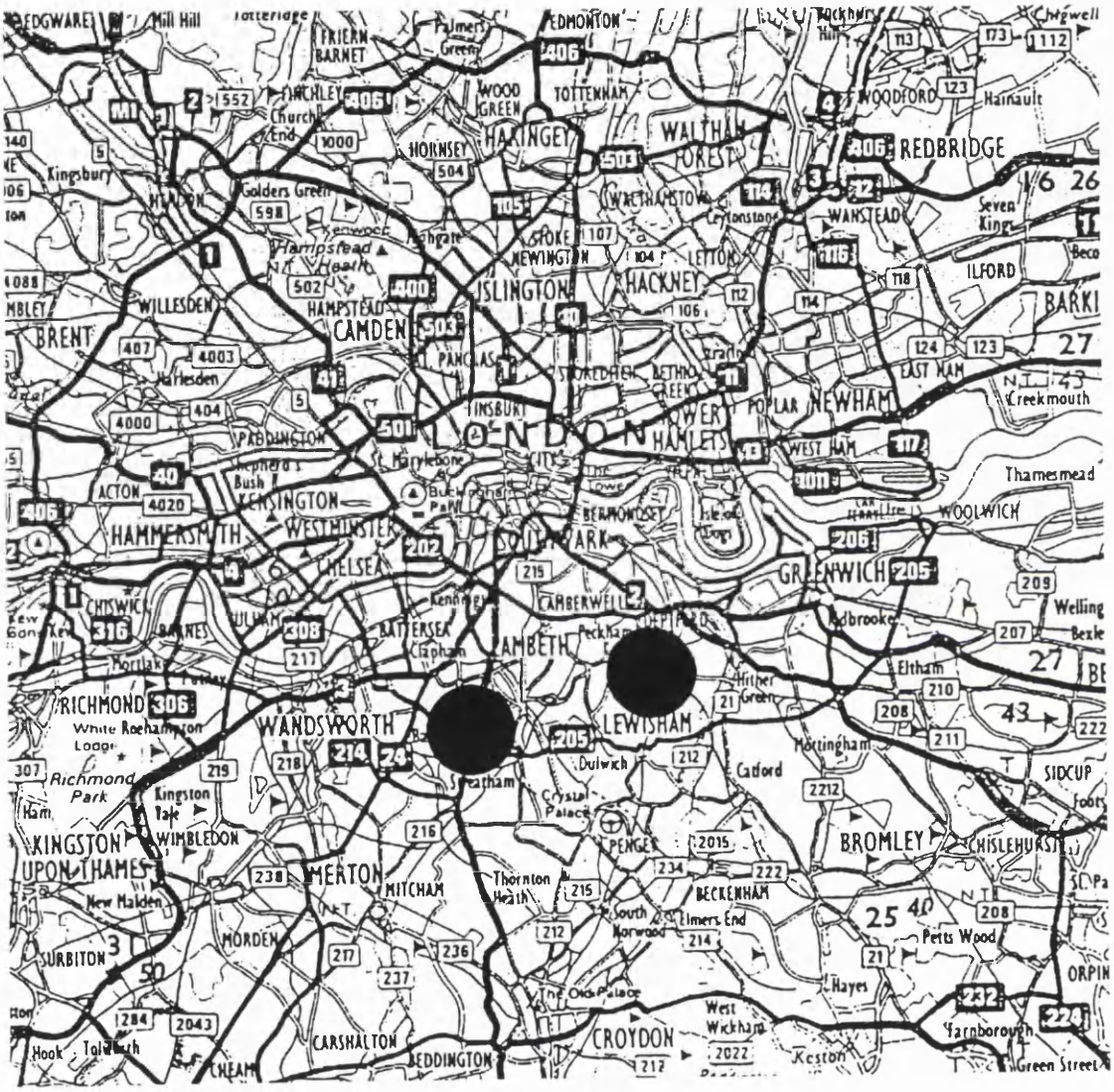


Scale 1.5" = 5 miles

Source: National Road Atlas of Great Britain (1982) ,George Philip & Son Ltd.

Figure 19: Map of South East London

The black circles show the approximate locations from where the control sample was drawn. The hospital was based in Southwark and the accident sample was drawn from the hospital catchment area which included the locations of control samples.

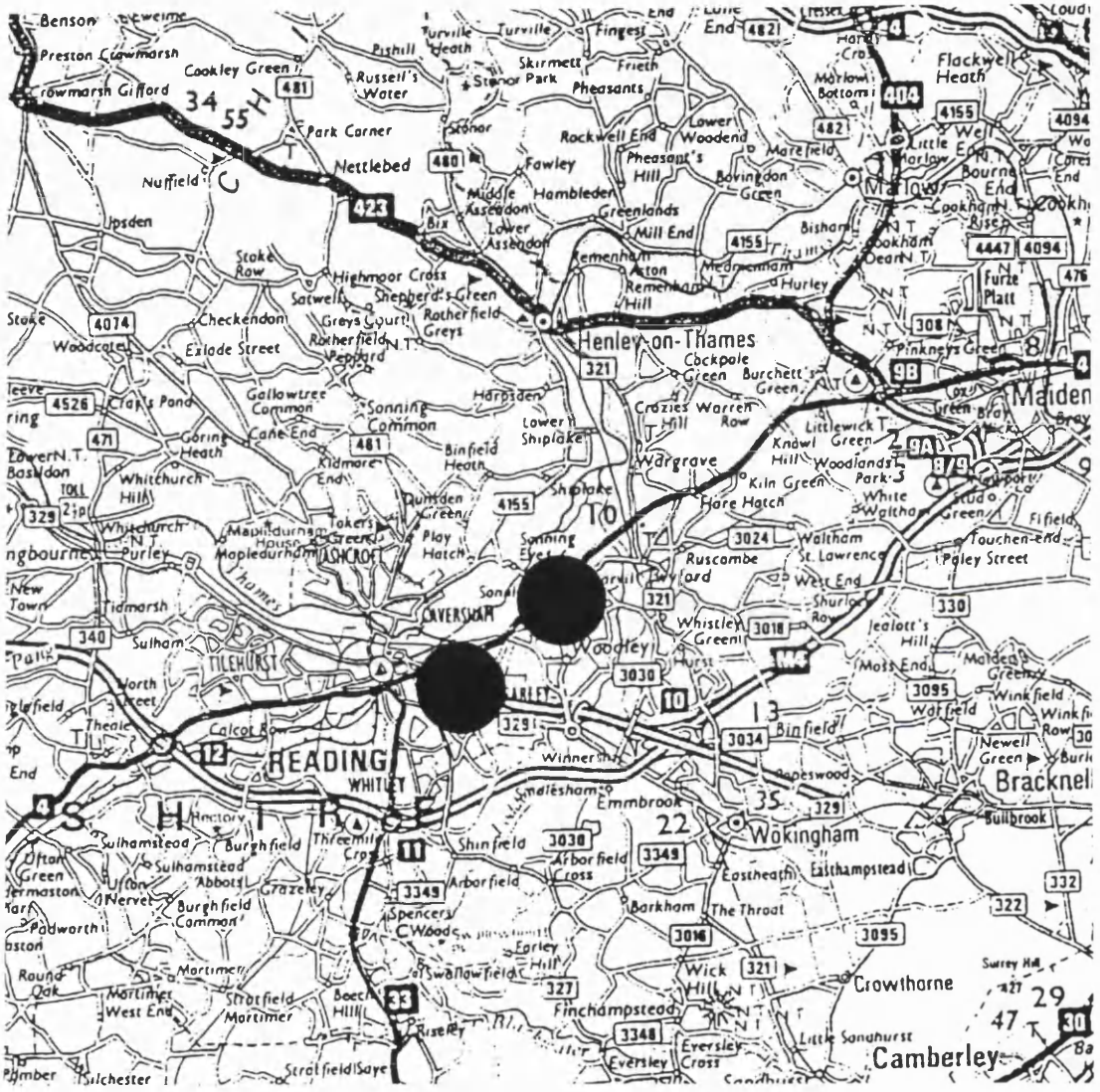


Scale 1.5" = 5 miles

Source: National Road Atlas of Great Britain (1982),George Philip & Son Ltd.

Figure 20: Map of Reading

The black circles show the approximate locations from where the control sample was drawn. The hospital was based in Reading and the accident sample was drawn from the hospital catchment area which included the locations of control samples.

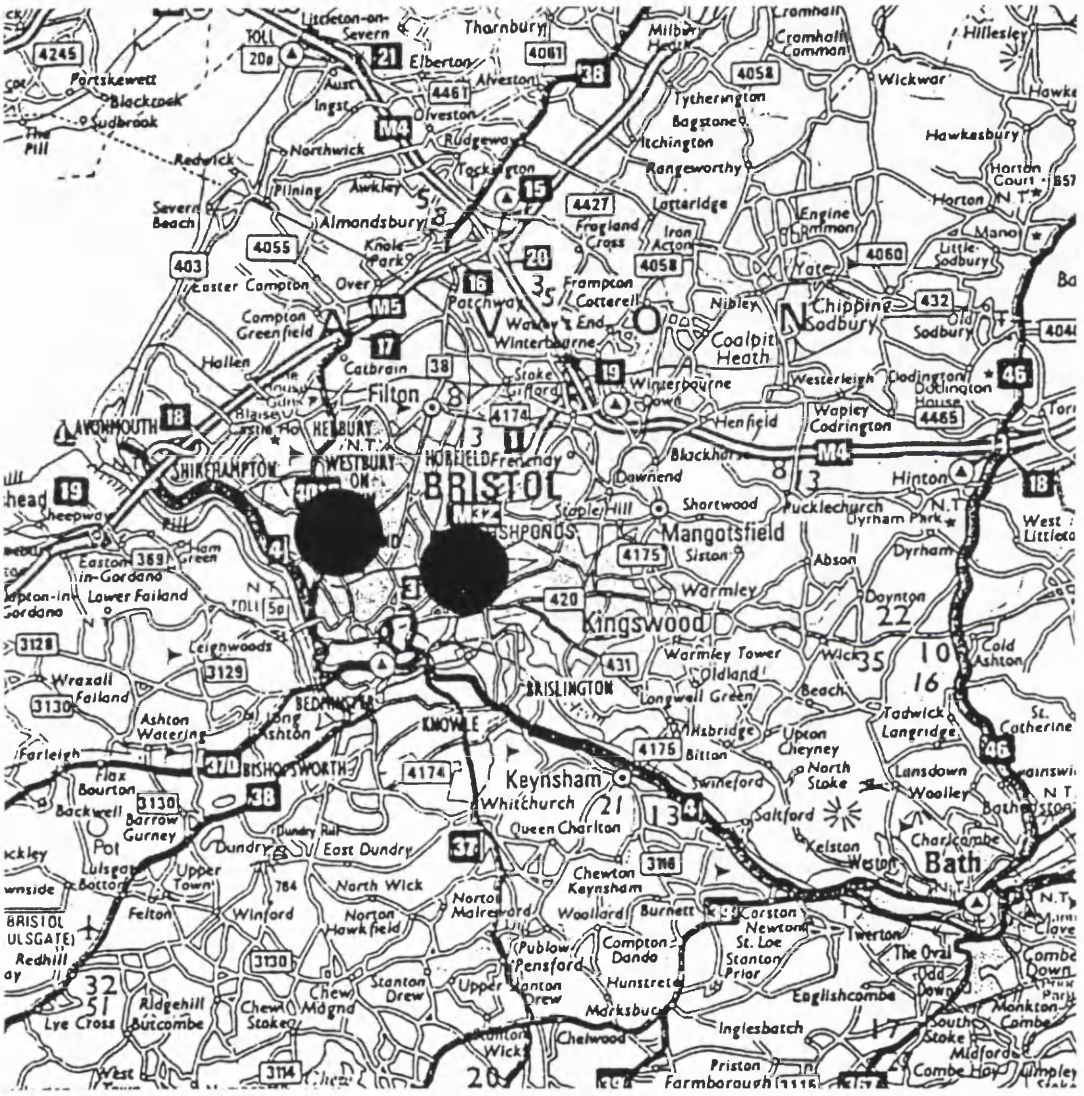


Scale 1.5" = 5 miles

Source: National Road Atlas of Great Britain (1982) ,George Philip & Son Ltd.

Figure 21: Map of Bristol

The black circles show the approximate locations from where the control sample was drawn. The hospital was based in Bristol and the accident sample was drawn from the hospital catchment area which included the locations of control samples.

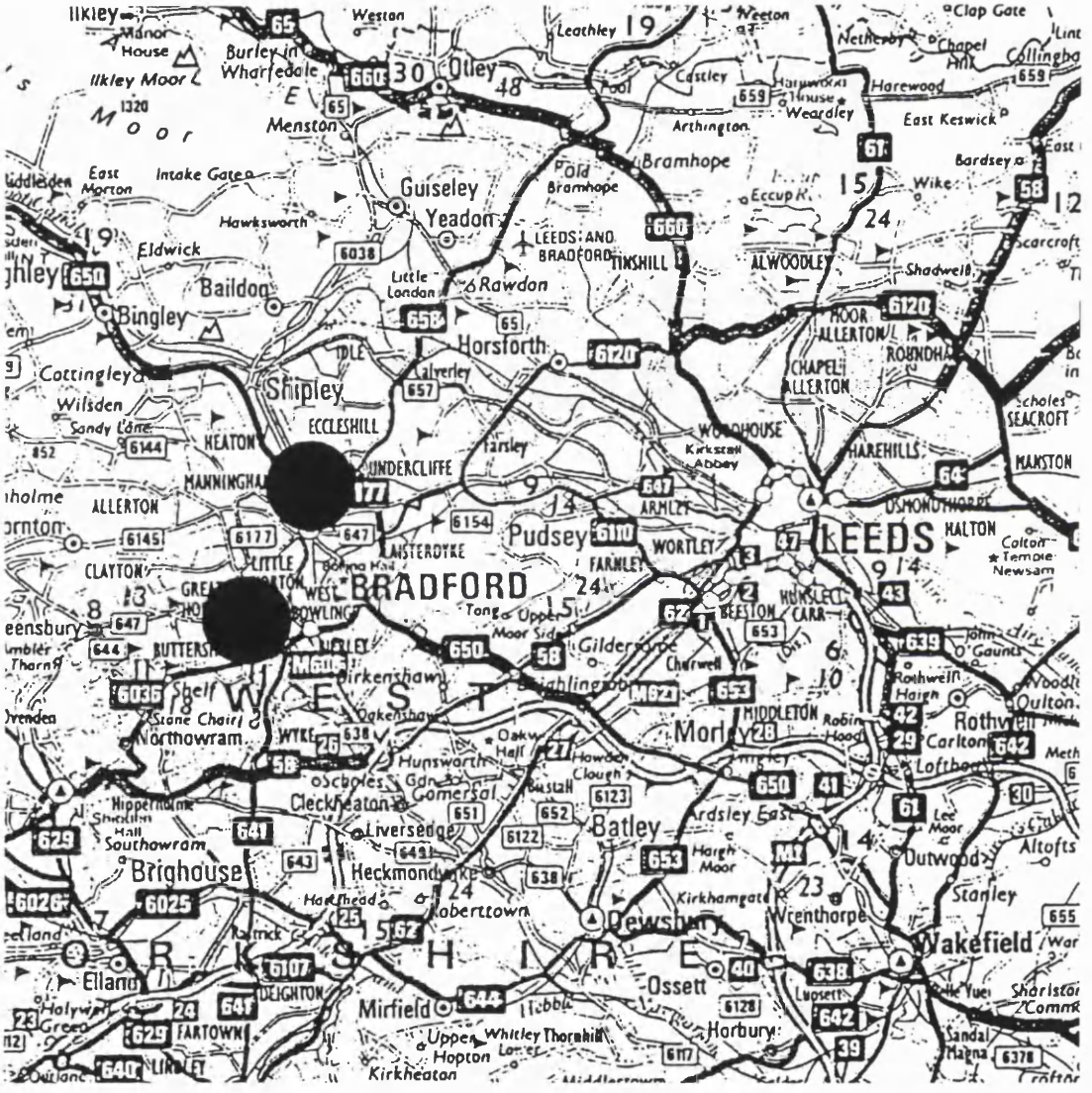


Scale 1.5" = 5 miles

Source: National Road Atlas of Great Britain (1982) ,George Philip & Son Ltd.

Figure 22: Map of Bradford

The black circles show the approximate locations from where the control sample was drawn. The hospital was based in Bradford and the accident sample was drawn from the hospital catchment area which included the locations of control samples.



Scale 1.5" = 5 miles

Source: National Road Atlas of Great Britain (1982) ,George Philip & Son Ltd.

3.9 Conceptual framework of empirical study.

The model described in section 2.7 forms the conceptual framework for the empirical study. The operational definition of socio-economic status follows that used by the Registrar General's classification which could be achieved by standard questions in the interview survey addressed to the child's carer. The exposure factor was measured in the questionnaire by looking at typical travel patterns to and from school and during journeys to clubs outside school hours. The cognitive component of the model was measured by the carer's attitude to a list of specified statements about the risks children face in traffic and about carers responsibilities for safe guarding children. The environmental component of the model was examined not by an interview survey but by direct observation of the child's local environment. This was achieved by using information about road names on maps gained from the interview survey. These measures were collected for a sample of school children and sample of accident involved child pedestrians within similar geographic areas. This experimental design allowed comparative analysis to be undertaken to investigate differences between the two groups with respect to each component of the model: socio-economic status, exposure, cognition and environment.

3.10 Summary

This Chapter has described the design of the study, the sampling strategy and how key measures were derived to assess the relative effect of a child's social and physical environment on their likelihood of being involved in a pedestrian accident. The following Chapter discusses some of the potential biases which may have influenced response rates as a result of the methodology used in this study.

CHAPTER 4

DISCUSSION OF POTENTIAL SAMPLING BIASES

The aim of the statistical analysis was to compare the accident and control samples in terms of a number of variables and identify to what extent any observed differences can account for differences in accident risk. The central statistical problem is whether the observed difference in accident risk is related to children having a certain characteristic or can be accounted for by some systematic sampling bias.

To assess the role of bias it is important to identify and account for sources of bias. For this study there are three main areas of potential bias:

1) Accident involved children whose parents or adult carers were willing to participate in the survey were not representative of all accident involved children treated at the hospital.

2) Children treated at the individual hospital were an unrepresentative sample of accident involved children in the general hospital catchment areas.

3) The control sample was not representative of children living in the hospital catchment area.

Each one of these potential sources of bias will be discussed in turn.

4.1 Bias relating to parents or adult carers willingness to participate in the hospital based survey.

A bias may have been introduced at the initial contact with the accident victims parent or adult carer at the hospital. It was possible that parents or adult carers who agreed to participate in the survey were systematically different to those who refused. To examine this bias the response rate status ie. refused', 'agreed' 'not known' was compared for child casualties against the available types of casualty data namely age, sex and severity of injury for the child pedestrian. Information of this type was not available for the Bradford or Bristol hospitals, but for the DTI hospitals it seems that contact rates are influenced by severity of injury but not by age or sex. In terms of

response when contacted, the indications are that the guardians of girls may be more likely to refuse (see Table 10).

Table: 10

Contact status : DTI HASS/LASS data for Mid-Glamorgan and Berkshire Hospital 1993 for child pedestrian casualties by injury severity, age and sex of casualty where known (percentages by status)

	positive	negative	unknown
INJURY SEVERITY:			
slight (base 73)	44	10	46
serious (base 35)	14	3	83
SEX:			
male (base 75)	39	5	56
female (base 43)	26	14	60
AGE:			
5-7 (base 30)	33	13	53
8-10 (base 30)	37	10	53
11-16 (base 58)	33	5	62

4.2 Bias relating to the characteristics of the children treated at hospitals involved in the survey.

To assess whether the accident sample was representative of children in the hospital catchment areas STATS 19 data was obtained for each relevant local authority area to assess the comparability of the accident involved children treated at the hospital with accident involved children in the hospital catchment area in terms of the age and sex of the casualty. Inspection of STATS 19 data shows some regional variations (see Table 11). However looking at the percentages for the combined areas the accident sample compares quite well with the STATS 19 total, though there may be some under representation of older children aged 11-16 and some over representation of

males (see Table 12). The experimental design of the study precluded the use of data on fatalities. Arguably, the omission of fatalities would mean that the results of the analysis of this studies data would be biased. However, the bias is negligible. Child pedestrian fatalities are very rare. In 1991 child pedestrian fatalities aged between 5-15 constituted only 1% of over 22,000 casualties of all severities. Therefore, in this study, comprising 152 casualties only about 2 fatalities would have been expected. Furthermore, because many of these seriously injured and some of those slightly injured might easily have died, the mechanisms underlying the cause of accidents involving child pedestrian accident fatalities are likely to be similar to those underlying accident involving injuries of less severity. For example, Sharples et al (1990) indicated lack of adult accompaniment and unsupervised street play were factors explaining the circumstances of fatal child pedestrian accidents in the North of England - mechanisms also reported by studies of non fatal casualties.

Table: 11

STATS 19 data for each geographical area by age and sex showing proportions in each demographic group.

	BERKS	BRADFORD	BRISTOL	MID GLAM	LONDON
AGE:					
5-7	20	31	18	25	18
8-10	21	28	32	29	26
11-16	60	42	50	46	56
SEX:					
Male	62	60	50	65	60
female	38	40	50	35	40

Table: 12

Comparison of mean percentages of STATS 19 casualties across the five areas in each age and sex group with those in the accident sample.

	STATS 19	ACCIDENT SAMPLE
AGE:		
5-7	22	28
8-10	27	32
11-16	51	40
SEX:		
Male	59	65
female	41	35

4.3 Bias relating to the selection of the control sample of children.

The schools were selected from the Education Authorities Directory: they were state schools, mixed sex and fairly large in size. Several schools were contacted and for the survey 2 primary and 2 secondary schools participated in each area. For sampling children within each chosen school the head teacher was asked to supply a list of names randomly selected from the appropriate age bands to provide a cross section of backgrounds and abilities. The list of names from the register was achieved by taking every third name until 20 names had been obtained for each specified age group.

To assess the representativeness of the control sample respective to the children living in the catchment area census data was obtained for each relevant local authority area. The Census data is taken from the 1991 Census, OPCS for the following areas:

1) London (Southwark, Lewisham, Newham and Lambeth)
2) Mid-Glamorgan
3) Berkshire
4) Bristol
5) Bradford

The information for this report was extracted from the following Census Tables:

T6: Ethnic origin of residents by age (5-16)

T36: Number of households by number of dependent children (0-15)

T38: Number of residents in households by age

T86: Number of households with dependent children (0-15) by SEG

T89: Total number of families with dependent children (0-15) where the parents are a married couple/other

Information on housing age was obtained from the 'English House Condition Survey:1991. Preliminary Report on unfit Dwellings' published by the Department of the Environment. It should be noted that these variables were selected to approximate the type of key variables analyzed in the study but may be based on a much wider area. Also many of these variables are based on families with dependent children whose age ranges between 0-15. In this study the accident victims were all aged between 5-15 and therefore will under represent the under fives relative to the census data. For housing age information was obtained for the following areas:

Yorkshire (for Bradford)

South east (for Berkshire)

Inner London (for south London)

South West (for Bristol)

No information has been obtained for Mid Glamorgan because no source corresponding to the English House Condition Survey could be located for Wales.

Census data and control data by demographic characteristics are shown for each region in Appendix E. Whilst these individual tables showed points where there are discrepancies between the data sets when the mean percentage for each demographic factor is computed across regions for both data sets the comparability seems good except for some over representation in the control sample of children living with carers of non-white ethnic origin, of those living in households with three or more children, and of those living in pre 1919 housing at the expense of those living in post 1960 housing (see Table 13).

Table:13

Comparison of key demographic characteristics : mean percentage across areas for census data and the study control

	CENSUS	CONTROL
AGE:		
5-7	27	23
8-10	26	25
11-16	47	52
ETHNIC ORIGIN:		
White	81	89
Non-white	19	11
DEPENDENT CHILDREN:		
2 or fewer	80	66
3 or more	20	34
SEG:		
ABC1	49	46
C2	31	27
DE	20	25
MARITAL STATUS:		
Typical	71	72
Atypical	29	28
AGE OF HOUSING		
Pre 1919	32	43
1919-1964	36	37
Post 1964	32	20

CHAPTER 5

DESCRIPTION OF ACCIDENT CIRCUMSTANCES

The aim of this Chapter is to summarise the characteristics of the accidents in which the children were involved. Information on the accident circumstances of child pedestrians is largely based on the report of the child aided by the parent or adult carer where necessary.

For some of the questions about accident circumstances more than one answer was allowed, these were called 'multi-response' answers.

5.1 Time of accident

Slightly more than the expected proportion of accidents (76%) occurred on a weekday compared to the weekend, with 9% of accidents occurring before 10.00am, 44% occurring between 14.00 and 16.00hrs and 29% after 18.00hrs. This distribution by day found in the accident sample is virtually identical to the distribution found nationally with 23% occurring at the weekend and 77% occurring on a week day. The distribution of accidents by time of day is broadly similar to that found nationally with 13% of accidents occurring before 10.00am, 47% occurring between 14.00 and 17.59 hours and 23% occurring after 18.00 hrs (STATS 19 data base, 1991).

5.2 Accompaniment

Over a third of children were alone at the time of the accident, including 5-7 year olds and of the remainder of this age group only a third were accompanied by an adult (Table 14). For those unaccompanied by their parent or adult carer at the time of the accident, most parents reported to be at home (Table 15).

Table:14

Reported accompaniment at the time of the accident by age, multi-response (percentage of age group)

	5-7 (base=43)	8-10 (base=48)	11-16 (base=61)
Alone	35%	33%	34%
With parent	26%	4%	3%
With adult	9%	4%	3%
With peers	37%	53%	54%
With siblings	33%	15%	8%

Table:15

Reported location of parent at the time of the accident by age (percentage of age group)

	5-7 (base=31)	8-10 (base=46)	11-16 (base=59)
Home	87%	72%	80%
Work	3%	9%	8%
Neighbours	3%	2%	-
Other	7%	17%	12%

5.3 Road use at time of accident

The reported road use by age at the time of the accident is shown in Table 16. For young children street play features highly, whilst for the oldest children the school journey is important. As street play tends to be unaccompanied these results indicate that this age group is particularly at risk from this activity.

Table:16
Reported purpose of road use at time of accident by age (percentage of age group)

	5-7 (base=43)	8-10 (base=48)	11-16 (base=61)
School journey	9%	23%	30%
Shopping "	23%	17%	28%
Social "	19%	23%	16%
Street recreation	35%	19%	11%
Other	9%	8%	8%

5.4. Activity just before accident

For the under 11's attention absorbing activities not related to the task of crossing the road featured strongly just before the accident occurred, for the older children the task of crossing featured most (Table 17). The large 'other' category comprises a miscellany of responses which could not be placed in a specific category . Such responses included 'picking apples','coming out from the mosque', 'buying an ice cream', 'talking to my friend on the green' etc.

Table:17
Reported activity just before the accident, multi-response (percentage of age group)

	5-7 (base = 43)	8-10 (base = 48)	11-16 (base = 61)
Playing	44%	50%	39%
Waiting to cross	23%	31%	26%
Crossing the road	28%	38%	52%
Fighting/arguing	-	6%	2%
Other	23%	21%	33%
Can't remember	7%	2%	-

5.5 Perception of cause

Failure to attend to traffic was most often mentioned as a causal factor in the accident by the parents or adult carers of children aged under 11, for older children the speed

of vehicles was regarded as the main cause of the accident (see Table 18). The importance of obstructive street parking decreases with increased age. For children who had some idea of what had caused their accident, more than half had felt that their attention had not been engaged fully in the task of crossing the road, (attentional failure as a proportion of responses other than "don't know") and this was particularly noticeable for the 8-10 year old's. Again the perception of speeding vehicles as a causal factor increases with age (Table 19).

The responses to this question by parents or adult carers and children may reflect certain biases. Younger children may be considered by their parents or adult carers as more blameworthy than older children, they may also be less able to defend themselves or give accurate witness leading to an underestimate of the role of the driver. Older children by comparison may be more able in these areas and may more readily attribute the blame to the driver than themselves.

Table:18

Perception of cause of accidents reported by parent or adult carer, multi-response (percentage of age group)

	5-7 (base = 43)	8-10 (base = 48)	11-16 (base = 61)
Attentional failure	60%	67%	48%
Speeding vehicles	28%	35%	57%
Pre-occupied with friends	23%	10%	8%
View obstructed by parked vehicles	16%	13%	5%
Don't know	12%	10%	13%

Table:19

Perception of cause of accident reported by child, multi-response (percentage of age group)

	5-7 (base = 43)	8-10 (base = 48)	11-16 (base = 61)
Attentional failure	33%	48%	41%
Speeding vehicles	19%	27%	41%
Pre-occupied with friends	2%	19%	8%
View obstructed by parked vehicles	5%	4%	7%
Don't know	44%	25%	26%

5.6 Environmental features of the accident location

The environmental features of the accident location are shown by age of casualty in Table 20. While most accidents occur on non-arterial roads, there is a clear trend showing that child pedestrian accidents on arterial roads increase with age of the children. Similarly whilst most accidents occur where the adjacent land use is residential, a higher proportion of accidents are associated with mixed or commercial land use when children are in the higher age groups. Locations where housing was built by the local authority have a higher proportion of accidents involving under 8's than of accidents to older age groups, though most accidents occur where the houses were built for private ownership. In terms of age of development the single category associated with the most accidents was the pre-1914 group. Over 90% of all accidents occurred on through roads, and while most accidents occurred on roads without on street parking the older age group was unexpectedly more likely to have their accidents on a road with obstructive parking compared to the younger groups. Table 20 shows the characteristics of the road where the child reported to have had their accident. No data was collected within the sampling areas about the distribution of accidents by the road characteristics identified in this study. Therefore, it is not known whether the pattern of accidents by road type in this study is representative of the distribution of accidents generally.

Table:20
Environmental features of the accident location by age (percentage of group)

	5-7 (base = 37)	8-10 (base = 34)	11-16 (base = 39)
Road type			
Arterial	14%	32%	54%
Non-arterial	86%	68%	46%
Land use			
Residential	89%	85%	72%
Mixed	11%	12%	13%
Commercial	-	3%	15%
Tenure			
Public	42%	15%	10%
Private	58%	85%	90%
Age of development			
Pre-1914	46%	59%	54%
1918-1939	19%	21%	31%
1945-1960	19%	11%	5%
Post 1960	16%	9%	10%
Vehicle access			
Through	97%	97%	95%
Closed	3%	3%	5%
Obstructive parking			
Yes	11%	14%	18%
No	89%	86%	82%
Traffic calmed			
Yes	-	-	3%
No	100%	100%	97%

5.7 Accidents on the school journey

The school route information was used to look at a sub-sample of children who had had their accidents on the school journey (33 children, 22% of the accident sample). Exposure information was available for the school journey. Analysis of the data indicated that time taken on a journey to school was important with children taking over 20 minutes for a journey being over-represented in the accident group (Table 21).

Analysis of accident involvement and accompaniment showed that a significantly larger proportion of children under 11 involved in accidents on the school journey were unaccompanied by an adult on a school journey than among the control group aged under 11 (Table 22). There was no significant difference in accident involvement with respect to level of accompaniment on the school journey for children aged over 11.

Table:21

Accident involvement on the journey to school by time taken (percentage of each sample)

	Control (base= 483)	Accident (base= 33)
up to 20 minutes	420 (87%)	21 (64%)
over 20 minutes	63 (13%)	12 (36%)

Table:22

Accident involvement and adult accompaniment on a school journey for children under 11 (percentage of each level of accompaniment)

	Control (base= 231)	Accident (base= 15)
accompanied by adult	201 (87%)	9 (60%)
unaccompanied by adult	30 (13%)	6 (40%)

5.8 Conclusions

In this study most accidents occurred during the week, in the afternoon and when not on a school journey. Very few accident involved child pedestrians (less than 10%) were accompanied by an adult at the time of the accident. Failure to attend to traffic properly was perceived as a key causal factor in the accident. Most accidents occurred on residential roads, where there was old housing stock and on roads with no obstructive parking. Data for accidents on the school journey were limited, but relatively long journey times and lack of adult accompaniment for the under 11's were significantly associated with accident involvement.

CHAPTER 6
UNIVARIATE ANALYSIS

This chapter shows the results of preliminary univariate analysis of the data. The univariate analysis was carried out in two ways. Firstly each independent variable was cross tabulated with the outcome variable ie. accident involvement to gain a feel for the relationships and to screen the data for zero or small cell counts which could cause problems in the multivariate modelling of the data. Secondly each variable was crosstabulated with social status to provide an understanding of how each variable is distributed across socio-economic groups. Data is tabulated for significant results only, Pearson chi-squared significance is also shown.

6.1 The social variables: relationship between socio-economic status and accident involvement and other social variables

The variables used in this analysis were selected because the literature review had indicated that they may be important factors in the accident involvement of child pedestrians.

The variables used in the analysis were:

socio-economic group
age of child
sex of child
number of working adult carers in family
level of household crowding
ethnic origin of adult carer
presence of disability in a family member
marital status of adult carer
responsibility score of adult carer
risk score of adult carer
number of dependent children in family
family size
access to a car
child's membership of clubs outside school hours
child's frequency of street play
adult accompaniment of child in school journey

These two last variables were included in this analysis because they were judged to be social aspects of exposure. A brief explanation of these variables with associated response levels is given below.

6.1.1 The relationship between socio-economic status and accident involvement

Children in the lowest socio-economic group were more likely to be involved in an accident and those in higher groups were less likely to be involved in an accident compared to those in group C2, $\chi^2 = 7.00$, df 2 $p < .05$ (Table 23).

Table:23

Accident involvement by socio-economic group of household (number and percentage of respondents in each sample group)

	ABC1	C2	DE
no accident	213 (44%)	139 (29%)	130 (27%)
accident	53 (35%)	40 (27%)	57 (38%)

6.1.2 The relationship between child's age and accident involvement

Children aged under 11 were significantly more likely to be involved in accidents compared to children aged over 11, $\chi^2 = 6.96$, df 2 $p < .05$ (Table 24).

Table:24

Accident involvement by age of child (number and percentage of respondents in each sample group)

	5-7 years	8-10 years	11-16 years
no accident	116 (24%)	115 (24%)	252 (52%)
accident	43 (28%)	48 (32%)	61 (40%)

6.1.3 The relationship between child's sex and accident involvement

Male children were significantly more likely to be involved in an accident compared female children, $\chi^2 = 14.1$, df 1 $p < .0001$ (Table 25).

Table:25

Sex of child by accident involvement (number and percentage of respondents in each sample group)

	male	female
no accident	227 (47%)	256 (53%)
accident	98 (65%)	54 (35%)

6.1.4 The relationship between number of working adults in a household and 1) accident involvement and 2)socio-economic status

The variable "TWORK" was computed to indicate how many incomes there were in a household. Of the total sample 288 (46%) had two parents or adult carers working, 212 (33%) had one parent or adult carer working and 132 (21%) had no working parents or adult carers. Children who lived in families where there were no working adults were significantly more likely to be involved in an accident compared to children who had two working parents, who in turn were significantly more likely to be involved in an accident than those with just one working parent, $\chi^2 = 29.5$, df 2 $p < .0001$ (Table 26). Children in the lowest socio-economic group were more likely to live in families where there were no working parents or adult carers and less likely to live in families with two or more working parents compared to the higher groups $\chi^2 = 98.7$, df 4 $p < .0001$ (Table 27).

Table:26

Accident involvement by number of working adult carers (number and percentage of respondents in each sample group)

	"none"	"one"	"two"
no accident	79 (16%)	241 (50%)	163 (34%)
accident	54 (36%)	47 (31%)	51 (34%)

Table:27

Socio-economic group by number of working adult carers (number and percentage of SEG)

Socio-economic Group:	"none"	"one"	"two"
ABC1	36 (14%)	83 (31%)	147 (55%)
C2	15 (8%)	64 (36%)	100 (56%)
DE/other	81 (43%)	65 (35%)	41 (22%)

6.1.5 The relationship between household crowding and 1) accident involvement and 2)socio-economic status

The "CROWDING" variable refers to the level of crowding in the household. The 1985 Housing Act definition of over-crowding includes criteria based on complex permutations of age, sex and floor space and could not be assessed without detailed measurements beyond the scope of this study. An alternative measure of overcrowding used in similar research (Alwash & McCarthy 1988) was more than 1.5 persons per room. The same criterion was computed for this study by dividing the total number of people in a household by the number of living rooms and bedrooms. Of the total sample 45 children (7%) were living in crowded accommodation. Children who lived in crowded households were significantly more likely to be involved in accident compared to children who lived in uncrowded households, $\chi^2 = 7.5$, df 1 $p<.05$ (Table 28) . There were significantly more children in the lower socio-economic group living in crowded households compared to the higher groups $\chi^2 = 17.7$, df 2 $p<.0001$ (Table 29).

Table:28
Accident involvement by level of crowding (number and percentage of respondents in each sample group)

	"uncrowded"	"crowded"
no accident	457 (95%)	26 (5%)
accident	134 (88%)	18 (12%)

Table:29
Socio-economic group by level of crowding (number and percentage of adult respondents in each SEG)

Socio-economic Group:	"uncrowded"	"crowded"
ABC1	259 (97%)	7 (3%)
C2	166 (93%)	13 (7%)
DE/other	163 (87%)	24 (13%)

6.1.6 The relationship between ethnic origin of the adult respondent and 1) accident involvement and 2)socio-economic status

The "ETHNIC" variable refers to the ethnic origin of the adult respondent which was recoded to represent 'white' and 'non-white' adult respondents. Of the total sample 89 (14%) were of a 'non-white' ethnic origin. Of the 'non-white' group 47 (52%) described themselves as Asian, 27 (30%) described themselves as black and 16 (18%) were classified as 'others'. Children who lived in families where an adult carer was of a non-white ethnic origin were more likely to be involved in an accident compared to those living with a 'white' carer, χ^2 =20.3, df 1 $p<.0001$ (Table 30). There were significantly more 'non-white' adult respondents in the lowest socio-economic group compared to the higher groups χ^2 =7.8, df 2 $p<.05$ (Table 31).

Table:30
Accident involvement by the ethnic origin of adult respondent (number and percentage of respondents in each sample group)

	"white"	"non-white"
no accident	432 (89%)	51 (11)
accident	113 (75%)	38 (25%)

Table:31
Socio-economic group by the ethnic origin of adult respondent (number and percentage of adult respondents in each SEG)

Socio-economic Group:	"white"	"non-white"
ABC1	232 (87%)	34 (13%)
C2	161 (90%)	18 (10%)
DE/other	150 (80%)	37 (20%)

6.1.7 The relationship between reported disability of a family member and 1) accident involvement and 2)socio-economic status

Factors affecting the ability of the parent or adult carer to supervise children were also included in the analysis. The "DISAB" variable indicates whether a family member has a physical disability. Of the total sample 91 (14.5%) reported that a family member had a physical disability. Children who lived in families where there was a family member with a disability were more likely to be involved in accident compared to children in families with no disabled member, χ^2 = 10.6, df 2 , $p< .05$

(Table 32). There was no significant relationship between reported disability and socio-economic group.

Table:32

Accident involvement by reported disability among family members (number and percentage of respondents in each sample group)

	"disabled member"	"none disabled"
no accident	57 (12%)	421 (88%)
accident	34 (23%)	116 (77%)

6.1.8 The relationship between marital status of the adult respondent and 1) accident involvement and 2)socio-economic status

The "MARITAL" variable indicates the marital status of the adult respondent and was recoded to indicate a 'typical' marital status where the adult respondent was married once only, 'atypical' status represented an adult respondent who was either not married, widowed, separated or married for the 2nd or 3rd time. Of the total sample 193 (30%) of children were living in an 'atypical' family unit. Of these 'atypical' families 67 (35%) of the adult respondents were divorced, 49 (25%) had never married, 45 (23%) had been married twice or more, 24 (13%) were separated and 7(4%) widowed. Children who lived in a family where the carer had an 'atypical' marital status were significantly more likely to be involved in accident compared to children whose carer had a 'typical' marital status, $\chi^2 = 19.1$, df 1 $p < .0001$ (Table 33). There were significantly more adult respondents in the lowest socio-economic group whose marital status was 'atypical' compared to the higher socio-economic groups $\chi^2 = 15.9$, df 2, $p < .001$ (Table 34).

Table:33

Accident involvement by the adult respondents marital status (number and percentage of respondents in each sample group)

	"typical"	"atypical"
no accident	357 (74%)	126 (26%)
accident	82 (55%)	67 (45%)

Table:34

Socio-economic group by the adult respondents marital status (number and percentage of adult respondents in each SEG)

Socio-economic Group:	"typical"	"atypical"
ABC1	193 (73%)	73 (27%)
C2	140 (78%)	39 (22%)
DE/other	106 (57%)	80 (43%)

6.1.9 The relationship between responsibility score and 1) accident involvement and 2)socio-economic status

Of the total sample 62% (398) scored a relatively poor responsibility score. Children whose adult carer scored a relatively poor responsibility score were more likely to be involved in an accident compared to children whose adult carer scored a good score, $\chi^2 = 8.00$, df 1 $p < .05$ (Table 35). There was no significant relationship between responsibility score and SEG.

Table:35

Accident involvement by the adult respondents responsibility score (number and percentage of respondents in each sample group)

	"good" responsibility score	"poor" responsibility score
no accident	195 (40%)	288 (60%)
accident	42 (28%)	110 (72%)

6.1.10 The relationship between risk score and 1) accident involvement and 2)socio-economic status

Of the total sample 284 (45%) scored a relatively poor risk score. There was no significant interaction between accident involvement and risk score. Significantly more adult respondents in the lowest socio-economic group had a poor risk perception score compared to the higher groups $\chi^2 = 6.3$, df 2 $p < .05$ (Table 36).

Table:36

Socio-economic group by the adult respondents risk score (number and percentage of adult respondents in each SEG)

Socio-economic Group:	"good" risk score	"poor" risk score
ABC1	154 (58%)	112 (42%)
C2	106 (59%)	73 (41%)
DE/other	89 (48%)	98 (52%)

6.1.11 The relationship between number of dependent children in a family and 1) accident involvement and 2)socio-economic status

The "FAM" variable was based on the number of children aged under 16 years in a family and distinguished families where there were 1 or 2 children from those with 3 or more. Of the total sample 227 (36%) were in families with 3 or more children. Children who lived in families where there were 3 or more dependent children were more likely to be involved in an accident compared to children living in families with 2 or fewer dependent children, $\chi^2 = 14.5$, df 1, $p < .001$ (Table 37). The proportion of families with 3 or more dependent children was lowest in the highest socio-economic group and is progressively higher in families in lower socioeconomic groups, with DE/OTHER being most likely to have 3 or more children, $\chi^2 = 15.9$, df 2, $p < .001$ (Table 38).

Table:37

Accident involvement by number of dependents in a family aged under 16 (number and percentage of respondents in each sample group)

	"two or fewer children"	"three or more children"
no accident	330 (68%)	153 (32%)
accident	78 (51%)	74 (49%)

Table:38

Socio-economic group by number of dependents in a family aged under 16 years (number and percentage of adult respondents in each SEG)

Socio-economic Group:	"two or fewer children "	"three or more children"
ABC1	192 (72%)	74 (28%)
C2	113 (63%)	66 (37%)
DE/other	101 (54%)	86 (46%)

6.1.12 The relationship between total family size and 1) accident involvement and 2)socio-economic status

The variable "FAMSIZE" was used to indicate family size. Of the total sample 359 (57%) lived in families with 4 or fewer members and 273 (43%) in families with 5 or more. There was no significant interaction between accident involvement and total family size. There was no significant relationship between total family size and socio-economic group.

6.1.13 The relationship between access to a car and 1) accident involvement and 2)socio-economic status

The "CARUSE" variable indicated whether the family had access to a car: of the total sample 485 (77%) of adult respondents said they had access to a car. Children in families which had access to a car were less likely to be involved in accidents compared to families without access to a car, $\chi^2 = 21.3$, df 1, $p < .0001$ (Table 39). There was a significantly larger proportion of children in the lowest socio-economic group whose parent or carer did not have access to a car compared to the higher groups $\chi^2 = 58$, df 1, $p < .0001$ (Table 40).

Table:39
Accident involvement by access to car (number and percentage of respondents in each sample group)

	"access to car"	"no access to car"
no accident	391 (81%)	91 (19%)
accident	95 (63%)	56 (37%)

Table:40
Socio-economic group by access to a car (number and percentage of adult respondents in each SEG)

Socio-economic Group:	"access to car"	"no access to car"
ABC1	223 (84%)	42 (16%)
C2	155 (87%)	24 (13%)
DE/other	107 (57%)	80 (43%)

6.1.14 The relationship between club attendance and 1) accident involvement and 2)socio-economic status

"CLUBT" indicated the number of clubs the child went to and was a measure of the extent of supervised extra-mural activities. Of the total sample 241 (38%) were not involved in club activities, 225 (36%) went to 1 club and 166 (26%) went to 2 or more. Children who did not attend any clubs outside school were significantly more likely to be involved in an accident compared to children who did attend clubs, χ^2 = 21.3, df 1, $p < .0001$ (Table 41). There was a significantly higher proportion of child respondents in the lowest socio-economic group who did not go to any clubs compared to the higher groups χ^2 =18.7, df 2, $p < .0001$ (Table 42).

Table:41
Accident involvement by child's club membership (number and percentage of respondents in each sample group)

	"none"	"one or more"
no accident	160 (33%)	323 (67%)
accident	82 (54%)	70 (46%)

Table:42
Socio-economic group by child's club membership (number and percentage of child respondents in each SEG)

Socio-economic Group:	"none"	"one or more"
ABC1	79 (30%)	187 (70%)
C2	69 (31%)	110 (69%)
DE/other	93 (50%)	94 (50%)

6.1.15 The relationship between playing in the street and 1) accident involvement and 2)socio-economic status

The "STREETP" variable indicated the reported frequency of playing out on the streets. Of the total sample 171 (27%) reported that they played in the street frequently (ie. everyday) and 461 (73%) reported that they either did not play in the street at all or played in the street less frequently than daily. Children who reported that they played in the streets frequently were more likely to be involved in an accident compared to children who said that they played in the street infrequently, χ^2 = 4.4, df 1, $p < .05$ (Table 43). Children in the highest group were least likely to

report playing in the street frequently. Progressively more children played frequently in the street the lower the socio-economic group, with children in group DE/OTHER being most likely to report frequent street play χ^2 =7.9, df 2, $p<.05$ (Table 44).

Table:43

Accident involvement by child's reported frequency of street play (number and percentage of respondents in each sample group)

	"infrequent"	"frequent"
no accident	363 (75%)	120 (25%)
accident	101 (66%)	51 (34%)

Table:44

Socio-economic group by frequency of street play (number and percentage of child respondents in each SEG)

Socio-economic Group:	"infrequent"	"frequent"
ABC1	208 (78%)	58 (22%)
C2	129 (72%)	50 (28%)
DE/other	124 (66%)	63 (34%)

6.1.16 The relationship between adult accompaniment on the school journey and 1) accident involvement and 2)socio-economic status

The "TACCOMP" variable indicated whether or not a child was accompanied by an adult on a school journey whatever their mode of transport to school. Overall 348 (55%) children were accompanied by an adult on a school journey. There was no significant interaction between accident involvement and adult accompaniment on the school journey. There was a significantly higher proportion of children in the lower socio-economic groups who were not accompanied by an adult compared to those in the highest group χ^2 =5.6, df 2, $p<.05$ (Table 45).

Table:45
Socio-economic group by adult accompaniment on a school journey (number and percentage of child respondents in each SEG)

Socio-economic Group:	"accompanied by adult"	"unaccompanied by adult"
ABC1	161 (61%)	105 (39%)
C2	93 (52%)	86 (48%)
DE/other	94 (50%)	93 (50%)

6.2 Home environment variables: relationship to accident involvement and socio-economic status

The home environment was selected for the analysis instead of the school journey route environment data because in this study relatively few accidents (22% of all accidents) had happened on the school journey. A second important factor in this decision was a recent study of pedestrian activity and accident risk carried out by Ward et al (1994). This examined the relative accident risk for pedestrians of different ages and gender travelling in different road environments and showed that for the 5-9 year old age group 80% of casualties occurred within 1km of their home, with over half being injured under 400m from home. For the 10-15 year old age group two thirds were injured under 1km from home and 40% were within 400m of home.

The variables used in this analysis were:
type of road
vehicle access on road
tenure and age of housing[2]
adjacent land use on road
presence of obstructive on-street parking.

6.2.1 The relationship between road type and 1) accident involvement and 2)socio-economic status

[2] The 1918-1939 and 1945-1960 housing age categories were combined because there was little difference in the size or direction of effects between them.

Overall only 6% (33) of children lived on main roads. There was no significant interaction between accident involvement or socio-economic status and the type of road a child lived on.

6.2.2 The relationship between road access and 1) accident involvement and 2)socio-economic status

Of the total sample only 195 (36%) lived on a road closed to through traffic. Children who lived on roads with through traffic access were more likely to be involved in accident compared to children who lived on a road closed to through traffic, χ^2 = 15.7, df 1 $p < .0001$ (Table 46). There was no significant relationship between road access and socio-economic status.

Table:46

Accident involvement by vehicle access on road in which child lives (number and percentage of respondents in each sample group)

	"through"	"closed"
no accident	255 (60%)	173 (40%)
accident	88 (80%)	22 (20%)

6.2.3 The relationship between housing age and housing tenure and 1) accident involvement and 2)socio-economic status

Of the total sample 210 (39%) lived in housing estimated to have been built before 1914 of which most (95%) was privately owned at the time of building, 205 (38%) lived in housing built between the 1918 and 1960 of which 61% was built by the local authority, 120 (22%) of the sample lived in housing estimated to have been built after 1960 of which most (77%) was privately owned at the time of building.

Children who lived on roads in which the predominant age of the housing was pre-1960 were more likely to be involved in an accident compared to children who lived on roads in which the housing was built later ,χ^2 =10.7, df 2, $p < .05$ (Table 47). A significantly higher proportion of respondents in the lower socio-economic groups lived on a road with predominantly pre-1914 housing compared to the highest socio-economic group who were the most likely to live on a road with modern development χ^2 =21.5, df 4 $p < .001$ (Table 48).

Table:47

Accident involvement by age of housing on road in which child lives (number and percentage of respondents in each sample group)

	pre-1914	1918-1960	1960+
no accident	160 (38%)	158 (37%)	108 (25%)
accident	51 (46%)	48 (43%)	12 (11%)

Table:48

Socio-economic group by age of housing on road in which child lives (number and percentage of respondents in each SEG)

Socio-economic Group:	pre-1914	1918-1960	1960+
ABC1	73 (32%)	82 (36%)	72 (32%)
C2	66 (43%)	59 (39%)	27 (18%)
DE/other	71 (46%)	64 (41%)	21 (13%)

6.2.4 The relationship between adjacent land use on road and 1) accident involvement and 2)socio-economic status

Nearly all children (98%) lived on roads where the adjacent land use was residential. There was too little data for other land uses to establish a significant interaction between road type and land use on the address road and accident involvement or socio-economic group. (NB. For the purposes of further analysis the 'mixed' and 'commercial' categories were combined).

6.2.5 The relationship between parking level on road and 1) accident involvement and 2)socio-economic status

More children (69%) lived on a road where there was no obstructive parking than on roads with obstructive parking. Children who lived on roads in which there was no obstructive parking were more likely to be involved in accidents compared to children who lived on a road with obstructive parking ,$\chi^2 = 32.7$, df 1 $p < .0001$ (Table 49). A smaller proportion of children in group ABC1 lived on a road with obstructive parking compared to children in the lower groups with those children in the lowest group being most likely to live on a road with obstructive parking $\chi^2 = 6.9$, df 2, $p < .05$ (Table 50).

Table:49

Accident involvement by presence of obstructive on street parking on road in which child lives (number and percentage of respondents in each sample group)

	"no obstructive parking"	"obstructive parking"
no accident	267 (63%)	159 (37%)
accident	101 (91%)	10 (9%)

Table:50

Socio-economic group by presence of obstructive parking on road in which child lives (number and percentage of respondents in each SEG)

Socio-economic Group:	"no obstructive parking"	"obstructive parking"
ABC1	168 (74%)	59 (26%)
C2	104 (68%)	49 (32%)
DE/other	95 (61%)	60 (39%)

6.3 Summary

The picture which emerges from the univariate analysis is that the majority of the explanatory variables are strongly associated with accident involvement of child pedestrians and that the distribution of the variables across socio-economic groups varies significantly. The social variables which were not significantly related to whether the child had been involved in an accident were the adult carers risk score, total family size and type of accompaniment; the remaining variables were all significantly related to the child's accident involvement. Most variables (not including age and sex of child) varied significantly with the socio-economic group of the child's household with the exception of whether or not there was a disabled family member, the adult carers responsibility score and total family size.

For the environmental variables most variables except road type and adjacent land use on road were related to whether or not the child was involved in an accident. Road type, road access and adjacent land use on road did not differ significantly with the socio-economic status of the household. Only age of housing and level of obstructive parking differed significantly with socio-economic group. The next stage of the analysis involves comparing the relative importance of each of these variables in explaining accident involvement. To assess the effect of these variables simultaneously multivariate techniques are required which are described next in Chapter 7.

CHAPTER 7

INTRODUCTION TO THE LOGISTIC REGRESSION MODEL

7.1 Introduction

Logistic regression describes the relationship between an outcome or a dependent variable and a set of independent variables or covariates. The key quantity being modelled is the estimated value of the outcome variable given the value of the independent variables, a quantity called the conditional estimate. The logistic distribution function is used to analyze a dichotomous outcome because it is an easily used and flexible mathematical function and it can provide direct interpretations in terms of the probabilities of the two outcomes (ie. in the present context it can estimate relative risk).

The conditional distribution of the outcome variable is binomial because it describes the proportion or relative frequency of the two outcomes in a population, with the probability determined by the conditional estimate.

The logistic regression model is a non linear function of a linear expression in the independent variables. A statistical algorithm is used to check for the importance of variables on the basis of fixed decision rules. Parameter estimation is achieved using the maximum likelihood (ML) method, ie. parameters are selected which agree most closely with observed data in the sense that the maximum likelihood estimate of a parameter is that value of the parameter which maximises the likelihood of the given observations. With computer software ML estimates are made by means of a series of iterative calculations to determine the required values of the parameters without being constrained to use summary measures like means and variances which can produce less accurate descriptions of the data. The ML technique also has the advantage that it provides a test of the hypothesis that a number of common parameters are sufficient to describe the data against an alternative that more parameters are required.

The linear expression in the independent variables estimates the logarithm of the ratio of probability of an event occurring to the probability that it will not, ie. the log of the odds ratio, or logit. Therefore each regression coefficient represents the change

in the log odds associated with a one unit change in the corresponding independent variable.

In this study the test whether a regression coefficient is significantly different from zero is based on the Wald statistic which has a chi-square distribution. The Wald test compares the maximum likelihood estimate of the regression coefficient β_1 to an estimate of its standard error. The resulting ratio, under the hypothesis $\beta_1=0$ will follow a standard normal distribution, and

$$W=\left(\frac{\beta_1}{\hat{SE}(\hat{\beta}_1)}\right)^2$$

a chi-square distribution. The likelihood ratio is the ratio of the likelihood of the observations under the current model to their likelihood under a saturated model ie. a model which contains as many parameters as datapoints. The logarithm of the likelihood multiplied by -2 has a chi-square distribution under the hypothesis that the current model accounts for all systematic variation in the observations.

The corresponding test of the hypothesis that including an additional variable in the model improves explanation of the data is based on the difference between the log likelihood chi-square for the existing model and that of a model containing the additional variable. In other words this tests whether the model that includes the variable tells us more about the observed values of the outcome variable than the model without it.

7.2 Model building strategy

The aim of statistical modelling is to be able to describe the relationship between the outcome variable and covariates clearly with the minimal number of parameters. The modelling process therefore starts with the assumption that all covariates and interactions between them for which data are available may be significant explanators of the data, subject only to the number of parameters not exceeding the number of subjects ie. with a fully saturated model, and proceeds to eliminate covariates and

their interactions until a few parameters can provide a plausible explanation of the relationship between the outcome variable and the covariates i.e to specify a parsimonious model. The criterion for the inclusion or exclusion of a variable during the automatic stepwise modelling procedure was the value of the Wald statistic. The default significance level for including a parameter was 0.1. If the resulting model contained a large number of parameters which made the model unparsimonious or difficult to explain the model was manually fine tuned excluding parameters significant at less than 0.0599. In practice, this significance level meant that some terms of borderline significance, but of interest as explanatory variables, could be retained.

7.3 Data screening

With logistic regression a number of numerical problems can occur with one of the most important being a zero cell frequency. A zero cell frequency means that the point estimate for one of the odds ratios will be either zero or infinity, which causes undesirable numerical outcomes. For this reason before the modelling procedure began the covariates were cross tabulated with the outcome variable, and covariate response levels were combined in meaningful ways to avoid these problems.

7.4 Stepwise procedure

For this study backward stepwise modelling was used. This method starts with all of the variables in the model and at each step variables are evaluated for removal and reentry.

The data was coded using the deviation coding which compares the effect of each category to the average effect of all of the categories. Thus the resulting coefficient represents the difference from the average. Where there are two categories the resulting coefficients are equal and opposite, and where there are more than two categories the coefficients sum to zero.

7.5 Model evaluation

The goodness of fit of the final model is assessed by inspection of summary measures of the difference between the observed and fitted values, of which the deviance is

one. The probability of the observed results given the parameter estimates is known as the likelihood. In logistic regression -2 times the log of the likelihood (-2LL) is used as a measure of how well a model fits the data. Under the null hypothesis that the model accounts for all systematic variation in the observations, -2LL has a chi-square distribution with N-p degrees of freedom, where N is the number of observations and p the number of parameters estimated. With this measure of deviance if the probability of a value at least as great as that observed is large the null hypothesis cannot be rejected.

7.6 Application of logistic regression to the data

Logistic regression was used in this study to estimate from a set of independent variables the probability of a child being in the accident sample given that it is in one of the two samples. Logistic regression models the log of the 'odds' ratio, where the 'odds' ratio is the ratio of the probability of being in the accident sample to the probability of not being in the accident sample. This transformation produces a dependent variable which is continuous and unbounded. In this study the relative importance of more than one independent variable is being investigated and so the model can be written as

$$\log\left(\frac{Probability(accident)}{Probability(control)}\right) = \beta_0+\beta_1X_1+\beta_2X_2+\ldots..+\beta_pX_p$$

where $X_1 \ldots X_p$ are independent variables and $\beta_1 \ldots \beta_p$ their associated coefficients.

It is usual to represent the log odds ratio by Z, where

$$Z = \beta_0+\beta_1X_1+\beta_2X_2+\ldots..+\beta_pX_p$$

The probability of being in the accident sample can be written as,

$$Probability(accident) = \frac{1}{1+e^{-z}}$$

and, $\quad Prob(control) = 1-Prob(accident).$

As mentioned in Section 8.1 the parameters $\beta_0, \beta_1, \ldots, \beta_p$ are estimated using the maximum-likelihood (Norusis 1990). If the co-efficient of the variable X_j is positive the odds are increased by a higher value of X_j and if negative the odds are decreased.

The example below using the "FAM" variable (number of children aged under 16

years) in a family shows how the odds of having an accident are calculated. The table below shows the variable "FAM" by accident involvement:

Table: 51

The relationship between accident involvement and number of dependent children showing counts and row proportions

Level of variable	accident	control	total
'2 or less children'	74(.18)	330(.82)	404
'3 or more children'	74(.32)	154(.68)	228
	148	484	632

The odds ratio for being in the accident sample is estimated from these data taken by themselves in the following way:

-if there are 2 or fewer children in a family (response level 1) 74/330 =.18/.82= 0.224

-if there are 3 or more children in a family (response level 2) 74/154 =.32/.68= 0.481

In the logistic regression model the average value of the logarithm of the odds ratio is given by the constant term: in this model, β_0 = -1.114. This differs from the value given directly by the totals in the bottom row of the table because of the non-linearity of the model. The coefficient for the number of children variable is β_1 = 0.3812, with the variable taking the value -1 when there are two or less children and +1 when there are three or more children. The values of Z are thus β_0 plus or minus β_1 and for this example with β_0= -1.114 and β_1 = 0.381, then Z takes the values -0.733 and -1.495. The odds ratios computed from exp(Z) are 0.481 and 0.224 as obtained directly from the data. The β_1 coefficient indicates the effect of the variable FAM in moving the odds ratio away from the average. When the model is multivariate the odds ratios given by the model can no longer be calculated directly from the cell frequencies as they could in this simple example.

7.7 Potential problems

A potential numerical problem with logistic regression analysis is that of colinearities between independent variables. The main problem arising from collinearity is the difficulty of interpreting the coefficients of collinear variables. For example, if two variables are strongly correlated it is difficult to estimate the separate effect of each one as they are both biased. The appropriate test for collinearity is to examine the correlation matrix and the variance/covariance matrix of the estimated parameters. The parameters in the models estimated generally had plausible signs and were statistically significant (at the 95% level) therefore no diagnostic checks for collinearity were thought necessary.

This Chapter has introduced the logistic regression model and illustrated how it can be used to estimate the probability of a child being in the accident sample given that it is in one of the two samples from a set of independent variables. The next Chapter will describe how the data was modelled and how the final model(s) were chosen.

CHAPTER 8

MULTIVARIATE MODELLING APPLIED TO THE DATA

The aim of this Chapter is to describe the approach to logistic regression modelling of the kind described in Chapter 7 as applied to the author's data for the purposes of this thesis and of the report presented to the Department of Transport (DOT) partway through the work (Christie 1995b). The Chapter will conclude with a short comment on the goodness of fit of the selected models leading to a full discussion of the results in Chapter 9.

8.1 Guiding principles for modelling

The guiding principles of modelling were to achieve a final model or a number of different models which met the following criteria:

(1) the model was parsimonious
(2) most of the parameter coefficients were significant (some insignificant main effects had to be included to be able to calculate coefficients in significant interaction terms including that main effect)
(3) the model was not significantly different from a model which contains every covariate (as measured by the deviance)

and that,

(4) the model parameters explained significantly more about accident risk than a model with just a constant term.

There are two main approaches to modelling variables using logistic regression. One approach involves entering all variables and every first order interaction between them, the second involves modelling all variables but including only those interactions of interest. The latter approach is usually preferred because it is more likely to yield a model which can readily be interpreted (Hosmer and Lemeshow 1992). However, for the purposes of the thesis the data were modelled without any presuppositions as to which factors and interactions might be significantly related to accident risk. Firstly the effects of the social variables upon accident involvement were modelled

separately, initially including every possible first order interaction term. Secondly the effects of environmental variables were modelled in the same way and finally the variables included in the final social and environmental models were combined in a single model including every possible first order interaction.

In the analysis for the more immediate purposes of the DOT report, the effects of the social and environmental variables were also modelled separately and the results of these models combined, but in the analysis for that report only those variables or variable interactions already known to be contributory factors in child pedestrian accidents were entered into the model, and therefore far fewer variables were used to model the data. A further model was also developed as a simple test of the research hypotheses. The purpose for choosing this modelling strategy was to investigate the relative effect of these factors to inform road safety policy decisions. The results of this analysis are presented in sections 8.6 to 8.10 in the light of more comprehensive analysis presented in sections 8.2 to 8.5.

The assessment of how effective the model is at describing the variation in the outcome variable, in this case an indicator of accident risk, is made by comparing the observed sample values with those predicted by the model. In logistic regression a summary measure of how well the model fits the data is a statistic known as the deviance. The probability of the observed results given the parameter estimates for a given model is known as the likelihood for that model. The deviance is calculated as minus twice the natural logarithm of the likelihood (-2LL). This statistic is distributed like χ^2 with degrees of freedom equal to the number of observations minus the number of model parameters. The null hypothesis is that the model describes all the systematic variation in the data.

The null hypothesis is given by values predicted by the fitted model. If the model fits well, the distance between the observed and fitted values is small and a large probability of the calculated value of the test statistic being exceeded by chance under the null hypothesis results, meaning that the null hypothesis that the fitted model describes all systematic variation in the data cannot be rejected.

Another measure of how well the selected model accounts for variation in accident risk is the model χ^2 which tests the null hypothesis that the coefficients in the model

except the constant are zero and thus compares a model with selected variables with a model which contains only a constant. The model χ^2 is the difference between -2LL for the latter and former models, and under the null hypothesis is distributed like χ^2 with one fewer degrees of freedom than there are parameters in the model. A high observed level of significance for this statistic means that the coefficients in the model are significantly discrepant from zero and they explain more accident risk than a constant only model.

This Chapter will proceed with a description of how each model was derived and an assessment of how well each model fits the data. For each model the selected parameters which were significant in the model are tabulated showing for each term the regression coefficient (β) its standard error where available (SE), probability of a value of β at least as far from zero occurring by chance under the null hypothesis (Sig) and impact on the odds ratio Exp (β). It should be noted that standard errors for interaction terms are not available from the software used and therefore discussion of these terms is limited to the size and direction of the coefficient. Inspection of the standard errors of the main effects used to calculate interaction terms would suggest that coefficients in the region between -.3 and .3 are probably not significant and will not be commented upon in this Chapter.The parameters are discussed briefly in terms of whether the probability of having an accident is higher or lower than the average probability. A fuller discussion of these results will be carried out in Chapter 9.

A full description of the variables used in this analysis can be found in Chapter 3.

Main effects will be presented in the following order (where applicable):

1. child specific
2. carer specific
3. household specific
4. environment specific

Discussion of the variables fitted as interaction terms and description of the main effects will be presented in the following order:

1. child specific variables interacting with

- other child specific variables
- carer specific variables
- household specific variables
- environment specific variables

2. carer specific variables interacting with
   - other carer specific variables
   - household specific variables
   - environmental specific variables

followed by

3. household specific variables interacting with other household specific variables

and,

4. environmental variables interacting with other environmental variables.

8.1.1 Overview of results

The results have confirmed many of the findings of previous accident studies. Children aged under 11, who are male and have a non-white carer are particularly at risk. Children were more likely to be a member of the accident group if their carers were less able to be responsible for them, if they had several dependent siblings and if their carers did not have typical marital status. Exposure factors which seem important confirm that unsupervised exposure and having less access to a car are important accident predictors. What was interesting is that children who went to clubs after school were much less likely to be members of the accident group. In terms of the environment once again the results confirm previous research indicating that older housing, through roads and land use which was mixed (eg.with shops and residential housing) are predictive of accident group membership. The surprising result of the modelling of the environmental variables was that the absence of obstructive on street parking was a very strong and robust predictor of accident group membership - a finding in direct contradiction to previous studies. These findings will be discussed in greater detail in Chapter 9.

8.2 Modelling the effects of social variables.

Firstly, the effects of social variables on accident involvement were modelled with each variable being entered as a main effect and also as a first order interaction term with every other variable.

The modelling was carried out in a stepwise procedure whereby the model contained all variables then each one was evaluated to see whether or not it is a significant explanator of accident risk. The significance of a variable is based on the Wald statistic. The default significance level for including a parameter was 0.1.

The final model resulting from this run contained a large number of parameters making the model difficult to interpret. Two methods were then used to reduce the number of parameters. Firstly the variables were inspected to see if any could be excluded on the basis that they were redundant ie. another variable was performing almost the same function. Overall, family size was not shown to be a predictor of accident risk and in this study was only used to calculate levels of over crowding. Therefore the "FAMILY" variable was already taken in to account in calculating the crowding variable and not on its own identified as an accident predictor. Therefore it was decided to exclude this variable from the analysis.

The social model was re-run without the variable "FAMILY" this resulted in a model which was more parsimonious and almost as good result as the model including this variable.

Secondly, the number of parameters could be reduced by setting a more stringent significance level. This was done manually after the data was re-modelled excluding the variable "FAMILY" and its interactions. It was decided that only parameters significant at the 0.05 level would be retained in the model.

The model resulting from the automatic procedure included a number of parameter coefficients which were not significant at the chosen criterion .05 level. Some terms were of borderline significance but were of interest so it was decided to retain less significant terms between the range 0.05 to 0.0599. The model did not include main

effects for interaction terms from which interaction coefficients could be calculated. At this point main effects for significant interaction terms were entered into the model. The resulting model was inspected and terms with coefficients which did not meet the relaxed significance level criterion were excluded and the model was refitted. This process was continued until the model included only those variables that were significant as main effects or as interactions together with those whose main effects were not themselves significant but which were part of a significant interaction. The model which resulted from this manual 'fine tuning ' was regarded as the final model. Those parameters that had been selected for removal during the manual model fitting were re-entered separately into the final model to check whether their significance had changed and to reassess whether they should be included in the final model. These variables remained insignificant when re-entered in the model.

The model statistics are shown in Table 52. The model is based on 625 cases[3] of which 149 (24%) were accident involved and 476 (76%) were not accident involved. upon which the analysis is based. These results indicate that the model provides a good description of the relationship between accident risk and the selected covariates. The final social model is shown in Appendix F:1.

Table:52

Model statistics: thesis social model

		degrees of freedom	significance
-2 Log Likelihood χ^2	500.165	592	.9975
Model χ^2	186.371	32	$<.001$

8.2.1 Main effects

The significant main effects for the social model (Table 53) indicated that the probability of being a member of the accident group was higher than the average probability if:

1) the child was aged under 11 compared to being 11 or over.

2) the child was male compared to female.

[3] It should be noted that the sample sizes may vary from model to model as the modelling procedure requires a full set of data for each case otherwise it is omitted. This factor particularly effects the environmental models because there were difficulties in collecting this data - a problem discussed in 3.6.

5) the child did not attend any clubs after school compared to attending one or more.

4) the child's carer had a 'poor' responsibility score compared to a 'good' score.

5) the child's carer had an 'atypical' marital status compared to a 'typical' status.

6) the child lived in a family with three or more dependent children compared to a family with two or fewer.

Table:53
Estimated main effects: thesis social model

Variable	β	Exp (β)	SE	Sig
AGENV-age of child (1) Under 11 (2) Over 11	 .7916 -.7916	 2.2069 .4531	.1995	.0001
NSEX -sex of child (1) Male (2) Female	 .6599 -.6599	 1.9345 .5169	.1497	.0001
CLUBT- membership to clubs (1) No club (2) One or more	 .3351 -.3351	 1.3981 .7153	.1225	.0062
RESPSCOR-carer's responsibility score (1) Good (2) Poor	 -.2725 .2725	 .7614 1.3132	.1278	.0329
MARITAL-carer's marital status (1) Atypical (2) Typical	 .3312 -.3312	 1.3927 .7181	.1291	.0103
FAM-number of dependent children (1) Two or fewer (2) Three or more	 -.3526 .3526	 .7028 1.4228	.1284	.0060

8.2.2 Significant interactions

There were a number of significant interaction terms. The significance level of each interaction term is shown in parenthesis.

(1) Age of child by child's club attendance (p=.0182)

This interaction term (Table 54) indicated that the probability of being a member of

1) the child was under 11 and did not go to any clubs.

A lower than average probability of being in the accident group was indicated if:

2) the child was aged 11 or over irrespective of attendance at one or more clubs.

Table: 54

Estimated effect of Age of child by child's club attendance (thesis social model)

	No clubs attended β (Exp (β))	Attended one or more β (Exp (β))
1) Under 11	1.409 (4.0919)	.1742 (1.1903)
2) 11 or over	-.7388 (.4777)	-.8444 (.4298)

(2) Sex of child by child's frequency of street play (p=.0179)

This interaction (Table 55) indicated that the probability of being in the accident group was higher than the average probability if:

1) the child was male and especially if he plays in the street infrequently.

A lower than average probability of being in the accident group was indicated if:

2) the child was female and played in the street frequently.

Table:55

Estimated effect of sex of child by child's frequency of street play (thesis social model)

	Male β (Exp (β))	Female β (Exp (β))
1) Infrequent street play	.8429 (2.3230)	.2277 (1.2557)
2) Frequent street play	.4769 (1.6111)	-1.5475 (.2127)

(3) Age of child by ethnic origin of carer (p=.0005)

This interaction (Table 56) indicated that the probability of being in the accident group was higher than the average probability if:

1) the child was under 11 and had a non-white carer.

A lower than average probability of being in the accident group was indicated if:

2) the child was aged 11 or over and had a non-white carer.

Table: 56
Estimated effect of age of child by ethnic origin of carer (thesis social model)

	Under 11		11 and over	
	β	(Exp (β))	β	(Exp (β))
1) White	.3573	(1.4295)	-.0425	(.9584)
2)Not White	1.2259	(3.4072)	-1.5407	(.2142)

(4) Age of child by socio-economic group (p=.0274)

This interaction (Table 57) indicated that the probability of being in the accident group was higher than the average probability if:

1) the child was aged under 11 and especially in socio-economic groups ABC1 and DE.

A lower than average probability of being in the accident group was indicated if:

2) the child was aged 11 or over and especially in socio-economic group DE.

Table: 57
Estimated effect of age of child by socio-economic group (thesis social model)

	ABC1		C2		DE	
	β	(Exp(β))	β	(Exp (β))	β	(Exp (β))
(1) Under 11	.9762	(2.6543)	.3520	(1.4219)	1.0466	(2.8479)
(2) 11 and over	-.4314	(.6496)	-.5086	(.6013)	-1.4348	(.2382)

(5) Age of child by number of dependent children in the family (p.0527)

This interaction (Table 58) indicated that the probability of being in the accident group was higher than the average probability if:

1) the child lived was aged under 11 and lived in a family with three or more dependent children.

A lower than average probability of being in the accident group was indicated if:

2) the child was aged 11 or over irrespective of number of dependent children.

Table: 58

Estimated effect of age of child by number of dependent children in the family (thesis social model)

	Under 11		11 and over	
	β	(Exp (β))	β	(Exp (β))
1) Family with two or fewer children	.2001	(1.2215)	-.9053	(.4044)
2)Family with three or more children	1.3831	(3.9872)	-.6779	(.5077)

(6) Age of child by carer's access to a car (p=.0437)

This interaction (Table 59) indicated that the probability of being in the accident group was higher than the average probability if:

1) the child was aged under 11 and especially if the family had no access to a car.

A lower than average probability of being in the accident group was indicated if:

2) the child was aged 11 or over and especially if the family had access to a car.

Table:59

Estimated effect of age of child by carer's access to a car (thesis social model)

	Under 11		11 and over	
	β	(Exp (β))	β	(Exp (β))
1) Access to car	.9519	(2.5906)	-1.1695	(.3105)
2) No access to car	1.4229	(4.1491)	-.4370	(.6459)

(7) Child's club attendance by number of working carers (p=.0039)

This interaction (Table 60) indicated that the probability of being in the accident group was higher than the average probability if:

1) the child did not attend any clubs and had only one working carer.

2) the child attended one or more clubs and had no working carers.

A lower than average probability of being in the accident group was indicated if:

3) the child attended one or more clubs and had one working carer.

Table:60

Estimated effect of child's club attendance by number of working carers (thesis social model)

	No clubs attended β (Exp (β))	Attended one or more clubs β (Exp (β))
(1) Two working carers	.1559 (1.1687)	-.2964 (.7435)
(2) One working carer	.6522 (1.9197)	-1.1326 (.3222)
(3) No working carers	.1981 (1.2191)	.4228 (1.5262)

(8) Frequency of child's street play by level of household crowding (p=.0419)

This interaction (Table 61) indicated that the probability of being in the accident group was higher than the average probability if:

1) the child played in the street infrequently and lived in uncrowded accommodation.

A lower than average probability of being in the accident group was indicated if:

2) the child played in the street frequently and lived in uncrowded accommodation.

Table: 61

Estimated effect of frequency of child's street play by level of household crowding (thesis social model)

	Crowded β (Exp (β))	Not crowded β (Exp (β))
1) Infrequent street play	.1168 (1.1239)	.9538 (2.5955)
2) Frequent street play	.2466 (1.2797)	-1.3172 (.2679)

(9) Presence of a disabled family member by accompaniment of child (p=.0304)

The interaction (Table 62) indicated that the probability of being a member of the accident group is higher than the average probability if:

1) the child or a family member did not have a disability and the child was not accompanied by an adult on the school journey.

A lower than average probability of being in the accident group was indicated if:

2) the child or a family member did have a disability and the child was not accompanied on by an adult on the school journey.

Table:62

Estimated effect of presence of a disabled family member by accompaniment of child (thesis social model)

	Disabled family member β (Exp (β))	No disabled family member β (Exp (β))
1) Accompanied by adult	-.2081 (.8121)	-.0857 (.9179)
2)Not accompanied by adult	-.5885 (.5551)	.8823 (2.4164)

(10) Ethnic origin of carer by presence of disabled family member (p=.0015)

This interaction (Table 63) indicated that the probability of being a member of the accident group was higher than the average probability if:

1) the child had a non-white carer and no family member with a disability.

2) the child has a white carer and a family member with a disability.

A lower than average probability of being in the accident group was indicated if:

3) the child had a non-white carer and a family member with a disability.

Table:63

Estimated effect of ethnic origin of carer by presence of disabled family member (thesis social model)

	Disabled family member β (Exp (β))	No disabled family member β (Exp (β))
1) White	.6921 (1.9979)	-.3773 (.6857)
2)Not White	-1.4887 (.2257)	1.1739 (3.2346)

(11) Number of working carers by socio-economic group (p=.0245)

There was no clear pattern in the relationship between number of working parents, socio-economic group and the probability of being a member of the accident group. However, this interaction (Table 64) term indicated that the probability of being a member of the accident group was higher if:

1) the child had no working carer and belonged to groups ABC1.

A lower than average probability of being in the accident group was indicated if:

2) the child had one working carer and belonged to groups DE.

3) the child had two working carers and belonged to groups ABC1.

The other combinations of number of working carers and socio-economic group were associated with probability values of being in the accident group whose difference could have arisen by chance.

Table:64
Estimated effect of number of working carers by socio-economic group (thesis social model)

	ABC1		C2		DE	
	β	(Exp (β))	β	(Exp (β))	β	(Exp (β))
(1) Two working carers	-.5501	(.5769)	.0452	(1.0462)	.2928	(1.3402)
(2) One working carer	.2446	(1.2771)	-.3036	(.7381)	-.6616	(.5160)
(3) No working carers	1.1227	(3.0731)	.0235	(1.0238)	-.2135	(.8077)

8.3 Modelling the effects of environmental variables

The effects of the environmental variables on accident involvement were modelled in the same way as for the social variables though in this case no variables needed to be excluded on the basis that they were redundant. The model statistics are shown in Table 65. The model is based on 534 cases of which 110 (21%) were accident involved and 424 (79%) were not accident involved. These results indicate that the model provides a good description of the relationship between accident risk and selected covariates. The full environmental model is shown in Appendix F:2.

Table:65

Model statistics: thesis environmental model

		degrees of freedom	significance
-2 Log Likelihood χ^2	427.882	524	.9992
Model χ^2	115.301	9	<.001

8.3.1 Main effects

The significant main effects (Table 66) indicated that the probability of being a member of the accident group was higher than the average probability if:

1) the child lived on a non-arterial road compared to an arterial road.

2) the child lived on a road with access to through traffic compared to a road closed to through traffic.

3) the child lived on a road where there is no obstructive on-street parking compared a road with obstructive on-street parking.

4) the child lived on a road with mixed commercial and residential use compared to a road with residential land use only.

Table:66
Estimated main effects: thesis environmental model

Variable	β	Exp (β)	SE	Sig
ADDTYP-type of road				
(1) Arterial	-.7464	.4741	.3367	.0266
(2) Non arterial	.7464	2.1093		
ADDACC-type of road access				
(1) Through	.4188	1.5202	.1479	.0046
(2) Closed	-.4188	.6578		
ADDUSE- adjacent land use on road				
(1) Residential	-.9206	.3983	.4815	.0559
(2) Mixed residential/commercial	.9206	2.5108		
ADDOBS-Parking level				
(1) Obstructive	-1.4620	.2318	.2047	.0001
(2) Non-obstructive	1.4620	4.3146		

8.3.2 Significant interactions

The only significant interaction (Table 67) term was age of housing by tenure of housing when built (p=.0140).

The interaction term indicated that the probability of being a member of the accident group was higher than the average probability if the child lived on a road with:

1) pre-1914 housing built for private ownership

or

2) housing built between 1918 and 1960 for public renting.

A lower an average probability of being in the accident group was indicated if the

child lived on a road with.

3) housing built before 1914 for public renting.

4) housing built after 1960 for private ownership.

Table:67

Estimated effect of age of housing by tenure of housing when built (thesis environmental model)

	Pre 1914		1918-1960		Post 1960	
	β	(Exp (β))	β	(Exp(β))	β	(Exp (β))
(1) Public	-1.0018	(.2317)	.6514	(1.9182)	-.1725	(.8415)
(2) Private	1.5496	(4.7096)	-.1368	(.8721)	-.8899	(.4107)

8.4 Modelling the effects of social and environmental variables together

Initially all social variables and all environmental variables were entered into the logistic regression including every first order interaction term between them. However, this run was abortive due to numerical problems in the data, namely zero cell counts. It was therefore decided to include in the fitting of the combined model only the variables which had been selected for the final social and environmental models, those interactions which were significant in each separate model and all possible interactions between the social and environmental variables. Therefore this model was still fairly inclusive of the different variables. However the run was again abortive due to zero cell counts for some of the variables, a problem exacerbated by the fact that the number of cases was reduced because environmental data was not available for all of them. The environmental variables were inspected and it was found that "ADDTYP" (type of road upon which child lived) had only 33 children in one cell (arterial roads) and that "ADDUSE" (adjacent landuse on road) had only 11 children living on non-residential roads. These two variables were therefore excluded from subsequent modelling. The re-run of the combined data modelling was successful and underwent the same procedures described in the modelling of the social data. When the omitted variables were checked for re-entry in the resulting model it was found that one of the interaction terms, "STREETP BY CROWDING" (frequency of street play by level of household crowding) should be re-entered.

The model statistics are shown in Table 68. The model is based on 527 cases of which 109 (21%) were accident involved and 418 (79%) were not accident involved.

These results indicate that the model does not significantly differ from a fully saturated model, and the selected parameters are significantly better than a model with only a constant. The full social and environmental model is shown in Appendix F:3.

Table:68
Model statistics: thesis social and environmental model

		degrees of freedom	significance
-2 Log Likelihood χ^2	308.347	490	1.000
Model χ^2	228.906	36	<.0001

8.4.1 Main effects

The significant main effects (Table 69) for the combined social and environmental model indicated that the probability of being a member of the accident group was higher than the average probability if:

1) the child was male compared to female.
2) the child did not attend any clubs after school compared to attending one or more.
3) the child had a non-white carer compared to a white carer.
4) the child lived on a road closed to through traffic compared to a through road.
5) the child lived on a road where there is no obstructive on-street parking compared a road with obstructive on-street parking.
6) the child lived on a road with housing built before 1914 compared to housing built after 1960.

Table:69

Estimated main effects: thesis social and environmental model

	β	Exp (β)	SE	Sig
NSEX -sex of child				
(1)Male	.4065	1.5015	.1610	.0116
(2)Female	-.4065	.6659		
CLUBT membership to clubs				
(1)No club	.4793	1.6149	.1593	.0026
(2)One or more	-.4793	.6192		
ETHNIC-ethnic origin of carer		.4571		
(1)White	-.7828	2.1876	.2343	.0008
(2)Non-white	.7828			
ADDACC-type of road access				
(1)Through	.4745	1.6072	.1942	.0145
(2)Closed	-.4745	.6222		
ADDOBS-parking level				
(1)Obstructive parking	-1.8454	.1579	.3125	.0001
(2)No obstructive parking	1.8454	6.3306		
ADDAGE-age of housing				
(1)Pre 1914	.9831	2.6727	.2913	.0007
(2)Inter war/pre 1960	-.2635	.7683	.2478	ns
(3)Post 1960	-.7196	.4869	.2960	.0150

8.4.2 Significant interactions

There were a number of significant interaction terms.

(1) Parking level by age of child (p=.0170)

The interaction (Table 70) term indicated that the probability of being a member of the accident group is higher than the average probability if:

1) the child lived on a road without obstructive parking irrespective of the child's age but especially if the child was aged under 11.

Lower than average probability of being in the accident group was indicated if:

2) the child lived on a road with obstructive parking irrespective of the child's age but especially if the child was aged under 11.

Table:70

Estimated effect of parking level by age of child (thesis social and environmental model)

	Under 11		11 and over	
	β	(Exp (β))	β	(Exp (β))
(1) Obstructive parking	-2.4817	(.0836)	-1.2091	(.2985)
(2) No obstructive parking	2.4735	(11.8639)	1.2173	(3.3780)

(2) Age of housing by age of child (p=.0077)

The interaction (Table 71) term indicated that the probability of being a member of the accident group is higher than the average probability if:

1) the child lived on a road with housing built before 1914 especially if the child was aged under 11.

A lower than average probability of being in the accident group was indicated if:

3) the child lived on a road with housing built after 1960 irrespective of the child's age.

4) the child lived on a road with housing built between 1918 and 1960 and was aged under 11.

Table:71

Estimated effect of age of housing by age of child (thesis social and environmental model)

	Under 11		11 and over	
	β	(Exp (β))	β	(Exp (β))
(1) Pre-1914	1.631	(5.1089)	.3352	(1.3982)
(2) 1918-1960	-.7977	(.4504)	.2707	(1.3109)
(3) Post 1960	-.8456	(.4293)	-.5936	(.5523)

(3) Frequency of child's street play by level of household crowding (p=.0516)

The relationship between level of household crowding, frequency of street play and accident risk in this model differs from the social model in that there is a stronger effect of frequency of street play for those living in a crowded household. A short comment on how the terms differ from the same terms in the social model is provided in parenthesis below. The interaction (Table 72) term indicated that the probability

of being a member of the accident group is higher than the average probability if:

1) the child played in the street frequently and lived in crowded accommodation (changed from average risk in social model to high risk in the combined model).

2) the child played in the street infrequently and lived in uncrowded accommodation.

A lower than average probability of being in the accident group was indicated if:

3) the child played in the street frequently and lived in uncrowded accommodation

4) the child played in the street infrequently and lived in crowded accommodation (changed from average risk in social model to low risk in combined model).

Table:72

Estimated effect of frequency of child's street play by level of household crowding (thesis social and environmental model)

	Crowded		Not crowded	
	β	(Exp (β))	β	(Exp (β))
1) Infrequent street play	-.4736	(.6227)	.7876	(2.1981)
2) Frequent street play	1.3694	(3.9329)	-.8958	(.4082)

(4) Presence of disabled family member by accompaniment of child (p=.0010)

The relationship between having a disabled family member, level of adult accompaniment and accident risk in this model differs from the social model in that there is a stronger effect of having a disabled family member and being accompanied on a school journey. A short comment on how the terms differ from the same terms in the social model is provided in parenthesis below. The interaction (Table 73) indicated that the probability of being a member of the accident group is higher than the average probability if:

1) the child or family member had a disability and the child was accompanied by an adult on the school journey (changed from average risk in social model to high risk in combined model).

A lower than average probability of being in the accident group was indicated if:

2) the child or family member did not have a disability and the child was accompanied by an adult on the school journey (changed from average risk in social model to low risk in combined model).

3) the child or family member had a disability and the child was not accompanied on by an adult on the school journey.

Having no disabled family member and not being accompanied by an adult on the

school journey changed from high risk in the social model to average risk in the combined model.

Table:73

Estimated effect of presence of disabled family member by accompaniment of child (thesis social and environmental model)

	Disabled family member β (Exp (β))	No disabled family member β (Exp (β))
1) Accompanied by adult	1.1879 (3.2802)	-.7685 (.4637)
2)Not accompanied by adult	-.6577 (.5180)	.2383 (1.2691)

(5) Number of working carers by socio-economic group (p=.0084)

Compared to the social model there is a clearer and stronger relationship between number of working parents, socio-economic group and the probability of being a member of the accident group. A short comment on how the terms differ from the same terms in the social model is provided in parenthesis below. This interaction (Table 74) term indicated that the probability of being a member of the accident group was higher if:

1) the child had no working carer and belonged to groups ABC1 (a stronger effect for this group than in the social model).

2) the child had two working carers and belonged to groups C2 or DE (changed from average risk in social model to high risk in combined model).

3) the child had only one working carer and belonged to group ABC1 (changed from average risk in social model to high risk in combined model).

A lower than average probability of being in the accident group was indicated if:

4) the child had one working carer and belonged to groups C2 or DE

5) the child had no working carers and belonged to groups C2 or DE.

Table:74

Estimated effect of number of working carers by socio-economic group (thesis social and environmental model)

	ABC1		C2		DE	
	β	(Exp (β))	β	(Exp (β))	β	(Exp (β))
(1) Two working carers	.0249	(1.0252)	.4915	(1.6348)	.7235	(2.0616)
(2) One working carer	.7018	(2.0174)	-1.1401	(.3198)	-.4752	(.6218)
(3) No working carers	1.4243	(4.1549)	-.8298	(.4361)	-.9209	(.3982)

(6) Parking level by socio-economic group (p=.0334)

The interaction (Table 75) term indicated that the probability of being a member of the accident group is higher than the average probability if:

1) The child lived on a road without any obstructive parking at all whichever SEG they belonged to but especially if the child belonged to SEG C2.

Lower than average probability of being in the accident group was indicated if:

2) the child lived on a road with obstructive street parking and belonged to SEG C2 or DE.

Table:75

Estimated effect of parking level by socio-economic group (thesis social and environmental model)

	ABC1		C2		DE	
	β	(Exp (β))	β	(Exp (β))	β	(Exp (β))
(1) Obstructive parking	-.2226	(.8004)	-3.2043	(.0405)	-2.1093	(2.0616)
(2) No obstructive parking	1.6566	(5.2414)	2.2187	(9.1954)	1.6609	(5.2640)

(7) Age of housing by socio-economic group (p=.0035)

The interaction (Table 76) term indicated that the probability of being a member of the accident group is higher than the average probability if:

1) the child lived on a road with pre-1914 housing whichever SEG the child belonged

to though the probability was particularly high for children who belonged to SEG DE.

2) the child lived on a road with housing built between 1918 and 1960 and the child belonged to SEG ABC1.

A lower than average probability of being in the accident group was indicated if:

3) the child lived on a road with housing built after 1960 and the child belonged to SEG DE.

4) the child lived on a road with housing built between 1918-1960 and the child belonged to SEG C2.

Table:76

Estimated effect of age of housing by socio-economic group (thesis social and environmental model)

	ABC1		C2		DE	
	β	(Exp (β))	β	(Exp (β))	β	(Exp (β))
(1) Pre-1914	.6469	(1.9096)	.4855	(1.6249)	1.8169	(6.1528)
(2) 1918-1960	1.1857	(3.2729)	-1.6049	(.2009)	-.3713	(.6898)
(3) Post 1960	.3184	(1.3749)	-.3590	(.6984)	-2.1182	(.1202)

(8) Tenure of housing when built by access to a car (p=.0096)

The interaction (Table 77) term indicated that the probability of being a member of the accident group is higher than the average probability if:

1) the child's carer had no access to a car and lived on a road with housing built for private ownership.

A lower than average probability of being in the accident group was indicated if:

2) the child's carer had access to a car and lived on a road with housing built for private use.

Table:77

Estimated effects of tenure of housing when built by access to a car (thesis social and environmental model)

	Public housing		Private housing	
	β	(Exp (β))	β	(Exp (β))
(1) Access to car	.2679	(1.3072)	-.6989	(.4971)
(2) No access to car	-.2877	(.7499)	.7187	(2.0518)

(9) Parking level by number of working carers (p=.0204)

The interaction (Table 78) term indicated that the probability of being a member of the accident group is higher than the average probability if:

1) the child lived on a road with obstructive parking irrespective of number of working carers though especially if the child lived in a family with fewer than two working carers.

A lower than average probability of being in the accident group was indicated if:

2) the child lived on a road with obstructive street parking though especially if the child had just one working carer.

Table:78

Estimated effect of parking level by number of working carers (thesis social and environmental model)

	Obstructive parking β (Exp (β))	No obstructive parking β (Exp (β))
(1) Two working carers	-.5123 (.5991)	1.3303 (3.7822)
(2) One working carer	-2.5646 (.0769)	1.9556 (7.0682)
(3) No working carers	-.8070 (.4462)	2.2503 (9.4906)

8.5 Comparison of the combined model with the separate social and environmental models

The combined model contained two of the six main effects and five of the eleven interaction terms fitted in the social model. Two of the five variables fitted in the environmental model were also fitted in the combined model. Six interaction terms between social and environmental variables were also fitted in the combined model (see Table 79). In terms of the explanatory power of these three models all were very significantly better at explaining accident risk than a model with just a constant term. Also inspection of the likelihood of the observed results given the parameter estimates suggests that none of the parsimonious models differed significantly from a fully saturated model.

Table:79

Summary of estimated effects for the thesis social, environmental and combined social and environmental models

Main effects: Social variables	soc	env	soc+ env
Age of child	√		
Sex of child	√		√
Child's club attendance	√		√
Carers ethnic origin			√
Carers responsibility score	√		
Carers marital status	√		
Number of dependent children in family	√		
Interaction terms: social variables			
Age of child by child's club attendance	√		
Sex of child by child's frequency of street play	√		
Age of child by ethnic origin of carer	√		
Age of child by socio-economic group	√		√
Age of child by number of dependent children	√		
Age of child by carers access to a car	√		
Child's club attendance by number of working carers	√		
Child's frequency of street play by level of household crowding	√		√
Presence of disabled family member by accompaniment of child	√		√
Ethnic origin of carer by presence of disabled family member	√		
Number of working carers by socio-economic group	√		√
Main effects: environmental variables			
Type of road		√	
Type of access on road		√	√
Age of housing			√
Adjacent land use on road		√	
Parking level		√	√
Interactions: environmental variables			
Age of housing by tenure of housing when built		√	
Interactions: environmental and social variables			
Level of obstructive parking by age of child			√
Age of housing by age of child			√
Parking level by socio-economic group			√
Age of housing by socio-economic group			√
Tenure of housing by access to a car			√
Parking level by number of working carers			√

8.6 Modelling the effects of social variables for the DOT report

The modelling of effects of social variables for the DOT report preceded the analysis made for the thesis and was carried out differently. Instead of the approach described in Section 8.1 the starting point for modelling was to include only those variables and interaction terms which had been identified from the literature review as possible predictors of accident involvement. As far fewer variables were included in the analysis the default inclusion criterion was used ($p <= 0.1$). All the social variables and only those interactions shown in Table 80 were included in the initial fitting procedure.

Table:80
Interactions included in the modelling of the social variables (DOT analysis)

Variables
sex of child by age of child
sex of child by child's frequency of street play
sex of child by ethnic origin of carer
age of child by child's frequency of street play
age of child by ethnic origin of carer
age of child by accompaniment of child
socio-economic group by risk score of carer
socio-economic group by responsibility score of carer
socio-economic group by number of dependent children in family
socio-economic group by access to a car
socio-economic group by child's frequency of street play
socio-economic group of carer by level of adult accompaniment on the school journey
risk score of carer by ethnic origin of carer
responsibility score of the carer by ethnic origin of the carer
ethnic origin of carer by accompaniment of child
child's frequency of street play by level of household crowding

The model statistics are shown in Table 81. The model is based on 627 cases[4] of which 149 (24%) were accident involved and 478 (76%) were not accident involved. These results indicate that the model provides a good description of the relationship between accident risk and the selected covariates. The full DOT social model is shown in Appendix F:4.

Table:81
Model statistics: DOT social model

		degrees of freedom	significance
-2 Log Likelihood χ^2	565.754	616	.9269
Model χ^2	121.869	10	$<.0001$

8.6.1 Main effects

The significant main effects (Table 82) for the social model indicated that the probability of being a member of the accident group was higher than the average probability if:

1) the child was aged under 11 compared to being 11 or over.
2) the child was male compared to female.
3) the child did not attend any clubs after school compared to attending one or more.
4) the child's carer had a 'poor' responsibility score compared to a 'good' score.
5) the child's carer had an 'atypical' marital status compared to a 'typical' status.
6) the child lived in a family with three or more dependent children compared to a family with two or fewer.
7) the child had a non-white carer compared to a white carer.
8) the child or family member had a disability compared to not having a disability.
9) the child was accompanied on the school journey by an adult compared to not being accompanied by an adult.

[4] The modelling procedure selects only cases which have full data records for the selected variables that is why this model includes more cases than the social model described for the thesis.

Table: 82
Estimated main effects: DOT social model

Variable	β	Exp (β)	SE	Sig
AGENV - age of child				
(1) Under 11	.7868	2.1963	.1687	.0001
(2) 11 or over	-.7868	.4552		
NSEX -sex of child				
(1) Male	.4350	1.5449	.1103	.0001
(2) Female	-.4350	.6472		
CLUBT-membership to clubs				
(1) No club	.3698	1.4474	.1062	.0005
(2) One or more	-.3698	.6908		
RESPSCOR-carers responsibility score				
(1) Good	-.2066	.8133	.1149	.0722
(2) Poor	.2066	1.2294		
MARITAL-carers marital status				
(1) Atypical	.4029	1.4961	.1090	.0002
(2) Typical	-.4029	.6683		
ETHNIC - ethnic origin of carer				
(1) White	-.4937	.6103	.1499	.0010
(2) Non-white	.4937	1.6383		
FAM-number of dependent children				
(1) Two or fewer	-.3378	.7133	.1095	.0020
(2) Three or more	.3378	1.4018		
DISAB- presence of disabled family member				
(1) Disabled family member	.4377	1.5491	.1363	.0013
(2) No disabled family member	-.4377	.6455		
TACCOMP- level of accompaniment on school journey				
(1) Accompanied by adult	-.3132	.7311	.1335	.0190
(2) Not accompanied by adult	.3132	1.3677		

8.6.2 Significant interactions

Only one significant interaction (Table 83) was found - age of child by ethnic origin of carer (p=.0001). This interaction indicated that the probability of being in the accident group was higher than the average probability if:

1) the child was under 11 and had a non-white carer.

A lower than average probability of being in the accident group was indicated if:

2) the child was aged 11 or over and had either a white or a non-white carer.

Table:83

Estimated effect of age of child by ethnic origin of carer (DOT social model)

	Under 11		11 and over	
	β	(Exp (β))	β	(Exp (β))
1) White	-.3100	(.7334)	-.6774	(.5079)
2)Not White	1.8836	(6.5771)	-.8962	(.4081)

8.7 Modelling the effects of environmental variables for DOT report

The modelling of the effects of the environmental variables for the DOT report was carried out in the same way as described for the social variables in the preceding section. All main effects and only interaction terms which had been identified from the literature review as possible accident predictors were included in the analysis. Again, as the number of variables was not large the default inclusion criterion ($p <= 0.1$) was used. All the environmental variables and only those interactions shown in Table 84 were included in the initial fitting procedure.

Table:84

Interactions included in the modelling of the environmental variables (DOT analysis)

Variables
age of housing by tenure of housing when built
access of traffic on road by parking level
age of housing by access of traffic on road
type of road by parking level
age of housing by parking level
tenure of housing when built by parking level

The model statistics are shown in Table 85. The model is based on 534 cases of which 110 (21%) were accident involved and 424 (79%) were not accident involved. These results indicate that the model provides a good description of the relationship between accident risk and selected covariates. The full DOT environmental model is shown in Appendix F:5.

Table:85
Model statistics: DOT environmental model

		degrees of freedom	significance
-2 Log Likelihood χ^2	435.020	526	.9985
Model χ^2	108.164	7	<.0001

8.7.1 Main effects

The significant main effects (Table 86) indicated that the probability of being a member of the accident group was higher than the average probability if:

1) the child lived on a road with through access to traffic compared to a road closed to through traffic.

2) the child lived on a road where there is no obstructive on-street parking compared to a road with obstructive on-street parking.

Table:86
Estimated main effects (DOT environmental model)

Variable	β	Exp (β)	SE	Sig
ADDACC-Type of road access (1) Through (2) Closed	.3853 -.3853	1.4700 .6802	.1456	.0081
ADDOBS-Parking level (1) Obstructive parking (2) No obstructive parking	-1.4259 1.4259	.2402 4.1616	.2007	.0001

8.7.2 Significant interactions

The only significant interaction (Table 87) term was age of housing by tenure of housing when built (p=.0125). The interaction term indicated that the probability of being a member of the accident group was higher than the average probability if the child lived on a road with

1) pre-1914 housing built for private ownership

or

2) housing built between 1918 and 1960 for public renting.

Lower than average probability of being in the accident group was indicated if the child lived on a road with

3) pre-1914 public housing

4) housing built after 1960 for private ownership.

Table:87

Estimated effect of age of housing by tenure of housing when built (DOT environmental model)

	Pre 1914		1918-1960		Post 1960	
	β	(Exp (β))	β	(Exp (β))	β	(Exp (β))
(1) Public	-1.0018	(.2317)	.6514	(1.9182)	-.1725	(.8415)
(2) Private	1.5496	(4.7096)	-.1368	(.8721)	-.8899	(.4107)

8.8 Modelling the effects of social and environmental variables together for the DOT report

Main effects and interaction terms identified as important in the modelling of the social and environmental variables described above were combined in the initial fitting procedure with interaction terms created between social and environmental variables identified as possible accident predictors in the literature review. The additional interaction terms are shown below in Table 88.

Table:88

Interactions included in the modelling of the combined social and environmental variables (DOT analysis)

Variables
age of child by level of parking on road
child's frequency of street play by level of obstructive parking on road
child's frequency of street play by type of access on road
child's frequency of street play by tenure of housing when built
child's frequency of street play by age of housing
ethnic origin of carer by age of housing
ethnic origin of carer by level of obstructive parking
socio-economic group by age of housing
socio-economic group by level of obstructive parking
socio-economic group by type of access on road

The model statistics are shown in Table 89. The model is based on 533 cases[5] of which 109 (20%) were accident involved and 424 (80%) were not accident involved. These results indicate that the model does not significantly differ from a fully saturated model, and the selected parameters are significantly better than a model with only a constant. The full DOT social and environmental model is shown in Appendix F:6.

Table:89
Model statistics: DOT social and environmental model

		degrees of freedom	significance
-2 Log Likelihood χ^2	383.650	522	1.000
Model χ^2	156.366	10	<.0001

8.8.1 Main effects

The significant main effects (Table 90) for the combined social and environmental model indicated that the probability of being a member of the accident group was higher than the average probability if:

1) the child was aged under 11 compared to being 11 or over.
2) the child was male compared to female.
3) the child did not attend any clubs after school compared to attending one or more.
4) the child's carer had an 'atypical' marital status compared to a 'typical' status.
5) the child lived in a family with three or more dependent children compared to a family with two or fewer.
6) the child had a non white carer compared to a white carer.
7) the child lived on a road with housing built before 1914 compared to housing built after 1960.
8) the child lived on a road where there is no obstructive on-street parking compared to a road with obstructive on-street parking.

[5] The modelling procedure selects only cases which have full data records for the selected variables that is why this model includes more cases than the combined social and environmental model described for the thesis.

Table:90

Estimated main effects: DOT social and environmental model

Variables	β	Exp (β)	SE	Sig
AGENV - age of child				
(1) Under 11	.5828	1.7910	.1782	.0011
(2) 11 or over	-.5828	.5583		
NSEX -sex of child				
(1) Male	.3752	1.4552	.1364	.0059
(2) Female	-.3752	.6871		
CLUBT membership to clubs				
(1) No club	.5551	1.7421	.1324	.0001
(2) One or more	-.5551	.5740		
MARITAL-carers marital status				
(1) Atypical	.4144	1.5134	.1347	.0021
(2) Typical	-.4144	.6607		
FAM-number of dependent children				
(1) Two or fewer	-.3347	.7155	.1347	.0140
(2) Three or more	.3347	1.3975		
ETHNIC-ethnic origin of carer				
(1) White	-.7008	.4961	.1876	.0002
(2) Non-white	.7008	2.0153		
ADDAGE - age of housing				
(1) Pre 1914	.6505	1.916	.2085	.0015
(2) 1918-1960	.1735	1.189	.1835	ns
(3) 1960+	-.8240	.4386	.2402	.0006
ADDOBS -parking level				
(1) Obstructive	-1.3165	.2680	.2085	.0001
(2) Non-obstructive	1.3165	3.7303		

8.8.2 Significant interactions

Only one significant interaction (Table 91) was found - age of child by ethnic origin of carer ($p=.0040$). A higher than average probability of being in the accident group was indicated if:

1) the child was under 11 and had a non-white carer.

A lower than average probability of being in the accident group was indicated if:

2) the child had a white carer.

Table:91

Estimated effect of age of child by ethnic origin of carer (DOT social and environmental model)

	Under 11		11 and over	
	β	(Exp (β))	β	(Exp (β))
1) White	-.6332	(.5308)	-.7681	(.4638)
2) Not White	1.7988	(6.0423)	-.3972	(.6721)

8.9 Hypotheses test model for DOT report

The hypotheses test model was developed to assess in a simple model the main effects of variables which directly tested the research hypotheses formulated at the outset of the study. Therefore the variables "RISKSCOR" and "RESPSCOR" were used to indicate the carer's attitude to their child's safety, the variable "STREETP" was used as an exposure measure and all the environmental variables were included. Variables measuring the age and sex of the child were also included in the initial fitting procedure. No interaction terms were entered into the model. The likelihood and model χ^2 indicate that the model was performing reasonably well (Table 92). The model was based on 534 cases of which 110 (21%) were accident involved and 424 (79%) were not accident involved. The full hypotheses test model is shown in Appendix F:7.

Table:92

Model statistics: DOT hypotheses test model

		degrees of freedom	significance
-2 Log Likelihood χ^2	424.284	528	.9995
Model χ^2	118.899	8	.001

The significant main effects (Table 93) for this model indicated that the probability of being a member of the accident group was higher than the average probability if:

1) the child was aged under 11 compared to being 11 or over.

2) the child was male compared to female.

3) the child played in the street frequently compared to infrequently.

4) the child's carer had a 'poor' responsibility score compared to a 'good' one.

5) the child lived on a road with housing built before 1914 compared to housing built.

6) the child lived on a road with access to through traffic compared to a road closed to through traffic.

7) the child lived on a road where there is no obstructive on-street parking compared to a road with obstructive on-street parking.

Lower than average probability of being in the accident group was associated with

8) housing built after 1960 compared with housing built between 1918 and 1960.

Table:93
Estimated main effects: DOT hypotheses test model

Variable	β	Exp (β)	SE	Sig
AGENV-age of child (1) Under 11 (2) 11 or over	 .3099 -.3099	 1.3633 .7335	 .1240	 .0125
NSEX-sex of child (1) Male (2) Female	 .2515 -.2515	 1.2860 .7776	 .1271	 .0479
STREETP-frequency of street play (1) Infrequent (2) Frequent	 -.3359 .3359	 .7147 1.399	 .1348	 .0127
RESPSCOR-carers responsibility score (1) Good score (2) Poor score	 -.3202 .3202	 .7260 1.3774	 .1325	 .0157
ADDAGE-age of housing (1) Pre-1914 (2) 1918-1960 (3) 1960+	 1.0165 -.0168 -.9997	 2.763 .9834 .3679	 .1912 .1799 .2363	 .001 ns .0001
ADDACC-type of road access (1) Through (2) Closed	 .4605 -.4605	 1.584 .6309	 .1513	 .0023
ADDOBS-parking level (1) Obstructive on street parking (2) No obstructive on street parking	 -1.3626 1.3626	 .2560 3.9063	 .2013	 .0001

8.10 Comparison of the DOT combined model with the separate social, environmental and hypotheses test model

The combined model comprised four of the nine variables fitted in the social model and also included the same interaction term. Two of the three variables fitted in the environmental model were included in the combined model though no interactions were fitted. Two of the three social variables fitted in the hypotheses test model were also fitted in the combined as were all three variables fitted in the environmental model (see Table 94). The estimated effects for all these models are shown in Table 95.

Table:94

Summary of estimated effects for the DOT social, environmental, combined and hypotheses test models

Main effects:social variables	soc	env	soc+ env	hypot heses
Age of child	√		√	√
Sex of child	√		√	√
Child's club membership	√		√	
Adult accompaniment of child on school journey	√			
Carers responsibility score	√			√
Carers ethnic origin	√		√	
Carers marital status	√			
Number of dependent children in family	√			
Presence of disabled family member	√			
Interaction terms: social variables				
Age of child by ethnic origin of carer	√		√	
Main effects: environment variables				
Type of access on road		√		√
Age of housing on road		√	√	√
Level of obstructive parking on road		√	√	√
Interaction terms: environment terms				
Age of housing by tenure of housing when built		√		

Estimated effects for the DOT social, environmental, combined and hypotheses test models

	social		environmental		combined		hypotheses	
Parameter	β	SE	β	SE	β	SE	β	SE
AGENV - age of child								
(1)Under 11	.7868	.1687			.5828	.1782	.3099	.1240
(2)11 or over	-.7868				-.5828		-.3099	
NSEX - sex of child								
(1)Male	.4350	.1103			.3752	.1364	.2515	.1271
(2)Female	-.4350				-.3752		-.2515	
CLUBT - membership to clubs								
(1)No club	.3698	.1062			.5551	.1324		
(2)One or more	-.3698				-.5551			
TACCOMP -level of accompaniment	-.3132	.1335						
(1)Accompanied by adult	.3132							
(2)Not accompanied by adult								
STREETP-frequency of street play							-.3359	.1348
(1)Infrequent							.3359	
(2)Frequent								
RESPSCOR-carers responsibility score	-.2066	.1149					-.3202	.1325
(1)Good score	.2066						.3202	
(2)Poor score								
ETHNIC - ethnic origin of carer								
(1)White	-.4937	.1499			-.7008	.1876		
(2)Non-white	.4937				.7008			
MARITAL-carers marital status								
(1)Atypical	.4029	.1090			.4144	.1347		
(2)Typical	-.4029				-.4144			
FAM-number of dependent children	-.3378	.1095			-.3347	.1362		
(1)Two or fewer	.3378				.3347			
(2)Three or more								
DISAB-presence of disabled family member	.4377	.1363						
(1) Disabled famile member	-.4377							
(2) No disabled family member								
AGE OF CHILD BY ETHNIC ORIGIN	-.3100				-.6332			
(1)White/under 11	1.8836				1.7988			
(2)Non-white/under 11	-.6774				-.7681			
(3)White/over 11	-.8962				-.3972			
(4)Non-white/over 11								
ADDACC-Type of road access			.3853	.1456			.4605	.1513
(1)Through			-.3853				-.4605	
(2)Closed								
ADDAGE-age of housing								
(1)Pre 1914					.6505	.2085	1.0165	.1912
(2)1918-1960					.1735	.1835	-.0168	.1799
(3)1960+					-.8240	.2402	-.9997	.2363
ADDOBS -parking level								
(1)Obstructive			-1.4259	.2007	-1.3165	.2135	-1.3626	.2013
(2)Non-obstructive			1.4259		1.3165		1.3626	
ADDAGE BY ADDTEN								
(1)Pre 1914/public			-1.0018					
(2)Pre 1914/private			1.5496					
(3)1918-1960/public			.6514					
(4)1918-1960/private			-.1368					
(5)Post 1960/public			-.1725					
(6)Post 1960/private			-.8899					

8.11 Overall comparison of the models

In terms of the -2LL χ^2 none of the parsimonious models differed significantly from a saturated model which explains all the variation in accident risk, with the thesis and DOT report models which combine the social and environmental data providing the best models. All of the models were significantly better in explaining accident risk compared to a model which had only a constant term.

In the next chapter the relative importance of individual parameters estimated in the models will be discussed in the context of the research hypotheses with special consideration of the relative impact of social, environmental and exposure variables. In the course of that discussion, the differences between the parameter estimates given by the various models will be considered.

CHAPTER 9

DISCUSSION

9.1 Model choice

The multivariate analysis described in Chapter 8 was based on two very different rationales for modelling the data. In the first instance, the data was modelled for the Department of Transport. The aim of this analysis was to look at the relative risk associated with social, economic and environmental variables which were already *known* to be linked to child pedestrian accident involvement in order to help prioritize policy decisions. The modelling rationale used for the purposes of the thesis was not circumscribed by any customer led requirements. The aim of the analysis for the thesis was not just to look at the relative risk as affected by known risk factors but furthermore to explore the relationships between accident risk and all the social and environmental variables on which data had been gathered in the hope of discovering hitherto *unknown* relationships between these variables and child pedestrian accident risk.

The focus of this discussion will be on the combined socio-economic and environmental model developed in Section 8.4 of the thesis for a number of reasons:

1) Firstly, the variables were modelled separately as a first stage of the analysis only because the available software was not able to cope with all the variables (and each interaction between them) in a single run. This stage enabled important variables to be distinguished from less important variables, thus reducing them to a manageable number.

2) If either the social or the environmental model were to be discussed separately then it would not be possible to take into account the possibility that a social variable may be acting as a proxy for an environmental variable or vice versa.

3) Finally, the aim of this thesis is to describe child pedestrian accident risk from a holistic perspective and to describe the models separately would seem to counter this aim.

Therefore the rationale behind the social and environmental thesis model seemed most

likely to reveal new relationships and enable relative risk to be examined from a truly holistic standpoint. In doing so, it would also put previously detected relationships into a wider context.

9.2 Evidence to support hypotheses

The key aim of this research study was to investigate why children in the lowest socio-economic group were significantly more likely to be killed or injured as pedestrians than their counterparts in the higher socio-economic groups. Based on evidence compiled from the literature review it was clear that there were social, economic and environmental factors which may explain the relatively high incidence of children from low socio-economic groups as child pedestrian casualties. The study aimed to construct a holistic description of child pedestrian accident involvement, looking at the relationships between socio-economic classification and other social and environmental factors. The discussion will focus on what evidence there is to support or reject the research hypotheses formulated at the outset of the study namely:

1. Children from low socio-economic groups are more exposed to traffic as pedestrians than children from higher socio-economic groups.

2. The parents or adult carers of children in low socio-economic groups are less able to be responsible for their children in traffic and less informed about risk compared to the parents or adult carers of children in higher socio-economic groups.

3. The traffic environments to which child pedestrians from low socio-economic groups are exposed are less safe than those to which children from higher socio-economic groups are exposed.

Whilst the findings will be discussed in terms of these three hypotheses for presentational purposes it is recognised that many of the accident factors are interrelated, which will be noted throughout the discussion. Factors which seem to protect the child from being involved in a pedestrian accident (ie. associated with a lower than average risk) will also be discussed as they have clear importance for the development of countermeasures.

9.2.1 Exposure

Hypothesis: Children from low socio-economic groups are more exposed to traffic as pedestrians than children from higher socio-economic groups.

Exposure related variables were important in explaining the accident involvement of child pedestrians in the lowest socio-economic groups. A predisposition to accident group membership was indicated if the child did not attend any clubs after school, if they played in the street frequently and lived in crowded accommodation or if their carer did not have access to a car but lived in housing built for private ownership. All three of these factors are more likely to be associated with low socio-economic status. Adult accompaniment of a child with a disabled family member also indicated a predisposition to membership of the accident group, though the likely causal mechanism does not seem to be explained by socio-economic status.

(1) Club membership

Children who do not attend any clubs after school had a higher than average probability of being in the accident group. Children in the lowest socio-economic groups were significantly less likely to attend any clubs after school. The association between accident involvement, club membership and socio-economic status may be related to qualitative differences in exposure. Attending clubs is generally an after school activity carried out with peers, arranged and supervised by adults. A child who does not have access to club facilities may be more likely to be involved in unsupervised activities like playing out with their peers in the street. Earlier analysis for the DOT (Christie 1995b)indicated that children who did not go to any clubs were significantly more likely to report playing in the street everyday. It is interesting to note that investigation of the accident circumstances showed that 35% of the under eight year old accident victims reported that they were playing in the street at the time of the accident. This finding confirms the findings of Preston (1972;1976) and Sharples et al (1990) who indicated that unsupervised street play was a main contributory factor in child pedestrian casualties.

The reasons that children from low socio-economic groups are significantly less likely

to attend clubs after school may related to either values, income or family structure variables. It has been argued (Klein 1980) that membership of clubs is a middle class value channelling children's activity and teaching new skills and values associated with club membership. Alternatively low income may influence the ability of carers to provide their child with access to club facilities. Membership to clubs can be costly and often require transport to and from the venue - two economic factors which militate against low socio-economic groups.

(2) Street play

Frequency of street play was fitted in the model as an interaction with level of household crowding . Accident group membership was most strongly predicted for crowded households and children who played frequently in the street both of which are related to low socio-economic status. This finding is in agreement with previous research by Preston who found that children in overcrowded accommodation were more likely to play in the street.

(3) Car ownership

Higher than average risk of being in the accident groups was associated with children whose carers did not have access to a car and lived in housing originally built for private ownership. Children in the lowest socio-economic group are significantly less likely to have access to a car compared to other children. Not having a car may mean that a child is more exposed to traffic as a pedestrian. This finding is similar to that of Harland et al (1996) who found that high rates of child pedestrian casualties in Scotland were predicted by low levels of car ownership which they argued "..is the direct effect of more exposure to pedestrian travel as a consequence of the absence of an alternative..".

(4) Adult accompaniment

Another measure of exposure of children to traffic is whether or not they were accompanied by an adult on the school journey. This variable was fitted as an interaction term with presence of a disabled family member. Increased likelihood of being in the accident group was associated with being accompanied by an adult on a

school journey and having a disabled family member. The relationship between this finding and socio-economic status is not clear. One explanation of this effect is that the accompaniment of an adult had not been adequately protective of the child and that this could be related to the child's disability. Earlier analysis of this data for the DOT had shown that of the 34 accident involved children who were in families where there was a disabled member 15 of these children were in fact the family member with the disability and over half of these (9) suffered from some level of hearing deficit. The incidence of reported hearing loss among the accident involved sample was much greater than that in the control sample and much higher than the national average (RNID 1994). Hearing deficit has been identified as an accident predictor in earlier studies (SDD 1989). An alternative mechanism of risk may be that the accompanying adult had a disability which affects their ability to provide adequate protection of the child.

Interactions between the disability variable and other variables is difficult to interpret because of the way in which variable was coded. The family member who had a disability could have been the child respondent, the carer, the carer's partner or some other relation in the family therefore this group of people may have been fairly disparate in terms of their age and status in the family.

It was thus not possible to disaggregate this group in terms of whether the disabled persons in the households were children or adults but it is clearly important to look at the relationship further to assess the underlying mechanisms associated with disability and accident risk to children living in households where it is present.

9.2.2 The carer

Hypothesis: The parents or adult carers of children in low socio-economic groups are less able to be responsible for their children in traffic and less informed about risk compared to the parents or adult carers of children in higher socio-economic groups.

The child's carer was also important in explaining the accident involvement of child pedestrians in the lowest socio-economic groups. A predisposition to accident group membership was indicated if the child had a non white carer, a characteristic

significantly associated with low socio-economic status. A predisposition toward accident group membership was also indicated for children in socio-economic groups C2 and DE with two working carers and for children in group ABC1 with no working carers.

(1) Ethnic origin

Having a carer with a non-white ethnic origin was an indicator of a child's predisposition to accident group membership clearly related to socio-economic group. The lowest group comprised a significantly greater proportion of non-white carers compared to the higher groups.

The ethnic effect is similar to that reported by Lawson (1990) who found that Asian pedestrians aged under nine were more than twice as likely to be killed than their white counterparts. In this sample over half of the non-white carers described themselves as from Asian origin and there is some evidence (Laungani 1989) that religious and cultural factors may influence attitudes to the risks their children face in traffic. Whilst the risk score variable was not fitted in any of the models, an earlier analysis of this data for the DOT (Christie 1995b) found that non-white carers were more likely to have a poor risk score compared to white carers - a difference which was highly significant.

To avoid ethnocentric assumptions about differences in risk perception between ethnic groups it is important to mention that this result may have been influenced by methodological and language factors. The home interviews were carried out by white middle class women who were not speakers of any Asian languages. Debriefing sessions with the interviewers indicated that the carer's children had on occasion acted as translators, a factor which may have influenced the results. Future research into the relationship between ethnicity and accident risk may need to deploy link workers trusted by the community and who speak their language to avoid these problems. Language barriers may also limit the safety information available to ethnic minority communities. Research by ROSPA into the safety information needs of ethnic minority groups in the UK (ROSPA 1993) has indicated that ethnic minority groups feel that the majority population is not sensitive to their special information needs and language difficulties.

(2) Work status of carers

Number of working carers in a household was fitted in an interaction with socio-economic group. A predisposition to accident group membership was indicated for children in socio-economic groups C2 and DE with two working carers and for children in group ABC1 with no working carers. The former effect may be explained by many factors associated with low income levels (low car ownership, little club membership, lack of adult accompaniment) which lead to unsupervised road use. The latter effect, having no working carers and being in a high group, may be related to loss of income or other stresses in the family which may influence the exposure of the child or influence the behaviour of the child.

It is a limitation of the study that number of working carers is only a rough proxy for income levels so it is difficult to evaluate the effect of limited income on accident risk.

9.2.3 The environment

Hypothesis: The traffic environments to which child pedestrians from low socio-economic groups are exposed are less safe than those to which children from higher socio-economic groups are exposed.

The environmental variables proved to be some of the strongest indicators of predisposition towards accident group membership. Age of housing was the only such environmental indicator clearly related to low socio-economic status and its effects on accident involvement was found to depend significantly upon socio-economic status. Other environmental predictors like living on a through road or where there was little obstructive parking were indicators of predisposition towards accident group membership that were not clearly related to socio-economic status, but the effect of obstructive parking on accident involvement was found to depend significantly upon socio-economic status.

(1) Age of housing

The age of housing on the road where the child lived was an important indicator of predisposition toward accident group membership associated with socio-economic group. Older housing built before 1914 for private ownership was associated with a higher than average probability of being in the accident group. This effect was largely confined to children under the age of 11 and was strong irrespective of socio-economic group but particularly so for children in groups D and E. Living in housing built for private ownership and not having access to a car was also an indicator of predisposition toward accident group membership. A possible explanation of this effect is that children whose carers do not have access to a car may, as well as making more journeys on foot, have high exposure to more hazardous environments such as roads with housing built before 1914. Children in the lowest socio-economic group are least likely to have access to a car and most likely to live in housing built before 1914, which was nearly all built for private ownership. Similarly this finding may help to explain the ethnicity effect as people in non-white ethnic groups are most likely to live in older inner city housing and have low economic status (Lawson 1990).

Modern housing developments (post 1960) are clearly associated with reduced accident risk for child pedestrians, a finding which concurs with previous research (eg. Ward et al 1994). The low risk of modern housing road layouts is likely to be associated with the use of short loops and culs-de-sac which reduce vehicle speed and the levels of through traffic, as well as with the partial separation of routes for pedestrians and vehicles.

(2) Parking

One of the strongest predictors of accident group membership was absence of obstructive parking. This effect was found in both age groups but was especially strong for children under the age of 11. It was also found in all social groups but was especially strong in socio-economic group C2. The effect was strong for each number of working carers but its strength was greater the fewer working carers there were in the child's household. The parking effect found in this study is unexpected as previous research (eg. Lawson and Edwards 1991) found that children under the age of 11 are masked from the drivers viewpoint by parked cars and may 'dart out' from between them, and in these ways parked cars represent a high risk to young children.

It may be that socio-economic status explains this effect in so far that the carers in the lowest socio-economic group are least likely to have access to a car and therefore there are fewer cars parked on the roads outside their homes compared to more affluent car owning families. Another explanation of this apparent contradiction may be that in previous studies the parked car factor referred to the traffic environment at the time of the child's accident whereas in this study the parking variable is an approximate characterisation of the local traffic environment.

The type of access on the road may have influenced the parking effect as a significantly larger proportion of accident involved children lived on roads with through access than was the case for the control sample and these roads may be subject to greater parking restrictions compared to roads without through traffic. Another explanation of this effect is that, particularly on through roads, high levels of parking have a protective role acting as a barrier segregating pedestrians from traffic, and reducing road width and vehicle speed.

In the description of the accident circumstances by the children and carers in the current study speeding vehicles were more often mentioned as a cause of the accident than obstructive parking. It is possible that on through and long loop roads the removal of obstructive parking may increase vehicle speed and pose a greater threat to pedestrian safety compared to the same road with obstructive parking, though the relative risk associated with these factors needs further exploration.

(3) Type of access on road

Living on a road where there was through traffic was also an indicator of predisposition toward accident group membership. The univariate analysis showed no relationship between access on roads and socio-economic group, though children from the lowest socio-economic group are most likely to live in older housing developments which are least likely to have roads closed to through traffic.

9.3 Sex differences

Irrespective of socio-economic group it is clear that being a boy is associated with a higher than average probability of being in the accident group. Previous research has

indicated that the over representation of boys does not seem to be explained by exposure alone. Ward et al (1994) have shown that for 5-9 year old pedestrians using number of casualties as the numerator and kilometres travelled as the denominator boys are still one and a half times more likely to be injured as pedestrians crossing the road than girls.

The high incidence of accidents involving boys may be explained by risk-seeking aspects of their behaviour which is qualitatively different to the behaviour of girls. Evidence to support this hypothesis comes from work on young offending which found that boys are much more likely than girls to report adopting risky behaviour like truancy, vandalism and substance abuse (Graham and Bowling 1995). Whilst these acts are at the extreme end of the spectrum of deviant behaviour these results are indicative of the greater propensity of boys to accept risks compared to girls. Truancy in particular is likely to increase the unsupervised exposure of the child to risk from traffic though the author is not aware of any research into child pedestrian accidents and truancy.

The accident involvement of boys may also be explained by their carers' allowing them greater exposure to risk from traffic. There is some evidence that young boys may be given more licence to travel independently of adults compared to girls (Hillman et al 1990).

9.4 Bias

It is possible that some of sampling biases discussed in Chapter 4 could account in part for the results discussed above. In order to estimate how much the observed results may have been influenced by sampling bias simple single factor risk ratios were calculated to look at the difference between the biased estimate and an unbiased estimate. The unbiased estimate was calculated by adjusting the relevant numbers in the control sample by what would have been expected if the proportions were to match the appropriate census or STATS 19 estimate. Comparison of the biased risk ratio with the unbiased risk ratio provided a rough numerical estimate of the extent to which the bias could account for the observed results. Comparison of risk ratios for the ethnic effect showed that the bias against non-whites in the control sample

could account for nearly half of the ethnic effect found in the statistical analysis. Comparison of the risk ratios for the sex effect indicated that the bias in favour of boys in the accident sample could only account for about one sixth of the overall sex effect and the bias in favour of children under the age of 11 in the accident sample could only account for about one fifth of the overall age effect.

A further limitation of the study was that because there were difficulties in achieving a large sample size there were not enough children who had experienced an accident on the school journey to permit a meaningful analysis of the many exposure variables that related specifically to that journey.

Another problem was that the modelling technique used requires a full set of data for a case otherwise the case is omitted from the analysis. The data is reduced mainly for the environmental models and combined social and environmental models because there was not enough information collected or available to code environmental data for the whole sample. The main reasons for this were because of the time and expense involved in collecting this type of data and because some of the road details were unclear. It is possible that the exclusion of cases on the basis of inadequate environmental data might have biased the sample distribution on social and exposure variables which may influence the effects in combined social and environmental models. To check this possibility the accident involvement of the reduced sample was inspected with respect to key variables like age, sex, socio-economic status and ethnic origin. This simple analysis showed that the proportions of accident and non accident involved respondents in the reduced sample were virtually identical to the full sample. Therefore, it seems unlikely that any systematic bias was introduced into the analysis by lack of environmental data for part of the sample.

It should be noted that software problems were encountered in the analysis of the data. The principal problem was that standard errors could not be obtained for the interaction terms. Therefore it was not possible to accurately judge the importance of particular components of the interaction term. Further consultation (by the author) with the software developers indicate that the software is being upgraded to overcome this limitation.

9.5 Countermeasures

In terms of countermeasures, whilst it is not possible to turn boys into girls, put old heads on young shoulders or change the economic infrastructure there are many practical solutions workable in the short term.

Firstly, it is clear that unsupervised exposure is hazardous for children. Carers need to be aware of the risks of allowing young children to play out or make journeys on foot without an adult. However, it seems pointless to make 'finger wagging' prescriptions to carers who are unable to provide a safe environments for their children and cannot afford for them to be involved in supervised activities. Such carers need support and local authorities need to ensure that the traffic environments to which these children are exposed are safe and that the needs of car drivers are subordinate to the safety needs of children. In addition, where there is space available, safe play areas could be developed involving the local community in the design to ensure that the area is perceived as being 'owned' by them.

Furthermore, after school clubs could be set up in areas of socio-economic disadvantage and where transport could be provided to and from club venues. Clubs could be subsidised by multiple agencies as the benefits of containing young under-privileged children and involving them in interesting and challenging activities are likely to reduce the incidence of young offending and help take the pressure off carers preoccupied with dependent children.

Carers of all ethnic origins need to be given information about traffic risks to be able to safeguard their children irrespective of different cultural or religious beliefs. The majority population has a clear responsibility to ensure that safety messages are communicated to all minority groups and via media which are acceptable to them, and also that the safety policies and consequent messages respect ethnic minority cultures.

Carers and health professionals need to be aware of potential heightened accident risk associated with hearing deficit whether it is acute (eg glue ear) or chronic.

Parking restrictions aimed at removing obstructive on street parking may need to be complemented by measures which reduce vehicle speed or afford greater protection to pedestrians such as barriers between the road and footway. Similarly, the principles of partial traffic/pedestrian segregation utilised in modern housing development need

to be incorporated into older housing areas to reduce the amount and speed of through traffic to provide a safer environment for the young pedestrians most at risk.

The DETR's recent White Paper on integrated transport (1998) outlines the government's strategy for developing an integrated and sustainable transport system. Within the paper the government makes its standpoint clear with regard to disadvantaged communities with integrated transport being key to a fairer more inclusive society: "We want to tackle the downward spiral of disadvantage in deprived areas, where difficulties in getting jobs combine with other social and economic problems. Better transport is an essential building block of our New Deal for Communities which will extend economic opportunity, tackle social exclusion and make life better in some of the most rundown neighbourhoods in the country". In this context, measures to reduce the higher accident involvement of children in such areas are a part of better transport.

9.6 Summary

In summary, there is evidence in this study to support all three hypotheses, confirming that it is valuable to look at child pedestrian accidents holistically taking into account factors related to the child, their carer and family structure and the local environment in which they travel. However, it is also important to note that one of the strongest influences found to affect accident risk was the environmental factor related to parking level which in this sample was not clearly related to socio-economic status. The environmental variables are the strongest influences upon accident involvement which suggests that countermeasures aimed at modifying the environment may be most effective at reducing the child pedestrian casualty toll in all areas but particularly in socially disadvantaged ones.

CHAPTER 10

FURTHER RESEARCH

This study has raised a number of issues which need further research.

1) It is important to understand the ethnicity effect and to what extent it can be explained by socio-economic disadvantage, cultural or religious beliefs, exposure or any interrelationship between these factors.

2) The accident risk associated with the absence of obstructive street parking needs to be explained by monitoring the behaviour of traffic before and after parking restrictions and looking at the impact on pedestrian behaviour and safety.

3) The relationship between disability, particularly hearing loss, and pedestrian accident involvement needs to be investigated to look at what particular traffic scenarios are risky for children with disabilities, and what effects disability among other members of their households may have upon the accident involvement of able-bodied children.

4) The accident risk of boys needs to be investigated in relation to how it is affected by carers' attitudes towards their independent exposure to risk and by their behaviour once so exposed.

ACKNOWLEDGEMENTS

I would like to acknowledge and thank the following people for their technical guidance and support during this study:

Richard Allsop, Heather Ward (University of London)

Geoff Maycock and Gordon Harland (Transport Research Laboratory)

Deirdre O'Reilly (Department of Transport)

I would also like to thank Philip Christie and Anne Roberts for their support throughout this study.

REFERENCES

Alwash R H and McCarthy M (1988). Accidents in the home among children under 5: ethnic differences or social disadvantage? *British Medical Journal* 296 21 May pp 1450 -1453.

Ampofo-Boateng K and Thomson J A (1990). Child pedestrian accidents: a case for preventive medicine. Health Education Research: Theory and Practice, 5, 265-74.

Assailly J (1992). The prevention of child pedestrian accidents and road safety education for children: A comparison of various European approaches in the perspective of developmental psychology. Paper presented to FERSI Conference, Berlin, Germany, 1992.

Backett E M and Johnston A M (1959). Social patterns of road accidents to children: some characteristics of vulnerable families. *British Medical Journal*, February 14, pp 409- 413.

Bagley C (1992). The urban setting of juvenile pedestrian injuries: a study of behavioral ecology and social disadvantage. *Acci.Anal & Prev* Vol 24, No.6 pp673-678.

Bennett G T and Marland J (1978). Road accidents in traditionally designed local authority estates. TRRL Report 394, Transport and Road Research Laboratory, Crowthorne, Berkshire.

Björklid P (1992). Children's traffic environment and road safety education from the perspective of environmental and developmental psychology. Paper presented to FERSI Conference, Berlin, Germany 1992.

Bocher W (1978). Why children should be involved in planning the traffic environment as part of the road safety education. *Safety Education* 144, pp 28-30.

Braddock M, Lapidus G, Gregorio D Kapp M Banco L (1991). Population, income, and ecological correlates of child pedestrian injury. *Pediatrics* Vol.88 No.6 December 1991.

Brower S N and Williamson P (1974). Outdoor recreation as a function of the urban housing environment. Environment and behavior, September 1974.

Brown GW and Davidson S (1978). Social class, psychiatric disorder of mother, and accidents to children. *The Lancet* Feb 18th.

Chapman R (1973). The concept of exposure. *Accident Analysis and Prevention*, Vol 5 pp 95-110.

Chapman A J, Foot H C and Wade F M (1980). Children at play. In Osborne D J and Levis J A (1980) Human factors in transport research. Academic Press.

Chapman A J, Wade F M and Foot H C (1982). Pedestrian accidents. John Wiley & Sons.

Chilton T (1985). Children's play in Newcastle upon Tyne. Birmingham: Association for Children's Play and National Playing Fields Association.

Christie N (1995a). Social, economic and environmental factors in child pedestrian accidents: A research review. TRL Project Report 116, Transport Research Laboratory, Crowthorne, Berkshire.

Christie N (1995b). The high risk child pedestrian: socio-economic and environmental factors in their accidents. TRL Project Report 117, Transport Research Laboratory, Crowthorne, Berkshire.

Christie N and Coffey M G (1992). An evaluation of local support for national road safety publicity 1989-1990. TRRL Research Report 362, Transport Research Laboratory, Crowthorne, Berkshire.

David K and Williams T (1987). Health education in schools. Harper and Row.

Department of Environment, Transport and the Regions (1998) A new deal for transport: Better for everyone. A summary of the Government's White Paper.

Department of Transport (1987). Road Safety: the next steps. HMSO, London

Department of Transport (1989). Pedestrians' Safety - new proposals for making walking safer. HMSO, London.

Department of Transport (1990). Children and roads: a safer way. HMSO, London.

Department of Transport (1992). Road Accidents Great Britain 1991: the casualty report HMSO, London.

Division of Injury Control (1990). Childhood injuries in the United States. *American Journal of Diseases of Children*, June 1990 Vol 144. American Medical Association.

Dunn F, Butterfoss, Goodman R M, Wandersman A (1993). Community coalitions for prevention and health promotion. *Health Education Research* Volume 8 number 3 September 1993

Graham J and Bowling B (1995). Young people and crime. Home Office Research Study 145. London: Home Office.

Grayson G B (1975). The Hampshire child pedestrian accident study. TRRL Report LR 668, Transport and Road Research Laboratory, Crowthorne, Berkshire.

Grayson G B (1979). Methodological problems in pedestrian research. PhD.

Harland D G, Murray G and Tucker S (1991).'Road safety Education; Making Safe Connections', Proceedings from Safety 91 J1-J9, Transport and Road Research Laboratory, Crowthorne, Berkshire.

Harland D G, Bryan-Brown K and Christie N (1996). The pedestrian casualty problem in Scotland: why so many?. The Scottish Office Central Research Unit, 1996.

Hillman M, Adams J and Whitelegg J (1990). One false move: a study of children's independent mobility. London: PSI.

Hosmer D W and Lemeshow S (1989). Applied Logistic Regression. John Wiley and

sons.

Howarth C I, Routledge D A, Repetto-Wright R (1974). An analysis of road accidents involving child pedestrians. *Ergonomics* 17, (3), 3199-330.

Husband P and Hinton P E (1972). Families of children with repeated accidents to children. *Archives of Disease in Childhood* 47, 396

Joly M, Foggin P M and Pless B I (1991). Geographical and socio-ecological variations of traffic accidents among children. ICADTS, New Delhi.

Kenchington M J, Alderson G J K and Whiting H T A (1977). An assessment of the role of motion prediction in child pedestrian accidents. TRRL Supplementary Report 320, Transport and Road Research Laboratory, Crowthorne, Berkshire.

Kendrick D (1993). Prevention of pedestrian accidents. *Archives of Disease in Childhood 1993*; 68:669-672.

King D M, Lawson S O, Proctor S, Johal K and Hoyland M (1987). Child pedestrian Accidents in inner areas: patterns and treatment. PTRC Summer Annual Meeting, Seminar D, University of Bath, September.

King W D, Palmisano P A (1992). Racial differences in childhood hospitalized pedestrian injuries. *Pediatric Emergency Care* Vol 8, No 4.

Klein D (1980). Societal influences in childhood accidents. *Accident Analysis and Prev* Vol 12 pp 275-281.

Kloeckner H, Lamm R, Choueiri E M, Mailaender T (1989). Traffic accidents involving accompanied and unaccompanied children in the Federal Republic of Germany. Transportation Research Record 1210. Transportation Research Board, National Research Council, Washington DC.

Knighting F A, Colbourne H V and Grayson G B (1972). A pilot study of child pedestrians in a residential area. Department of the Environment, Department of Transport, TRRL Report TN736, Crowthorne.

Lamm R, Mailaender T, Choueiri E M (1992). Fatality development of vulnerable road user groups in Europe (1980-1989) - Pedestrians, cyclists, the teens and the elderly. Paper presented to FERSI Conference, Berlin, Germany, 1992.

Laungani P (1989). Accidents in children-an Asian perspective. *Public Health* (1989) 103,171-176.

Lawson S D (1989) Traffic collisions in an urban area of Great Britain: a demographic and hierarchic review of road accidents in Birmingham and the West Midlands metropolitan districts. AA Foundation for Road Safety Research and Birmingham City Council. AA Foundation for Road Safety, Basingstoke.

Lawson S D (1990). Accidents to young pedestrians: distributions, circumstances, consequences and scope for countermeasures. AA Foundation for Road Safety Research and Birmingham City Council. AA Foundation for Road Safety, Basingstoke.

Lawson S D and Edwards P J (1991). The involvement of ethnic minorities in road accidents: data from three studies of young pedestrian casualties. *Traffic Engineering and Control*, January.

Lynam D A, and Harland D G (1992). Why does the UK have a comparatively poor child pedestrian safety record? Paper presented to FERSI Conference, Berlin, Germany, 1992.

Mackie A M, Ward H A, Walker (1990). Urban Safety project 3 : Overall evaluation of area wide schemes. TRRL Report 263, Transport and Road Research Laboratory, Crowthorne, Berkshire.

Mackie A M, Hodge A R, Webster D C (1993) Traffic calming: the design and effectiveness of 20 mph zones. PTRC September 1993.

Malek M, Guyer B, Lescohier I (1990). The epidemiology and prevention of child pedestrian injury. *Accident Analysis and Prev Vol 22*, 4, pp 301-313.

Manheimer D I and Mellinger G D (1967). Personality characteristics of the accident repeater. *Child Development*, Vol 38, pp 491-513.

Market Research Society (1991) Occupation Groupings A job dictionary, 2nd Edition.

Mueller B A, Rivara F P, Lii S, Weiss N S (1990) Environmental factors and the risk for childhood pedestrian -motor collision occurrence. *American Journal of Epidemiology*. Vol 132,No 3.

National Playing Fields Association (1989). Mean streets: The crisis on our doorsteps. London: NPFA

Norusis M J (1990) SPSS Advanced Statistics User's Guide. SPSS INC.

OECD (1983). Traffic safety of children. Paris.

Office of Population Censuses and Surveys (1988). Occupational mortality childhood supplement 1979-1980, 1982-1983 England and Wales. HMSO, London.

Office of Population Censuses and Surveys (1994). General Household Survey 1992. HMSO, London.

Parker Morris (1961). Homes for today and tomorrow. Ministry of Housing and local government. HMSO.

Phinney J, Colker L, Cosgrove M (1985). Literature review on the pre-school pedestrian. US Department of Transportation.

Piaget J (1950). The psychology of intelligence, Routledge.

Piaget J and Inhelder B (1956). The child's conception of space. Routledge and Kegan Paul, London.

Pitt R, Guyer B, Hsieh C, Malek M (1990). The severity of pedestrian injuries in children: an analysis of the pedestrian injury causation study. *Accident Analysis and*

Prev Vol 22 No 6 pp 549-559.

Preston B (1972). Statistical analysis of child pedestrian accidents in Manchester and Salford. *Accident Analysis and Prev* Vol 4 pp 323-332.

Preston B (1976). Child pedestrian accidents in Manchester and Salford. Manchester Studies publication.

Proctor S (1992) Accident reduction through area-wide traffic schemes. VTI Rapport 380A. Proceedings of the Conference Road Safety in Europe, Berlin, Germany September 30th -October 2nd, 1992.

Roberts I and Coggan C (1994). Blaming children for child pedestrian injuries. *Soc. Sci. Med.* Vol 38, No 5, pp 749-753.

Roberts I, Norton R, Dunn R, Hassall I and Lee-Joe T (1994). Environmental factors and child pedestrian injuries. *Australian Journal of Public Health 1994*,Vol 18 No.1.

Roethlisberger F J and Dickson W J (1939). Management and the Worker, Harvard University Press.

RoSPA (1993). Safety and minority ethnic communities. RoSPA.

Routledge D A, Repetto-Wright R and Howarth C (1974). The exposure of young children to accident risk as pedestrians. *Ergonomics*, 17, 4, pp.457-480.

Routledge D A, Repetto-Wright R and Howarth C (1976). Four techniques of measuring the exposure of young children to accident risk as pedestrians. Proceedings of International Conference on Pedestrian Safety, Haifa, Israel.

Royal National Institute for Deaf People (1994) Factsheet. RNID, London.

Sadler J (1972). Children and road safety: a survey amongst mothers. OPCS, Social Survey Division, Report SS450, HMSO, London.

Salvatore S (1974). The ability of elementary and secondary children to sense oncoming car velocity. *Journal of Safety Research 1974*, 6, pp 118-125.

Sandels S (1975). Children in traffic. London: Elek Books Ltd.

Schioldborg P (1978). Children in traffic. *Institute of Transport Economics Journal.* June 1978.

Scottish Development Department (1989). Must do better: a study of pedestrian accidents and road crossing behaviour in Scotland. Consultants Report to SDD by MVA Consultancy, Scottish Office, Edinburgh.

Sharples P M, Storey A, Aynsley-Green A, Eyre J A (1990). Causes of fatal childhood accidents involving head injury in Northern Region 1976-86. *British Medical Journal* Vol 301 (24 November 1990) pp 1193-7. .

Simpson H F (1997) National Hospital study of road accident casualties. TRL Report 272, Transport Research Laboratory.

Spear M G, Singh A and Dowling C S (1987). The current state of road safety education in primary and middle schools. TRRL RR 101, Transport and Road Research Laboratory, Crowthorne, Berkshire.

Tight M R (1987). Accident involvement and exposure to risk for children as pedestrians on urban roads. Unpublished PhD Thesis, University College London.

Tight M R (1992). Characteristics and circumstances of child pedestrian accidents. Paper presented to FERSI Conference, Berlin, Germany,1992.

Townsend P and Davidson N (1982). Inequalities in health: The Black Report. Pelican.

Townsend P, Phillmore P, Beattie A (1988). Health deprivation: inequality and the North. Pelican.

Transport and Road Research Laboratory (1977). Road accidents in residential areas. Leaflet LF650, Transport and Road Research Laboratory, Crowthorne.

Tunbridge R J, Everest J T, Wild B R and Johnstone R A (1988). An in-depth study of road accident casualties and their injury patterns. TRRL report RR136-7, TRRL, Crowthorne.

Tursz A, Crost M and Lavaud J (1991). Childhood traffic injuries in France: from epidemiology to preventative measures. Proceedings of the International Conference on Traffic Safety, New Delhi, January 1991. Macmillan India Ltd (New Delhi, 1991) pp 195-198.

Van der Molen H H (1981). Child pedestrian exposure, accidents and behaviour. *Accident Analysis and Prevention*, Vol 13 (3) pp 225-240.

Vinje M P (1978). Children as pedestrians: abilities and limitations. Draft paper for OECD Workshop on Pedestrian Safety Education.

Wadsworth J, Burnell J, Taylor B and Butler N (1983). Family type and accidents in pre-school children. *Journal of epidemiology and community health* 37 pp100-104.

Wallin J A (1979). Child traffic accidents - an investigation of accident factors. *Journal of Social Medicine*, 7, 143-149.

Ward H A (1991). Preventing road accidents to children: the role of the NHS London: Health Education Authority.

Ward H A, Cave J, Morrison A, Allsop R, Evans A (1994). Pedestrian activity and accident risk. AA Foundation for Road Safety Research, AA Foundation for Road Safety, Basingstoke.

Wright J C and Vlietstra A G (1975). The development of selective attention: from exploration to logical search. In Advances in Child development and Behavior (Edited by H W Reese), Vol.10 Academic Press , New York,1975.

APPENDIX:A
THE QUESTIONNAIRES

Interviewer [7 8] Reference [1 2 3 4 5]

use only

9

10

11

12

Good afternoon. I am from the Transport Research Laboratory, which is part of the Department of Transport. I understand that your child was involved in a road accident in and was treated in hospital. We are carrying out a survey about childrens' journeys on the roads.

Thinking back to **before** the accident, what school did you go to?

School attended (full address)

Street

Town

How long had you been at this school?

What class and year were you in?

14

1. Before the accident what time did you usually leave for school in the mornings?

2. How did you usually get to school?

1. walked all the way
2. went some or all the way by bus
3. went some or all the way by private car
4. went some or all the way by bicycle
5. other (please specify)

16

ACC 1

3. Did someone usually go with you to school in the mornings?

17

0. No alone all the way ☐ ***Go to Q4***

1. Yes ☐

3a. *If yes:* Did your parents or other adults go with you?

18

0. No ☐ ***Go to Q3b***

1. Yes ☐ please specify

If yes: Did they usually go all or just part of the way with you?

1. All ☐ 2. Part ☐

3b. Did your brothers and sisters go with you?

19

0. No ☐ ***Go to Q3c***

1. Yes ☐ please specify age & sex

If yes: Did they usually go all or just part of the way with you?

1. All ☐ 2. Part ☐

3c. Did your friends go with you?

20

0. No ☐ ***Go to Q4***

1. Yes ☐ please specify age & sex

If yes: Did they usually go all or just part of the way with you?

1. All ☐ 2. Part ☐

by car or bus?

Write in number [ ] 24

If none, go to Q7

What were the names of these roads in the order you used to cross them?

Involve parent to help child identify road names where necessary.

Road
1
2
3
4
5
6
7
8

5. How many of these roads did you cross on your own? 25

Running prompt

1. all of them [ ]
2. some of them [ ]
3. one of them [ ]
4. none of them [ ]

6. When you crossed these roads did you use any crossings like these?

Show photosheet of crossings and tick all that apply

1. zebra [ ] 26
pelican [ ]
2. subway [ ] 27
footbridge [ ]
3. crossing patrol (lollipop) [ ] 28
4. traffic lights [ ] 29
pedestrian islands [ ] 30
5. other (please specify) [ ]

ACC 3

use only

32

.low long did it usually take you to get to school?

8. From what you have told me about your journey to school before the accident would you say you did this every day?

33

1. Yes ☐ ***Go to Q10***
0. No ☐

9. *If No:* How was it different on other days?

Write respondents exact words

34

10. What about if the weather was bad eg raining, did this change how you got to school at any time?

35

0. No ☐
1. Yes ☐ Please specify

ACC 4

11. At what time did school usually finish in the afternoon?

37 ☐

12. Where did you usually go when you left school in the afternoon?

If home not mentioned probe P: What about after that, and then?

38 ☐

1. home ☐
2. other (please specify) ☐

13. How did you usually get back from school?

1. walked all the way ☐
2. went some or all the way by bus ☐
3. went some or all the way by private car ☐
4. went some or all the way by bicycle ☐
5. other (please specify) ☐

39 ☐

from school?

40

0. No alone all the way ☐ *Go to Q15*

1. Yes ☐

14a. *If yes:* Did your parents or other adults come back with you?

41

0. No ☐ *Go to Q14b*

1. Yes ☐ please specify

If yes: Did they usually go back all or just part of the way with you?

1. All ☐ 2. Part ☐

14b. Did your brothers and sisters come back with you?

42

0. No ☐ *Go to Q14c*

1. Yes ☐ please specify age & sex

If yes: Did they usually go back all or just part of the way with you?

1. All ☐ 2. Part ☐

14c. Did your friends come back with you?

43

0. No ☐ *Go to Q15*

1. Yes ☐ please specify age & sex

If yes, did they usually go back all or just part of the way with you?

1. All ☐ 2. Part ☐

back, even if you went some of the way by car or bus?

Write in number ☐ 47

If none, go to Q18

What were the names of these roads in the order you used to cross them?

Involve parent to help child identify road names where necessary.

	Road
1	
2	
3	
4	
5	
6	
7	
8	

16. How many of these roads did you cross on your own?

Running prompt

1. all of them ☐
2. some of them ☐ 48
3. one of them ☐
4. none of them ☐

17. When you crossed these roads did you use any crossings like these?

Show photosheet of crossings and tick all that apply

1. zebra ☐ 49
pelican ☐
2. subway ☐ 50
footbridge ☐
3. crossing patrol (lollipop) ☐
4. traffic lights ☐
pedestrian islands ☐ 51
5. other (please specify) ☐

52

53

ACC 7

afternoons?

54

19. From what you have told me about your journey back from school before the accident would you say you did this every day?

55

1. Yes ☐ *Go to Q21*
0. No ☐

20. *If No:* How was it different on other days?

Write respondents exact words

56

21. What about if the weather was bad eg raining, did this change how you got back from school at any time?

57

0. No ☐
1. Yes ☐ Please specify

the weekend shortly before the accident:

22. Did you belong to any clubs or go to any lessons after school or at the weekends?

P: eg Brownies / scouts, football / netball, swimming / music lessons, youth clubs etc

59

0. No ☐ *Go to Q23*

1. Yes ☐ Please specify

If yes: List types of clubs and ask questions a - g for the first three mentioned

60

a. How often did you go there?

	1	2	3
1. every day	☐	☐	☐
2. more than once a week	☐	☐	☐
3. once a week	☐	☐	☐
4. less than once a week	☐	☐	☐

62 1 18

b. What time did you go there?

1	2	3

63 2 19

c. How did you usually get there?

	1	2	3
1. by car	☐	☐	☐
2. by bus	☐	☐	☐
3. by bike	☐	☐	☐
4. walks	☐	☐	☐
5. other (please specify)	☐	☐	☐

64 3 20

ACC 9

use only

d. Who usually went with you?

	1	2	3	use only
1. alone	☐	☐	☐	65 ☐ 4 ☐ 21 ☐
2. parents/other adults	☐	☐	☐	66 ☐ 5 ☐ 22 ☐
3. brother/sister	☐	☐	☐	67 ☐ 6 ☐ 23 ☐
4. friends/peers	☐	☐	☐	68 ☐ 7 ☐ 24 ☐
5. other (please specify)	☐	☐	☐	69 ☐ 8 ☐ 25 ☐

e. How did you usually get home?

	1	2	3	use only
1. by car	☐	☐	☐	
2. by bus	☐	☐	☐	
3. by bike	☐	☐	☐	71 ☐ 10 ☐ 27 ☐
4. walks	☐	☐	☐	
5. other (please specify)	☐	☐	☐	

f. Who did you usually go home with?

	1	2	3	use only
1. alone	☐	☐	☐	72 ☐ 11 ☐ 28 ☐
2. parents/other adults	☐	☐	☐	73 ☐ 12 ☐ 29 ☐
3. brother/sister	☐	☐	☐	74 ☐ 13 ☐ 30 ☐
4. friends/peers	☐	☐	☐	75 ☐ 14 ☐ 31 ☐
5. other (please specify)	☐	☐	☐	76 ☐ 15 ☐ 32 ☐

g. What time did you usually get back?

1	2	3	use only
			77 ☐ 16 ☐ 33 ☐

ACC 10

use only

i. Did you go to parks?
ii. and/or play outside on the streets?

35 52

Parks 1. Yes ☐ Streets 1. Yes ☐
0. No ☐ 0. No ☐

If no at both of the above, go to Accident Section

a. How often did you go there?

	Parks	Streets
1. every day	☐	☐
2. more than once a week	☐	☐
3. once a week	☐	☐
4. less than once a week	☐	☐

36 53

b. What time did you go there? Parks ☐☐☐☐ Streets ☐☐☐☐

37 54

c. How did you usually get there?

	Parks	Streets
1. by car	☐	☐
2. by bus	☐	☐
3. by bike	☐	☐
4. walks	☐	☐
5. other (please specify)	☐	☐

38 55

ACC 11

d. Who usually went with you?

	Parks	Streets
1. alone	☐	☐
2. parents/other adults	☐	☐
3. brother/sister	☐	☐
4. friends/peers	☐	☐
5. other (please specify)	☐	☐

e. How did you usually get home?

	Parks	Streets
1. by car	☐	☐
2. by bus	☐	☐
3. by bike	☐	☐
4. walks	☐	☐
5. other (please specify)	☐	☐

f. Who did you usually go home with?

	Parks	Streets
1. alone	☐	☐
2. parents/other adults	☐	☐
3. brother/sister	☐	☐
4. friends/peers	☐	☐
5. other (please specify)	☐	☐

g. What time did you usually get back?

Parks	Streets

	Parks	Streets
1. alone	39	56
2. parents/other adults	40	57
3. brother/sister	41	58
4. friends/peers	42	59
5. other (please specify)	43	60
e. How did you usually get home?		
1. by car	44	61
2. by bus		
3. by bike		
4. walks		
5. other (please specify)		
f. Who did you usually go home with?		
1. alone	45	62
2. parents/other adults	46	63
3. brother/sister	47	64
4. friends/peers	48	65
5. other (please specify)	49	66
g. What time did you usually get back?	50	67

ACC 12

1. On what day did the accident happen? 1

2. At what time did the accident happen? 2

3. What was the name of the road?

4. Where were you going at the time of the accident and where had you come from? 3

To
From

5. Was this a journey that you did often?

No ☐ ***Go to Q6***

Yes ☐

If Yes: How often?

1. every day ☐
2. more than once a week ☐ 4
3. once a week ☐
4. less than once a week ☐

6. What were you doing just before the accident happened?

Probe: 5

7. Were you running or walking when you had the accident?

1. running ☐
2. walking ☐ 6
3. other (please specify) ☐

ACC 13

relationship, sex and age)

1
2
3
4

9. *If not with parents ask:* When the accident happened where were your parents?

10. *To child:* Can you describe what happened?
Provide paper and pencil if child has difficulty verbalizing

11. *Ask child and parent:* What do you think caused the accident

Child

Parent

use only
8
9
10
11
12
13
14
15
16
17
18
20
21
22
23
24
25
26
27
28
29

or prevent the accident?

Child

Parent

13. Have you been back to school since the accident?

1. Yes
0. No *Go to Q16*

14. Since the accident has there been any changes in the way you travel to and from school?

1. Yes
0. No *Go to Q16*

15. *If Yes:* In what ways?

30 31 32 33 34 35 36 37 38 39 40 41 42 43 44

use only

1. Have you been involved in any other road accidents?

1. Yes ☐ 45
0. No ☐ ***Finish***

17. *If Yes:* When was this? ☐ 46

18. Can you tell me briefly what happened? 47

19. Did you have to go to hospital after the accident? 48

1. Yes ☐
0. No ☐ ***Go to Q21***

20. *If Yes:* Did you have to stay? 49

1. Yes ☐
0. No ☐

21. Did you see your local doctor after the accident? 50

1. Yes ☐
0. No ☐

Finish and Thank

Reference

1. Attitudes

I am going to read out some things that people have said about children using roads. From the card can you tell me how much you agree or disagree with each of them.

Read out and show scale card A.

	agree a lot	agree a little	disagree a little	disagree a lot	don't know	
1. "It's nearly always the driver's fault when a child gets knocked down"	☐	☐	☐	☐	☐	6 ☐
2. "Often young children forget to stop at the kerb and can easily dart out into the road"	☐	☐	☐	☐	☐	7 ☐
3. "It's hard to keep an eye on children playing outside near roads because there is always lots to do"	☐	☐	☐	☐	☐	8 ☐
4. "Children are just as likely to have accidents on roads they use everyday as they are on roads they hardly ever use"	☐	☐	☐	☐	☐	9 ☐
5. "As children get to the age of about 11 or 12 years they are less likely to be involved in a road accident"	☐	☐	☐	☐	☐	10 ☐
6. "It's the parents responsibility to make sure their children know how to cross roads safely"	☐	☐	☐	☐	☐	11 ☐
7. "Young children are as good as adults at seeing how fast and close cars are coming towards them"	☐	☐	☐	☐	☐	12 ☐
8. "Older children have as many accidents as young children because thay take risks"	☐	☐	☐	☐	☐	13 ☐
9. "It's hard to know what to say to children to make them safe on the roads"	☐	☐	☐	☐	☐	14 ☐
10. "These days parents don't have enough time to teach children how to cross roads safely"	☐	☐	☐	☐	☐	15 ☐
11. "It is difficult to make sure that young children never cross roads on their own"	☐	☐	☐	☐	☐	16 ☐
12. "When children start secondary school they are old enough to get there on their own"	☐	☐	☐	☐	☐	17 ☐

PAR 1

Show card B.

1. Which of the following do you think would be best placed to give advice to parents about making their children safer on the roads? And why? You can give more than one answer.

1. health visitor	20
2. community worker	21
3. doctor	22
4. local authority / road safety officer	23
5. police	24
6. schools	25
7. other (specify)	26

Show card C.

2. Which of the following do you think would help most to make children safer on the roads? And why? You can give more than one answer.

1. road safety education in schools	28
2. national publicity	29
3. parental action and involvement	30
4. use of the Green Cross Code	31
5. slow down traffic	32
6. other (specify)	33

PAR 2

1. Yes ☐
0. No ☐ ***Go to 'Home Environment' section***

35 ☐

4. *If Yes:* When was this? ☐ 36 ☐

5. Can you tell me briefly what happened? 37 ☐

6. Did you have to go to hospital after the accident? 38 ☐

1. Yes ☐
0. No ☐ ***Go to Q8***

7. *If Yes:* Did you have to stay? 39 ☐

1. Yes ☐
0. No ☐

8. Did you see your local doctor after the accident? 40 ☐

1. Yes ☐
0. No ☐

3. Home Environment

1. (By observation)

1. a detached house/bungalow ☐
2. a semi-detached house/bungalow ☐
3. a terraced house ☐
4. a flat/maisonette (self contained) ☐
5. room in someone else's house ☐
6. other ☐

42 ☐

2. How long have you lived in the area?

1. less than 1 year ☐
2. 1-4 years ☐
3. 5-9 years ☐
4. 10 years or more ☐
5. all your life ☐

43 ☐

3. Is this your own home or your parents or others?

1. own home ☐
2. parents home ☐
3. other situation ☐

44 ☐

Show card D

4. Which of the following best applies to your home?

1. being bought/mortgaged ☐
2. owned outright ☐
3. rented from council ☐
4. rented from private landlord furnished ☐
5. rented from private landlord unfurnished ☐
6. rented from housing association ☐
7. other ☐

45 ☐

5. How many living rooms and bedrooms do you have use of? (not including the kitchen or bathroom)

living rooms ☐

bedrooms ☐

46 ☐

47 ☐

PAR 4

household including yourself who are?

adults aged over 18 ☐
young adults aged 16 - 18 ☐
children under 16 ☐

use only
48 ☐
49 ☐
50 ☐

7. What is the age and sex of each child aged 16 and under?

1.
2.
3.
4.
5.

8. Do you or any of the people living in your house have any physical disability or any problem with vision or hearing? *(Specify who, age, sex)*

52 ☐
53 ☐
54 ☐

Show card E

9. Which of the following best applies to you?

1. never married ☐
2. widowed ☐
3. divorced ☐
4. separated ☐
5. married (once only) ☐
6. married (for 2nd or 3rd time) ☐

55 ☐

Show card F

10. Do you currently have a partner?
If Yes: Which of these best applies?

0. No ☐
1. husband ☐
2. wife ☐
3. other male partner ☐
4. other female partner ☐
5. other ☐

56 ☐

car (including vans, minibuses, etc)

1. yes ☐
0. no ☐ ***Go to Q13***

use only

57 ☐

12. *If Yes:* How often do you have use of a car?

0. never ☐
1. sometimes ☐
2. everyday ☐

58 ☐

Show card G

13. *Ethnic Origin*
From the card which best applies to you and your partner?

	You	Your partner
1. white	☐	☐
2. black/Caribbean	☐	☐
3. black/African	☐	☐
4. black/other	☐	☐
5. Indian	☐	☐
6. Pakistani	☐	☐
7. Bangladeshi	☐	☐
8. Chinese	☐	☐
9. other	☐	☐

59 ☐ 60 ☐

14. How old were you last birthday? ☐☐

61 ☐☐

15. *If applicable:* How old was your partner last birthday? ☐☐

62 ☐☐

16. *Interviewer to record*

1. Mother ☐
2. Father ☐
3. Both ☐
4. Other ☐

63 ☐

PAR 6

use only

64

Current occupation

1. Are you in paid work, either as an employee or self employed?

   1. Yes ☐
   0. No ☐ ***Go to Q13***

2. *If Yes:* Do you work full time or part time?
   (Full time is 30 hours/week or more)

   1. full ☐
   2. part ☐

3. Are you an employee or self employed?

   1. employee ☐
   2. self-employed ☐ ***Go to Q9***

If employed

4. What type of work do you do?

5. What industry is that in?

6. What is your grade or position?

Interviewer to note: For civil servants, police and forces miss out Q7 & 8.

7. How many people are you in charge of?

8. What qualifications do you hold? (since leaving school)

65

Now go to Section 5 "Work Situation - Partner" if applicable. Otherwise finish and thank.

PAR 7

use only

9. What type of work do you do?

10. What industry is that in?

11. How many employees do you have?

12. What qualifications do you hold? (since leaving school)

66

Now go to Section 5 "Work Situation - Partner" if applicable. Otherwise finish and thank.

If not in paid work

13. Are you:

1. On a government employment or training scheme
2. Unemployed and looking for a job
3. In full time or part time further education
4. Unable to work because of long term sickness or disability
5. Retired from paid work *(ask about last main job)*
6. Looking after home and family
7. other (please describe)

67

68

14. How long has it been since you were in paid work?

If never been employed ask for qualifications and code here: ***otherwise go to Q15.***

Now go to Section 5 "Work Situation - Partner" if applicable. Otherwise finish and thank.

PAR 8

use only

15. Did you work full time or part time?
(Full time is 30 hours/week or more)

69

1. full ☐
2. part ☐

16. Were you an employee or self employed?

1. employee ☐
2. self-employed ☐ ***Go to Q22***

If employed

17. What type of work did you do?

18. What industry was that in?

19. What was your grade or position?

Interviewer to note: For civil servants, police and forces miss out Q20 & 21.

20. How many people were you in charge of? ☐

21. What qualifications do you hold? (since leaving school)

70

Now go to Section 5 "Work Situation - Partner" if applicable. Otherwise finish and thank.

PAR 9

use only

22. What type of work did you do?

23. What industry was that in?

24. How many employees did you have?

25. What qualifications do you hold? (since leaving school)

71

Note: If respondent has no partner finish and thank.

PAR 10

use only

72

Current occupation

1. Are they in paid work, either as an employee or self employed?

1. Yes ☐
0. No ☐ ***Go to Q13***

2. *If Yes:* Do they work full time or part time?
(Full time is 30 hours/week or more)

1. full ☐
2. part ☐

3. Are they an employee or self employed?

1. employee ☐
2. self-employed ☐ ***Go to Q9***

If employed

4. What type of work do they do?

5. What industry is that in?

6. What is their grade or position?

Interviewer to note: For civil servants, police and forces miss out Q7 & 8.

7. How many people are they in charge of?

8. What qualifications do they hold? (since leaving school)

73

Now finish and thank.

PAR 11

use only

9. What type of work do they do?

10. What industry is that in?

11. How many employees do they have?

12. What qualifications do they hold? (since leaving school)

74

Now finish and thank.

If not in paid work

13. Are they:

1. On a government employment or training scheme
2. Unemployed and looking for a job
3. In full time or part time further education
4. Unable to work because of long term sickness or disability
5. Retired from paid work *(ask about last main job)*
6. Looking after home and family
7. other (please describe)

75

76

14. How long has it been since they were in paid work?

If never been employed ask for qualifications and code here:
Otherwise go to Q15.

Now finish and thank.

PAR 12

use only

15. Did they work full time or part time?
(Full time is 30 hours/week or more)

77

1. full ☐
2. part ☐

16. Were they an employee or self employed?

1. employee ☐
2. self-employed ☐ ***Go to Q22***

If employed

17. What type of work did they do?

18. What industry was that in?

19. What was their grade or position?

Interviewer to note: For civil servants, police and forces miss out Q20 & 21.

20. How many people were they in charge of? ☐

21. What qualifications do they hold? (since leaving school)

78

Now finish and thank.

PAR 13

use only

22. What type of work did they do?

23. What industry was that in?

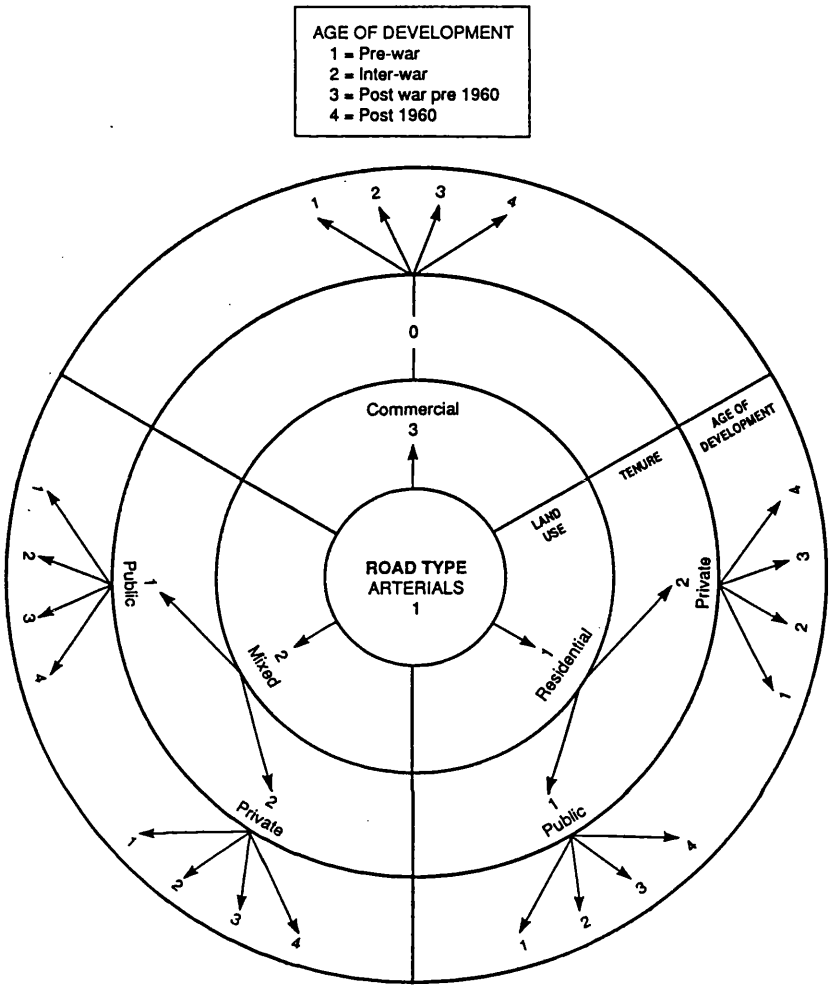
24. How many employees did they have?

25. What qualifications do they hold? (since leaving school)

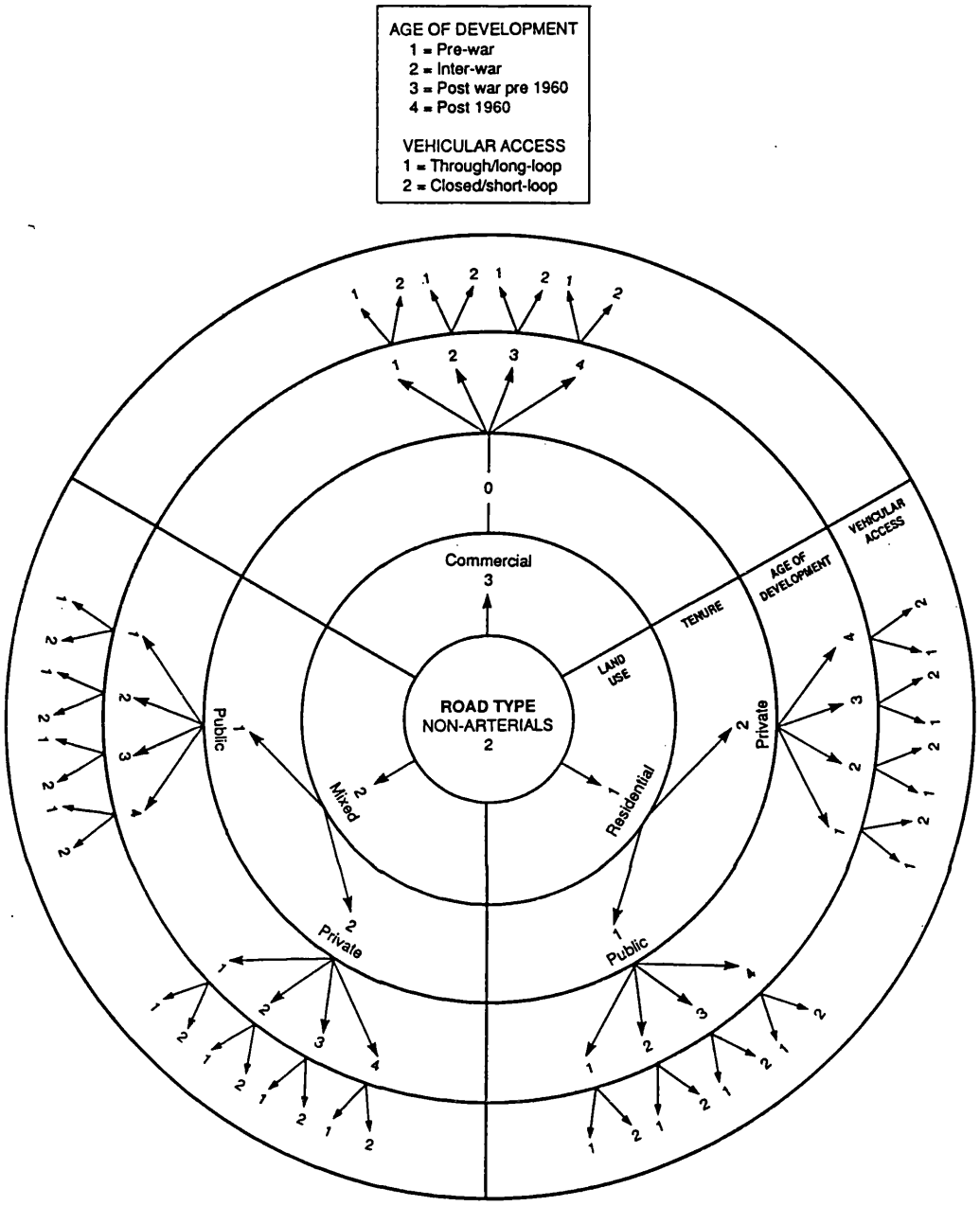
79

Finish and thank.

PAR 14



Child pedestrian accident study
Environmental typology: arterials



Child pedestrian accident study
Environmental typology: non-arterials

APPENDIX:C HOSPITAL INTRODUCTORY QUESTIONNAIRE

Day: | Date: | Time of attendance: | Casualty Number:

If Accident Involved Other Patients
Number of patients involved: | Accident reference casualty number

Brought in by ambulance: Yes No Unk | Clerk on duty: Yes No Unk | Receptionist on duty: Yes No Unk

Source: Interview by clerk or receptionist | adult patient or child patient with adult or accompanying adult → Relationship to patient: | Medical records only (no interview)

Introduction

As you know, a great many accidents happen every day. To try and cut down on the number of these accidents, we are carrying out a special study. We are interested in all accidents regardless of how they happened -whether through faulty goods carelessness or whatever the causes. So I'd like to ask you a few simple questions about your/this particular accident.

Accident Details

When did the accident happen? Date? | Time?

Could you describe as fully as possible how the accident occurred

Can I just check, was a fall of any kind involved in the accident? What kind of fall was it?

Fall on same level from tripping etc | Fall on or from stairs or steps | Fall on or from ladder | Fall from or out of building/structure | Fall off/with (motor) cycle or horse | Other fall from one level to another | Unspec type of fall | No fall involved | Unknown if any fall

Article involvement What articles, equipment, vehicles or building features were in any way involved in the accident (and the injury)?
(where applicable establish type, brand, condition and age of article mentioned and if it was aquired new, secondhand, hired or borrowed)
Can I just check, was any protective equipment being used or worn?

	1	2	3	4
Article etc				
Specific type				
Make/Brand and model				
New/Secondhand/ Hired/Borrowed				
Age(Approx)/Condition				
Fuel/power				

RTAs Only: How many vehicles altogether (including pedal cycles)were involved in the accident?

If patient was in or on a vehicle: which of the above was it? | Were they the driver or the passenger? (or unknown)

Location: Could you describe as fully as possible where exactly the accident happened?

Accidents in Home/Garden Only: Is this normal residence?

In / outside what kind of building did the accident happen?: Yes No Unk

(House: Ask if terraced/detached/bungalow)
(Flat: Ask if self contained?, a conversion?, on 2 floors? part of business premises?)

RTAs Only: Was the road a motorway? Yes No Unk | What was the speed limit? mph

If speed limit unknown ask: Was the road street lit? Yes No Unk | Was this a built up area or in the country? Unk

Activity: What were you/ the patient doing when the accident happened?:

Can I just check, was any sport or exercise involved in the accident?

Sports Only What sport was it? | Was there a referee, coach or teacher in charge of the activity? Yes No Unk

RTAs Only: Were any of the following emergency services contacted / present at the scene of the accident? Police Yes No Unk | Fire Yes No Unk | Ambulance Yes No Unk

Explanation of the follow-up

It might be helpful for us to have a few more details about the accident. would it be alright for someone to get in touch with you at home in the near future to do this? Yes No Postal only Unk

Ask of Adults only

Do you have a full-time or part-time job, or are you a full-time student? CSU1

Years mths

Injuries

(1) Part of body injured: Article causing injury:

Injuries:

(2) Part of body injured: Article causing injury:

Injuries:

(3) Part of body injured: Article causing injury:

Injuries:

(4) Part of body injured: Article causing injury:

Injuries:

Outcome / Disposal

- ☐ Dead on arrival/before admission
- ☐ Admitted to this hospital → Left on ____ and:
- ☐ Admitted to ____ (type of) hospital
- ☐ Referred to **any** outpatient department
- ☐ Referred to GP
- ☐ Treated, no further treatment specified
- ☐ Examined but not treated
- ☐ Did not wait
- ☐ Unknown outcome/records lost
- ☐ Other outcome/disposal: ____

- ☐ Still inpatient after 30 days
- ☐ Unknown outcome / records lost
- ☐ Died while inpatient, on: ____

- ☐ Transferred (as IP) to ____ (type of) hospital
- ☐ Referred to **any** outpatient department
- ☐ Referred to GP
- ☐ No further treatment specified
- ☐ Other outcome/disposal: ____

Special Studies Only:

Blood Alcohol: ____ mg/100ml

SS1

Name:

☎ code: no.

Address

SS2

1. Letter to casualties

Dear Parent

SURVEY OF CHILD PEDESTRIAN ACCIDENTS

One of the aims of the Department of Transport is to reduce child pedestrian casualties by the year 2000. To help find out about such accidents the TRRL is conducting a survey about children's journeys to and from school, their spare time activities and their parents' attitudes to issues concerning children and their use of roads.

We know that your child has recently been involved in an accident and that you have kindly agreed to help future research.

In the next few weeks one of our interviewers will call on you, after school to interview you and your child. If you are not at home or happen to be busy at the first call she will be happy to come again. The interviewer will show an official identification card. Any information given to the interviewer will be treated in strict confidence and be used for statistical purposes only.

Your co-operation will be greatly appreciated as the information will be used to help prevent such accidents occurring in the future.

Please feel free to ring me if there is anything you wish to know before the interviewer calls.

Yours faithfully

NICOLA CHRISTIE
Road User Safety Division

2. Letter to schools

Dear

RE: SURVEY OF CHILD PEDESTRIAN ACCIDENTS

One of the aims of the Department of Transport is to significantly reduce the number of children involved in road accidents by the year 2000. As part of working towards this goal the Transport and Road Research Laboratory are developing a questionnaire survey which will attempt to assess the influence of social, economic and environmental factors in child pedestrian accidents (that is children aged between 5-16).

We have the support of the local Accident and Emergency Department in your area, who are providing us with a sample of road accident involved children for us to interview to test the questionnaire. We also need to test the questionnaire with a sample of non-accident involved children and their families for comparison.

The survey will involve both parent and child being interviewed at their home by a highly trained interviewer, concerning details about journeys to school, spare time activities and the social environment of the family eg type of housing, number of children, access to work, etc. The interview will last for about 30 minutes and will take place at a time which is convenient to the family concerned.

We feel that the best way to reach children of the right age would be via schools. It would be very helpful if you could help us to achieve this sample. All we would need is a list of names and addresses with the ages of the child, randomly selected from the following age bands to provide a cross-section of backgrounds and abilities:

Age Band	Number of Children required
5 - 6	20
7 - 8	20
9 - 10	20

The parents of these children could then be written to by yourself, explaining the survey and being given the opportunity to 'opt out' if they so wished. Administrative costs will of course be met by TRRL. In most surveys of this nature we have had good response rates.

I would be extremely grateful for your full support and co-operation for this survey as I believe the results will help towards the design of improved ways to prevent such accidents.

I look forward to your reply and do not hesitate to contact me if you have any queries.

Yours sincerely

NICOLA CHRISTIE
Road User Safety Division

3. Letter to carers of school children

Dear Parent/ Guardian

CHILD PEDESTRIAN SURVEY

The Department of Transport are carrying out research to try to help reduce the number of school children killed and seriously injured on the roads. The school has been asked to provide a random selection of children from the register so that a highly trained interviewer can ask both parent and child a number of simple questions about their journeys to and from school.

These interviews will take place at home at a convenient time after school. All information will be confidential and used by the researchers only.

If you do not wish to be involved in the survey, please return the slip below to your teacher at school within the next week.

Mrs N Christie
Researcher

I do not wish to be involved in the Road Safety survey.

Parent/ Guardian's name:_____

Child's name:_____

4. Opt out letter to casualties.

July

1993

Dear Parent/Guardian

One of the aims of the Department of Transport is to significantly reduce the number of children involved in road accidents by the year 2000. As a result, the Transport Research Laboratory is conducting a survey about road accidents involving children. It is hoped that a better understanding of this type of accident will enable safety schemes to be better designed which will in turn lead to a reduction in the number of children involved in accidents on the roads.

Your child was selected to take part in the survey from patients who were involved in an accident and were treated at the Prince Charles Hospital Accident and Emergency Department. The Transport Research Laboratory would like to include you and your child in the survey and need to know whether you would be willing to provide some simple information about the accident. This would involve both yourself and your child being interviewed at your home by a highly trained interviewer at a time which is convenient to yourselves.

This letter has been sent to you by the Prince Charles Hospital on behalf of the Laboratory to ensure that your name and address is kept confidential.

If you **DO NOT** wish to take part in the survey please fill in the slip below and return it as soon as possible, in the pre-paid envelope provided. If you do not return the slip, the hospital will pass your name and address to TRL and one of the Laboratory's interviewers will call on you in the next few weeks. If you are not at home or happen to be busy at the first call they will be happy to call again at a more convenient time. The interviewer will show an official identification card.

I should stress that all information given to the interviewer will be treated in the strictest confidence and used for statistical purposes only. I hope you will be able to help.

Yours sincerely

Nicola Christie
Safety Resource Centre (0344) 770336

Transport Research Laboratory/Prince Charles Hospital
Child Road Accident Survey

I DO NOT wish to be involved in the Road Safety Survey

Parent's name:_____

Child's name:_____

5. Letter to hospital consultants

Dear

I am writing to ask your co-operation in a major interview survey of children involved in road traffic accidents. The survey will investigate the social, economic and environmental factors in child (5-16 years) pedestrian accidents. It will be conducted by staff from the Transport Research Laboratory as part of the Department of Transport's aim to seek ways of significantly reducing the number of children involved in such accidents. You may know that although Great Britain has a fairly good road safety record generally, we do not compare well with other European countries in terms of child pedestrian accidents.

The survey aims to measure the risk exposure (ie opportunities for accidents) of a sample of accident and non-accident involved children from a range of different social and cultural backgrounds, and from a mixture of urban and rural areas. It is hoped that a better understanding of the role of these factors will enable the development and implementation of more effective safety schemes.

So far, the survey has been piloted and a sample of accident involved child pedestrians has been gained via a research project set-up using the DTI's Home and Leisure Accident Surveillance Surveys (HASS/LASS) at 3 hospitals. A small number of special questions were added to the standard HASS/LASS form and a request was made to take part in a follow-up interview at home. At the hospitals, co-operation by casualties was very good and our follow-up home interviews indicated a highly positive response. All information is treated in the strictest confidence by the TRL and used for research purposes only.

For the main survey we are including several more hospitals and we are therefore seeking your support and co-operation in allowing us to work at your hospital. Casualties sampled at the hospitals will be interviewed at home a few weeks after the accident, or if they are well enough but still in hospital, interviews will be conducted there. Interviews will be carried out by our own team of trained professional interviewers who are accustomed to working with road accident casualties.

I enclose a copy of the road accident research questionnaire used by the HASS/LASS clerks in the casualty departments of participating hospitals; names and addresses were only released to the TRL if respondents had agreed at Section VIII. I would envisage using a much simplified form (see copy enclosed) only administered to child pedestrian casualties. Alternatively, a system preferred by some of the participating hospitals is to give the parents a copy of a TRL letter (enclosed) asking for their co-operation whilst registering their child at casualty reception, this method reduces the input from the nursing staff. Any cost involved in collecting this information would be met by the TRL; perhaps a 'piece' rate could be negotiated for a member of hospital staff to help with this survey.

I would be extremely grateful if you could let me know as soon as possible whether you would be willing for your Accident and Emergency Department to collaborate in this research. I would be happy to come to the hospital and give you more details if you wish.

APPENDIX:E
CENSUS AND CONTROL DATA BY REGION

LOCATION: MID GLAMORGAN

Variable	census	control
Age:		
5-7	26	23
8-10	26	24
11-16	48	53
Ethnic origin:		
White	99	100
non-white	1	-
Dependent children:		
2 or fewer	84	73
3 or more	16	27
SEG:		
ABC1	46	29
C2	43	28
DE	11	43
Marital status:		
Typical	75	80
Atypical	25	20
Age of housing:		
pre 1914		55
inter war		23
modern		22

LOCATION:BRISTOL

Variable	census	control
Age:		
5-7	28	24
8-10	25	27
11-16	47	49
Ethnic origin:		
White	91	75
non-white	9	25
Dependent children:		
2 or fewer	81	52
3 or more	19	49
SEG:		
ABC1	51	32
C2	27	28
DE	22	39
Marital status:		
Typical	69	72
Atypical	31	28
Age of housing:		
pre 1914	34	38
inter war	42	43
modern	25	19

Variable	census	control
Age:		
5-7	28	19
8-10	27	37
11-16	45	44
Ethnic origin:		
White	55	77
non-white	45	24
Dependent children:		
2 or fewer	79	64
3 or more	21	36
SEG:		
ABC1	46	45
C2	28	39
DE	26	16
Marital status:		
Typical	56	62
Atypical	44	32
Age of housing:		
pre 1914	48	70
inter war	29	30
modern	23	-

LOCATION:BRADFORD

Variable	census	control
Age:		
5-7	26	34
8-10	26	12
11-16	47	56
Ethnic origin:		
White	71	99
non-white	29	1
Dependent children:		
2 or fewer	76	75
3 or more	24	25
SEG:		
ABC1	41	48
C2	33	22
DE	26	20
Marital status:		
Typical	72	74
Atypical	28	26
Age of housing:		
pre 1914	25	13
inter war	44	52
modern	31	36

LOCATION:BERKSHIRE

Variable	census	control
Age:		
5-7	26	16
8-10	26	24
11-16	48	60
Ethnic origin:		
White	88	92
non-white	12	8
Dependent children:		
2 or fewer	82	68
3 or more	18	32
SEG:		
ABC1	60	77
C2	25	16
DE	15	8
Marital status:		
Typical	81	74
Atypical	19	26
Age of housing:		
pre 1914	21	38
inter war	41	37
modern	39	25

1) Thesis social model

Variable	B	S.E.	Wald	df	Sig	R	Exp(B)
RESPSCOR(1)	-.2725	.1278	4.5503	1	.0329	-.0609	.7614
FSEG			2.5845	2	.2746	.0000	
FSEG(1)	.2724	.1789	2.3195	1	.1278	.0216	1.3131
FSEG(2)	-.0783	.2001	.1533	1	.6954	.0000	.9246
MARITAL(1)	.3312	.1291	6.5835	1	.0103	.0817	1.3927
CROWDING(1)	.1817	.3104	.3429	1	.5582	.0000	1.1993
DISAB(1)	-.3983	.3007	1.7544	1	.1853	.0000	.6715
FAM(1)	-.3526	.1284	7.5474	1	.0060	-.0899	.7028
NSEX(1)	.6599	.1497	19.4206	1	.0000	.1593	1.9345
AGENV(1)	.7916	.1995	15.7396	1	.0001	.1415	2.2069
STREETP(1)	.5353	.2895	3.4180	1	.0645	.0454	1.7079
ETHNIC(1)	.1574	.2971	.2807	1	.5963	.0000	1.1705
CLUBT(1)	.3351	.1225	7.4879	1	.0062	.0894	1.3981
CARUSE(1)	-.1088	.1421	.5864	1	.4438	.0000	.8969
TWORK			2.4270	2	.2972	.0000	
TWORK(1)	-.0707	.1931	.1339	1	.7144	.0000	.9318
TWORK(2)	-.2402	.1799	1.7824	1	.1819	.0000	.7865
TACCOMP(1)	-.1469	.1845	.6339	1	.4259	.0000	.8634
AGENV(1) by CLUBT(1)	.2823	.1196	5.5750	1	.0182	.0722	1.3262
AGENV(1) by ETHNIC(1)	-.5917	.1688	12.2819	1	.0005	-.1224	.5534
AGENV by FSEG			7.1942	2	.0274	.0682	
AGENV(1) by FSEG(1)	-.0878	.1641	.2862	1	.5927	.0000	.9160
AGENV(1) by FSEG(2)	-.3613	.1717	4.4296	1	.0353	-.0595	.6968
AGENV(1) by FAM(1)	-.2389	.1233	3.7529	1	.0527	-.0505	.7875
AGENV(1) by CARUSE(1)	.2691	.1334	4.0674	1	.0437	.0549	1.3088
NSEX(1) by STREETP(1)	-.3523	.1487	5.6104	1	.0179	-.0725	.7031
STREETP(1) by CROWDING(1)	-.6002	.2950	4.1387	1	.0419	-.0558	.5487
ETHNIC(1) by DISAB(1)	.9330	.2935	10.1025	1	.0015	.1086	2.5422
TWORK by FSEG			11.1930	4	.0245	.0682	
TWORK(1) by FSEG(1)	-.7518	.2318	10.5177	1	.0012	-.1114	.4715
TWORK(1) by FSEG(2)	.1942	.2479	.6137	1	.4334	.0000	1.2143
TWORK(2) by FSEG(1)	.2124	.2400	.7834	1	.3761	.0000	1.2367
TWORK(2) by FSEG(2)	.0149	.2606	.0033	1	.9545	.0000	1.0150
DISAB(1) by TACCOMP(1)	.3371	.1558	4.6852	1	.0304	.0625	1.4009
CLUBT by TWORK			11.0844	2	.0039	.1016	
CLUBT(1) by TWORK(1)	-.1094	.1626	.4530	1	.5009	.0000	.8963
CLUBT(1) by TWORK(2)	.5573	.1722	10.4710	1	.0012	.1111	1.7460
Constant	-1.3388	.4083	10.7534	1	.0010		

2)Thesis environmental model

---------- Variables in the Equation ----------

Variable	B	S.E.	Wald	df	Sig	R	Exp(B)
ADDTYP(1)	-.7464	.3367	4.9143	1	.0266	-.0732	.4741
ADDACC(1)	.4188	.1479	8.0228	1	.0046	.1053	1.5202
ADDOBS(1)	-1.4620	.2047	50.9949	1	.0000	-.3003	.2318
ADDUSE(1)	-.9206	.4815	3.6554	1	.0559	-.0552	.3983
ADDAGE			4.4850	2	.1062	.0299	
ADDAGE(1)	.2739	.3860	.5034	1	.4780	.0000	1.3151
ADDAGE(2)	.2573	.2486	1.0710	1	.3007	.0000	1.2934
ADDTEN(1)	-.1743	.2210	.6222	1	.4302	.0000	.8400
ADDAGE by ADDTEN			8.5392	2	.0140	.0914	
ADDAGE(1) by ADDTEN(1)	-1.1014	.3833	8.2589	1	.0041	-.1073	.3324
ADDAGE(2) by ADDTEN(1)	.5684	.2480	5.2525	1	.0219	.0774	1.7654
Constant	-2.7589	.4880	31.9587	1	.0000		

3) Thesis social and environmental model

Variable	B	S.E.	Wald	df	Sig	R	Exp(B)
ADDACC(1)	.4745	.1942	5.9714	1	.0145	.0860	1.6073
ADDOBS(1)	-1.8454	.3125	34.8795	1	.0000	-.2474	.1580
ADDAGE			11.5022	2	.0032	.1182	
ADDAGE(1)	.9831	.2913	11.3885	1	.0007	.1322	2.6728
ADDAGE(2)	-.2635	.2478	1.1303	1	.2877	.0000	.7684
ADDTEN(1)	-.0099	.2255	.0019	1	.9650	.0000	.9901
FSEG			3.8403	2	.1466	.0000	
FSEG(1)	.7170	.3661	3.8352	1	.0502	.0584	2.0482
FSEG(2)	-.4928	.4722	1.0889	1	.2967	.0000	.6109
DISAB(1)	.2651	.2034	1.6986	1	.1925	.0000	1.3036
NSEX(1)	.4065	.1610	6.3711	1	.0116	.0902	1.5015
AGENV(1)	-.0041	.2944	.0002	1	.9889	.0000	.9959
STREETP(1)	.1570	.3435	.2089	1	.6476	.0000	1.1700
ETHNIC(1)	-.7828	.2343	11.1617	1	.0008	-.1306	.4571
CLUBT(1)	.4793	.1593	9.0594	1	.0026	.1146	1.6150
CARUSE(1)	-.2155	.1885	1.3063	1	.2531	.0000	.8061
TWORK			1.6452	2	.4393	.0000	
TWORK(1)	.4133	.3435	1.4477	1	.2289	.0000	1.5118
TWORK(2)	-.3045	.3510	.7523	1	.3857	.0000	.7375
TACCOMP(1)	.2097	.2505	.7008	1	.4025	.0000	1.2333
TWORK by FSEG			13.6775	4	.0084	.1028	
TWORK(1) by FSEG(1)	-1.1054	.3184	12.0532	1	.0005	-.1368	.3311
TWORK(1) by FSEG(2)	.5710	.3270	3.0492	1	.0808	.0442	1.7700
TWORK(2) by FSEG(1)	.2893	.3136	.8507	1	.3564	.0000	1.3355
TWORK(2) by FSEG(2)	-.3428	.3534	.9408	1	.3321	.0000	.7098
DISAB(1) by TACCOMP(1)	.7131	.2169	10.8124	1	.0010	.1281	2.0404
ADDOBS by FSEG			6.7997	2	.0334	.0722	
ADDOBS(1) by FSEG(1)	.9058	.3553	6.4993	1	.0108	.0915	2.4738
ADDOBS(1) by FSEG(2)	-.8661	.4580	3.5760	1	.0586	-.0542	.4206
ADDAGE by FSEG			15.6411	4	.0035	.1193	
ADDAGE(1) by FSEG(1)	-1.0532	.3650	8.3266	1	.0039	-.1085	.3488
ADDAGE(1) by FSEG(2)	-.0048	.3479	.0002	1	.9891	.0000	.9952
ADDAGE(2) by FSEG(1)	.7322	.3033	5.8289	1	.0158	.0844	2.0797
ADDAGE(2) by FSEG(2)	-.8486	.3213	6.9759	1	.0083	-.0962	.4280
ADDOBS(1) by AGENV(1)	-.6322	.2648	5.7011	1	.0170	-.0830	.5314
ADDAGE by AGENV			9.7379	2	.0077	.1033	
ADDAGE(1) by AGENV(1)	.6520	.2546	6.5579	1	.0104	.0921	1.9194
ADDAGE(2) by AGENV(1)	-.5301	.2179	5.9205	1	.0150	-.0854	.5885
ADDTEN(1) by CARUSE(1)	.4933	.1905	6.7049	1	.0096	.0936	1.6377
ADDOBS by TWORK			7.7803	2	.0204	.0839	
ADDOBS(1) by TWORK(1)	.9284	.3328	7.7802	1	.0053	.1037	2.5304
ADDOBS(1) by TWORK(2)	-.4147	.3422	1.4684	1	.2256	.0000	.6605
CROWDING(1)	.0541	.3628	.0222	1	.8816	.0000	1.0555
STREETP(1) by CROWDING(1)	-.6847	.3517	3.7902	1	.0516	-.0577	.5043
Constant	-2.0087	.4665	18.5402	1	.0000		

4) DOT social model

---------- Variables in the Equation ----------

Variable	B	S.E.	Wald	df	Sig	R	Exp(B)
AGENV(1)	.7868	.1687	21.7507	1	.0000	.1695	2.1963
CLUBT(1)	.3698	.1062	12.1139	1	.0005	.1213	1.4474
DISAB(1)	.4377	.1363	10.3100	1	.0013	.1099	1.5492
ETHNIC(1)	-.4937	.1499	10.8428	1	.0010	-.1134	.6104
FAM(1)	-.3378	.1095	9.5128	1	.0020	-.1045	.7134
NSEX(1)	.4350	.1103	15.5644	1	.0001	.1405	1.5449
MARITAL(1)	.4029	.1090	13.6703	1	.0002	.1303	1.4961
TACCOMP(1)	-.3132	.1335	5.5013	1	.0190	-.0714	.7311
RESPSCOR(1)	-.2066	.1149	3.2314	1	.0722	-.0423	.8134
INT_1	-.6031	.1487	16.4508	1	.0000	-.1450	.5471
Constant	-.4350	.1786	5.9318	1	.0149		

5) DOT environmental model

---------- Variables in the Equation ----------

Variable	B	S.E.	Wald	df	Sig	R	Exp(B)
ADDAGE			4.1783	2	.1238	.0181	
ADDAGE(1)	-.5284	.2883	3.3598	1	.0668	-.0500	.5896
ADDAGE(2)	.2183	.2464	.7849	1	.3756	.0000	1.2440
ADDOBS(1)	-1.4259	.2007	50.4773	1	.0000	-.2987	.2403
ADDACC(1)	.3853	.1456	7.0035	1	.0081	.0960	1.4701
ADDTEN(1)	-.1306	.2195	.3539	1	.5519	.0000	.8776
ADDAGE * ADDTEN			8.7578	2	.0125	.0936	
INT_1	.4608	.2869	2.5794	1	.1083	.0327	1.5854
INT_2	.6188	.2463	6.3098	1	.0120	.0891	1.8566
Constant	-2.9321	.2909	101.5599	1	.0000		

6) DOT social and environmental model

---------- Variables in the Equation ----------

Variable	B	S.E.	Wald	df	Sig	R	Exp(B)
AGENV(1)	.5828	.1782	10.6970	1	.0011	.1269	1.7911
ADDAGE			12.9649	2	.0015	.1288	
ADDAGE(1)	-.8240	.2402	11.7687	1	.0006	-.1345	.4387
ADDAGE(2)	.1735	.1835	.8943	1	.3443	.0000	1.1895
ETHNIC(1)	-.7008	.1876	13.9547	1	.0002	-.1488	.4962
ADDOBS(1)	-1.3165	.2135	38.0083	1	.0000	-.2582	.2681
FAM(1)	-.3347	.1362	6.0423	1	.0140	-.0865	.7156
CLUBT(1)	.5551	.1324	17.5837	1	.0000	.1699	1.7421
MARITAL(1)	.4144	.1347	9.4607	1	.0021	.1175	1.5134
NSEX(1)	.3752	.1364	7.5675	1	.0059	.1015	1.4552
INT_1	-.5152	.1790	8.2854	1	.0040	-.1079	.5974
Constant	-1.6796	.2448	47.0856	1	.0000		

7) DOT hypotheses test model

---------- Variables in the Equation ----------

Variable	B	S.E.	Wald	df	Sig	R	Exp(B)
AGENV(1)	.3099	.1240	6.2441	1	.0125	.0884	1.3633
ADDAGE			29.1310	2	.0000	.2151	
ADDAGE(1)	-.9997	.2363	17.8950	1	.0000	-.1711	.3680
ADDAGE(2)	-.0168	.1799	.0087	1	.9257	.0000	.9834
ADDOBS(1)	-1.3626	.2013	45.8159	1	.0000	-.2840	.2560
NSEX(1)	.2515	.1271	3.9152	1	.0479	.0594	1.2860
STREETP(1)	-.3359	.1348	6.2106	1	.0127	-.0880	.7147
ADDACC(1)	.4605	.1513	9.2587	1	.0023	.1156	1.5848
RESPSCOR(1)	-.3202	.1325	5.8396	1	.0157	-.0841	.7260
Constant	-2.5802	.2315	124.1736	1	.0000		