EDPHiS

The Scottish Government

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EDPHiS

Environmental Determinants of Public Health in Scotland

D.3 – Literature Review: Unintentional Injuries Case Study

Project Start Date: 1 April 2008 **Duration: 4 years**

EDPHiS

The Scottish Government

Unintentional Injuries case study

Scoping report

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FOREWORD

EDPHiS and its role in relation to Good Places, Better Health

EDPHiS (Environmental Determinants of Public Health in Scotland) is a multi-disciplinary collaborative scientific project, funded by the Scottish Government, and designed to inform the development of policy on environment and health in Scotland. As such, EDPHiS is one of the four components of the Intelligence Partnership of Good Places, Better Health (GPBH), whose current (Prototype) phase focuses on how young people in Scotland experience the physical environment, and how that impacts on the four GPBH priority health-related effects of obesity, unintentional injuries, asthma, and mental health and well-being.

GPBH is concerned ultimately with protecting and improving the health of Scotland's young people, and reducing health inequalities among them, by identifying and informing the implementation of policies and actions which protect and improve health through improvements to the physical environment in Scotland, and how young people interact with it. Within the GPBH Intelligence Partnership (IP), and working closely with the other IP partners, EDPHiS helps to inform this development of policy by:

a. Providing evidence reviews of the international scientific literature concerning how the environment affects the lives and health of young people, up to ages 8 or 9 years; and in particular (i) how environmental exposures of young people affect their risks and chances in relation to the four priority health-related effects of GPBH; and (ii) what evidence there is from studies internationally of the success (or not) of interventions intended to improve children's health via the environment.

b. Working with others in the IP and in Scotland more widely to identify relevant sources of information about Scotland in terms of population, environment, health and other contextual factors that may affect the relationships between environment and health.

c. Linking these to provide – as far as the scientific evidence and data allow – estimates of the likely benefits to children in Scotland of policies and actions that may affect their health via changes to the environment and/or how children interact with that environment. These estimates also will include an assessment of how the public health effects are distributed across age, gender, urban-rural and indices of social deprivation.

Evidence reviews of the international literature

These were designed to consider in turn the four priority health impacts of the GPBH Prototype, and to be carried out in two phases: First, a preliminary assessment of the evidence to scope approximately the issues to be addressed and to see what kind of evidence there was about them (Phase 1);

then, a more detailed and focused assessment aiming to provide quantitative evidence of those relationships which were identified as most relevant and important (Phase 2).

The present set of preliminary evidence assessments

The present set of preliminary evidence assessments took as a starting-point a diagrammatic representation (a 'map') of the relationships linking environment, exposure and health effect, developed using the modified DPSEEA modelling framework (Morris et al., 2006) adopted by GPBH. These maps were developed in a series of workshops, led by George Morris and Sheila Beck, where experts summarised current best thinking about how the environment relates to and affects public health.

Where maps were as yet unavailable for the priority health effects in young people, or were limited in scope, they were developed further or from new by the EDPHiS team as part of the preliminary evidence assessment. The main focus of the work thereafter was to consider the relationships proposed by the DPSEEA maps and to make a first assessment of the strength of evidence underlying them, especially insofar as that evidence is relevant to Scotland and its young people.

Following the DPSEEA framework, the Phase 1 reports focus both on (i) the Drivers and Pressures which influence the State of the environment, and the behaviours of children in interacting with it, and (ii) relationships between State of the environment, Exposures (i.e. interactions, whether favourable or unfavourable to health, of young people with the environment), and health Effects; with attention throughout on Actions which might improve children's environment and health.

The present set of four reports is the outcome of these preliminary assessments, which largely were completed about 12 months ago. Each of the four reports is the work of a particular multi-disciplinary team within EDPHiS, and so the reports are individually authored accordingly.

Taking the reports as a set, they represent a compromise between a desire for consistency of approach, and the need to allow differences according to (i) health effect, what it means and how it is measured; (ii) the complexity of the issues that arise in the relationships of environment to that health effect in children; and (iii) the strength and maturity of evidence concerning those relationships. Co-ordination of these compromises between the four case studies was overseen by my colleague Hilary Cowie, who is in effect scientific co-ordinator of EDPHiS and Editor-in-Chief of this set of reports.

We welcome comments and suggestions…

We welcome comments and suggestions on these Phase 1 reviews – on how they are useful, on what needs to be changed and on what in addition should be included – relative to their purpose within GPBH, which is to help ensure that proposed policies and actions are informed by evidence. We hope you

enjoy reading them, and please use the EDPHiS website to let us know what you think: www.edphis.org.

Meanwhile work is now ongoing on more detailed assessments, and on some cross-cutting issues (methodology; what states of the environment have wide impacts across several health endpoints; information needs), as part of the EDPHiS contribution to the Intelligence Partnership of GPBH; and we plan to complete and publish these in the coming months.

Fintan Hurley,
EDPHiS Principal Investigator
IOM Edinburgh, September 2010

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SUMMARY

Background

This case-study is part of the initial stage of the EDPHiS project, which aims to examine the environmental determinants of public health in Scotland and the effects of policies concerning environment on public health. This report concentrates on unintentional injuries, with a focus on scalds and pedestrian road traffic injuries. Injuries are the largest single cause of death in children and young people in most developed countries in the world. They are also a major cause of morbidity, as reflected by hospitalisation, emergency department attendance, primary care visits and long term disability.

Injuries are also very costly to health services. A study in the UK found that the average cost of treating a minor uncomplicated scald in a child was about £1,850, while a study in the US found the average cost of hospitalisation for a scald to be about $1,187. The costs of all road crash injuries are estimated at roughly 1% of gross national product in low-income countries, 1.5% in middle income countries and 2% in high income countries.

Injuries can result in long-term disability and/or treatment. In fact, for every child who dies as the result of an injury there are several thousand who live on with varying degrees of disability. The types of injury suffered differ for different age groups; pre-school children tend to have incidents in the home (e.g. falls, burns and scalds), while school age children are typically injured on the roads or while playing.

According to the WHO Global Burden of Disease data, in 2002, over 700,000 children under the age of 15 died as a result of injury and the majority of these were unintentional injuries (93%). Injury is expected to rise up the global burden of disease league table from around five million deaths to over eight million by 2020, primarily due to growth of motor vehicle ownership and economic growth in low and middle-income countries. The 2004 WHO Global Burden of Disease update states that injuries account for 5% of all female deaths and 8% of all male deaths and that injuries are responsible for 4% of all deaths in children under 5 and 8% of all children under 15.

The proportion of unintentional injuries in children under 15 from road traffic incidents in Scotland (over 25%) is very similar to that of Europe (23%) and the World as a whole (26%). A much higher proportion of deaths occurs in the age group 5-14 than in those aged 0 to 4 (33% vs. 18%, World; and 32% vs. 13%, Europe). These numbers include those killed as vehicle occupants, cyclists and pedestrians. In those aged under 15 48% of all road deaths occur to pedestrians.

Each year in the UK there are about 112,000 burn and scald injuries, of which approximately 104,000 are minor injuries, 7,765 severe, involving admittance to hospital or a specialist burns unit, and 211 fatalities. Children under 5

account for 45% of all severe burn and scald injury, while children aged 5 to 10 account for 8%. In Scotland there were 47 admissions to hospital of children aged under 1,201 children aged 1 to 4 and 19 children aged 5 to 9, for burns and scalds in the year ending March 2008.

Scalds typically occur in children at their learning stage, when they are learning to crawl, walk and explore; hence the highest rate of burns and scalds being in the age group 1-4. Although scalds do not account for a high proportion of deaths in the UK or Scotland (2 deaths from bath water scalds a year) the number of injuries is relatively high.

Both pedestrian road traffic injuries and scald injuries are big problems worldwide and Scotland is no different.

DPSEEA chains

Chains for scalds and pedestrian road traffic accidents developed at DPSEEA workshops are summarised graphically in Figure 1.

It was agreed that for scalds the number of existing chains were enough to describe the causes of scalds in children but there were some additions made to the detail of the chains. There were a number of possible actions and drivers added to the scalds chains. The chain that was seen to be of most importance was hot water systems and there was some debate over the drivers for having hot water systems, in particular the conflict between keeping the stored water very hot to eliminate legionnaires disease and keeping it cooler so that the water that comes from the taps is not at scalding temperature. It was realised that although we know people typically keep their hot water very hot it is unknown the reasons for this. This would be very useful information in deciding how to address the problem of very hot water at taps, particularly bath taps. It was noted that policy aimed at reducing hot water temperature could work in line with climate change policy and could highlight the cost effectiveness of doing so.

For road traffic injuries, it was again thought that the chains were sufficient to describe the risk factors associated with pedestrian road traffic incidents. Through discussion further drivers, actions and contexts were added to the chains. Some of these additions were considered to work in line with policy in other areas, while some might conflict with other policy. An example of this is improving street lighting to make pedestrians more visible which may conflict with possible climate change policies to reduce street lighting. A number of additional actions were discussed, including the use of driver-education, such as ‘Pass-Plus’ and extra benefits that could be associated with this education to encourage new drivers to take part. The issue of speed enforcement devices was discussed and the issue of whether they should be hidden and moved around or left in plain view, as in this country, and which method would work better at reducing the number of crashes and therefore injuries.

There was some agreement that for unintentional injuries burns needed to be considered as well as scalds and road traffic incidents needed to be looked at

in terms of car occupants and car safety. These are possible subjects for further workshops and would result in a number of additional maps.

Figure 1 : Unintentional injuries: maps held by NHS Health Scotland

Summary of evidence for scalds

It is clear from the literature that all of the chains have some impact on the scalds experienced by children.

Hot water systems
There is strong evidence that hot bath water causes scalds in children. There is strong evidence that water in hot water tanks needs to be kept at high temperatures to eliminate the risk of legionnaires disease, recommended 60°C. There is, however, some debate over whether this needs to be kept as high as is recommended. Some studies have found a drop in numbers at temperatures as low as 50°C, which is close to the recommended maximum hot water temperature of 46°C, while other studies have reported that the temperature needs to be higher than 66°C. There is evidence that immunocompetent people are not at risk of legionnaires disease.

There is no available evidence on people's attitude to hot water and the reasons that hot water heaters are set so high. There is evidence concerning the use of educational methods to encourage people, parents in particular, to reduce their hot water temperature. It appears that education alone is not effective in getting people to reduce their hot water temperature but that in combination with media campaigns and safety assessments it may work.

There is strong evidence that thermostatic mixing valves (TMVs) are effective in reducing the temperature of hot water at the tap without reducing the temperature at the tank although there are some issues about the longevity and maintenance of these. There is evidence about the possible cost and energy savings associated with reducing the temperature of hot water, along with evidence that appliances such as washing machines do not need very hot water to be able to function properly.

Domestic appliances which heat water
There is strong evidence that other appliances used to heat water, such as kettles, pots and pans, washing machines and dishwashers, cause scalds in children. There have been a number of suggested design features to prevent scalds, such as coiled flexes on appliances, fully lockable lids, not being able to open appliance while it is on. There is, however, little or no evidence of the effect of these design features on the incidence of scalds.

Hot drinks
There is evidence that hot drinks cause scalds in children, in fact they are the most common cause of scalds in children under 5. Although it has been suggested that changing design of mugs and cups may prevent scalds there is no evidence whether this is the case.

Over-heated formula feeds
There is evidence that hot water being used to heat formula feeds is a cause of scalds in children. The current WHO guidelines on preparing and heating formula feeds may conflict with any policy aimed at reducing scalds in this

area. There is some evidence, however, that the temperature of feeds does not affect the baby.

In the case of scalds, with the exception of hot bath water, the majority of interventions are aimed at reducing scalds in children, and, more generally, incidents in the home. There is evidence that education increases the knowledge of children and parents of the risk factors associated with scalds. It is unclear from the literature, however, how effective education is at reducing the number of injuries in children.

There is evidence that there are gender and socio-economic differences in the incidence of scalds, with males and those from the lower socio-economic status groups experiencing a higher rate of scald injuries.

Summary of evidence for RTA

Traffic speed
There is strong evidence that reducing the speed of cars reduces the risk of injury as well as the severity of injury. There is strong evidence that speed enforcement devices reduce the number of crashes and injuries.

Road infrastructure
There is evidence that traffic calming methods, such as speed bumps, mini roundabouts and 20mph zones, result in a reduction of road traffic incidents, but they do not seem to significantly reduce the number of pedestrian-motor vehicle collisions.

Pedestrians
There is evidence that education changes the knowledge of children and parents but whether this in turn reduces the risk of injury is not clear. The best education programmes are suggested to be those that involve some roadside experience, not just classroom based.

There is evidence that making pedestrians more visible, through improved street lighting as well as reflective clothing on pedestrians improves a driver's recognition and identification of pedestrians. In the case of reflective clothing there is no evidence of whether this reduces the incidence of injury, but there is evidence that improved street lighting reduces the number of incidents and suggestions that this may result in a reduction of injuries.

There is evidence that, as children are still growing, their injuries following a motor-vehicle collision are typically more severe than would be in an adult.

Vehicle design
There are suggestions as to design changes that can be made to the exterior of cars that will aid in lowering the severity of injuries upon impact with a pedestrian. There is little evidence given on the effects of these particular changes but there is evidence that changes that have been made to cars already have improved the safety of the occupants.

Other suggested design changes include the use of alcohol interlocking systems in which drivers have to blow into a breathalyser before starting the car reduce the number of drink-drivers. It is also believed that 'back-up' cameras would reduce the incidence of injuries to children being reversed over as it would make them more visible.

There is evidence that Intelligent Speed Adaptation (ISA), a device within the car which is linked to local speed limits, works in reducing the speed of the driver and raising their awareness of the speed limit. There is currently more research being carried out into these devices.

Traffic levels
There are suggestions that a decrease in walking, and increase in travelling by car, has resulted in lower numbers of pedestrian injuries.

There is evidence that the 'walking bus' increases children's physical activity as well as knowledge of safety in the road setting. It would seem intuitive that an increase in children travelling to school via the 'walking bus' would result in fewer cars being involved in the school run.

Recommendations for phase 2

In phase 2, we will move forward in two principal areas. Firstly, we will scope in more detail the evidence behind the DPSEEA chains for scalds and pedestrian road traffic accidents; looking in particular at the drivers and pressures. For example:

- It would be useful to know people's attitudes to hot water. It will be easier to encourage people to turn down their water temperature if we know why they keep it so hot in the first place. We could also investigate whether people know how to turn down their water temperature, and how easy is it to do this.
- Some investigation into the trade-off between the recommended minimum temperature for legionella control and the recommended maximum temperature of hot tap water to reduce the risk of scalds. Which of these is more important and has biggest effect on the population as a whole and in children specifically
- More research into the effect possible design modifications to cups, mugs, and appliances used to heat water have on the incidence of scalds in children.
- More information of the effects that education has on the incidence of scalds in children and the best type of education (GP, Health Visitor, School etc).
- Research into the use of bottle warmers to heat formula feeds, whether they are used and whether the use of them is effective in reducing the number of scald injuries in children.
- More information is needed about the reasons behind why there are gender and socio-economic differences in injury rates. Is this due to attitudes or circumstance?

- More research into strategies which get children walking more – how do these affect injury rates, traffic levels at start and end of school-day etc.
- Modifications to car fronts and evaluation of the effects this has on child pedestrian injury

Secondly, we will extend the scope of the unintentional injuries case study to include other types of injuries; likely to include burns and road traffic incidents in terms of cyclists, car occupants and car safety.

1 Background

Injuries are the largest single cause of death in children and young people in most developed countries in the world. They are also a major cause of morbidity (Peden *et al.*, 2008), as reflected by hospitalisation, emergency department attendance, primary care visits and long term disability.

Injuries can result in long-term disability and/or treatment; in fact, for every child who dies as the result of an injury there are several thousand who live on with varying degrees of disability.

There has been a decline in unintentional injury mortality over the past 20 years in the UK, but the reasons for this are not clear. It may be that this reflects improved trauma care and survival rather then declining incidence (Roberts *et al*., 1996), though it is assumed that specific injury prevention measures have contributed to this trend.

According to the WHO Global Burden of Disease data, in 2002, over 700,000 children under the age of 15 died as a result of injury. The majority of these are unintentional injuries (93%). The 2004 WHO Global Burden of Disease update states that injuries account for 5% of all female deaths and 8% of all male deaths and that injuries are responsible for 4% of all deaths in children under 5 (WHO GBD update, 2004). Injury is expected to rise up the global burden of disease league table from around five million deaths to over eight million by 2020 (Murray and Lopez, 1997).

The types of injury suffered differ for different age groups; pre-school children tend to have accidents in the home (e.g. falls, burns and scalds), while school age children are typically injured on the roads or while playing (MacInnes and Stone, 2008). In Scotland the death rate per 100,000 population, of children under 15, was 0.1 for home accidents and 0.3 for road traffic accidents, in 2007.

It is well known that boys are at a higher risk of accidents, after infancy, than girls (Pearson *et al*., 2009). It is also evident that there is a strong association between injury risk and social deprivation (Edwards *et al*., 2006) and with dysfunctional parenting in particular, possibly mediated through child behavioural problems (Bijur *et al*,. 1988).

Child injury care at A & E departments in the UK is estimated to cost about £146 million each year (Audit Commission/Healthcare Commission, 2007). The costs to the NHS in the UK of child injury are around £2 billion annually, with the global costs to society estimated to be about 10 times this (Department of Health, 2002).

According to the WHO European report on child injury prevention (WHO, 2008) the average cost per capita of injuries is €19 for those aged under 15.

1.1 Approaches to injury prevention

Prevention is better than cure, particularly as injuries can result in long-term disability and treatment and the effects can be life altering. There is a wide range of injury prevention approaches reported in the public health literature; the two most common are:

1.1.1 Primary, secondary and tertiary prevention

Primary prevention: the removal of circumstances, risks and hazards that lead to injury. Examples are traffic speed reduction, the manufacture of fireproof nightwear, the fitting of hot water thermostats, and intensive parenting interventions.

Secondary prevention: the reduction of injury severity in incidents that do happen. Examples are the fitting of seat belts, the wearing of motorcycle or bicycle helmets and the use of absorbent playground surfaces.

Tertiary prevention: the optimal treatment and rehabilitation of the injured person to minimise the impact of injury. Examples are the administration of effective first aid, the rapid evacuation of injured patients to specialist care facilities, acute surgery and intensive care for trauma victims and the provision of services for the disabled injury victims.

1.1.2 The Three (or four) Es

An alternative and widely quoted conceptualisation of injury prevention is the so-called three Es: education, enforcement of legislation, and engineering (or environmental) measures (in reverse order of efficacy).

Education. Unless people are educated about safety, it is unreasonable to expect them to avoid injury through intuition or guesswork. Education may be directed at various groups – children, parents or carers, professionals and politicians.

Enforcement. Passing legislation that is not enforced, for whatever reason, is pointless. Enforcement, however, is labour intensive and requires sustained commitment on the part of the statutory agencies such as the police and trading standards officers.

Engineering/Environment. Advances in technology, building (including home design), road design, consumer product safety and other forms of engineering, in the broadest sense, all play a role in preventing injury. The wider environment – physical, social, emotional – is crucial to the generation or avoidance of injury risk. An important environmental dimension is poverty; the gradient of risk across children of different social classes is steeper for injury mortality than for many other causes of death in childhood, a phenomenon that may reflect the more hazardous environment of poorer localities.

1.1.3 Active and passive safety

Another distinction in injury prevention approaches is between active and passive approaches. The active approach to safety requires individuals to take positive actions or to change behaviour. The passive approach requires neither but creates the conditions where safety is promoted regardless of human judgement or behaviour. Examples of the former are: avoiding drink driving, supervising children at play and using seat belts. Examples of the latter are: domestic water thermostats, automatic sprinklers attached to smoke detectors and energy absorbent playground surfaces. In general, passive approaches to injury prevention have been found to be more effective than active ones presumably because it minimises the necessity for human decision-making. This finding has important implications for preventive policy making.

Over the past few decades many studies have investigated the impact of different intervention methods on the incidence and severity of injuries, particularly in children. Although more research is always required, full implementation of the existing body of evidence could reduce the incidence and impact of injury substantially. A study of childhood injury in the US estimated that a further third of all childhood injury deaths could be avoided if the interventions known to be effective were implemented across the country (Rivara and Grossman, 1996). The effect of this has not yet been investigated in the UK but it is intuitive that there would a substantial reduction in the injuries to children in the UK if all of the interventions known to be effective were implemented.

1.2 Injury Prevention and the Environment

The relationship between environment, health and safety is far from straightforward. We are exposed to many environmental influences as we move between our homes and the places where we work, learn, shop, play and socialise. Aspects of environment combine and interact in complex ways to create and damage health, wellbeing and safety. Effects may be immediate or delayed, depending on the nature of the exposure, and are influenced by personal factors such as age, gender, and genetic make up.

Aspects of environment may shape whether an individual can engage in healthy and safe behaviour. The absence of facilities like parks and green space will limit opportunity for safe physical activity. Threatening, poorly designed or otherwise unsatisfactory environments may pose direct or indirect hazards to residents, particularly children, or may discourage or prevent access to places where health promoting activity can take place.

The physical environment also influences how we think about our communities and ourselves, whether we feel safe and indeed whether we feel part of a community at all. Thus the physical environment in our communities and particularly our poorest communities may affect levels of stress, capacity to cope and general resilience. This can lead to psychological problems and influence both the biological and behavioural processes of disease, including

injury. The term ‘psychosocial’ is often used to capture what can be seen as a rather diffuse, but potentially very important mechanism linking health in general, and safety in particular, to life circumstances**.**

Morris *et al*. (2006) asserted that manipulation of the environment is an underexploited option in Western societies in addressing contemporary health challenges to the point where the term “environmental health” is associated overwhelmingly with a narrow range of activities centring on the enforcement of regulations relating to specific toxic, infectious or allergenic agents. A consequence of this phenomenon is that one of the most serious threats to human health – injury – has been largely excluded from the environmental health paradigm.

2 Scalds

2.1 Health endpoint definition

Unintentional physical injuries of any severity – fatal and non-fatal - to children aged 0-8 years as a result of direct skin contact with a hot liquid of any type in any setting during any activity.

2.2 Background

Home accidents are more likely to occur to pre-school children; these include falls, burns and scalds. Burns and scalds are thought to be the most debilitating of home accidents, and the ones for which the correct methods of prevention could make a big difference.

In the majority of the literature burns and scalds are grouped together as the resulting injuries are very similar, although they do have different causes. The long-term effects of scalds include disability, disfigurement and psychological harm. Repeated skin grafts may be needed as the child gets older. The severity of a scald is dependent on the temperature of the liquid, length of exposure, treatment and the speed at which this treatment is given.

Each year in the UK there are about 112,000 burn and scald injuries, of which there approximately 104,000 minor injuries, 7,765 serious, involving admittance to hospital or a specialist burns unit, and 211 fatalities (DTI, 1999).

In Scotland in the year ending March 2008 there were 4 deaths due to accidents in the home and 3,105 hospital admissions. Burns and scalds accounted for 154 of these admissions. There were 47 admissions of children under 1, 201 in children aged 1-4 and 19 in children aged 5 to 9, for burns and scalds.

According to the WHO GBD data 5.4% of all burn related deaths are as the result of scalds (WHO report on child injury prevention, 2008).

In Finland an 11 year old study found that of all children being admitted to 2 paediatric burns units 42.2% were due to scalds, 100% of all those under 3 were scalded by hot water (Papp *et al*., 2008). In Kuwait, scalds were the most common cause of burns in children under 15, accounting for 67% (Sharma *et al*., 2006).

A study in the UK found that the average cost of a minor uncomplicated scald in a child was about £1,850 (Griffiths *et al.*, 2006), while a study in the US found the average cost of hospitalisation for a scald to be about $1,187 (Forjuoh, 1998).

Table 1 illustrates the temperatures and length of exposure to hot water at which second degree burns occur in adults. In children this would occur a lot faster and at lower temperatures as a baby's skin is up to 15 times thinner than an adult's. Water at 60°C can result in a second degree burn after 3 seconds and a third degree burn after 5. The Child Accident Prevention Trust recommends that bath hot water tap temperature be no more than 46°C.

Typically the bath and shower temperature for infants and toddlers is between 32 and 41°C while adults normally bathe and shower in water of temperatures between 34 and 41°C.

There were 3,439 admissions to hospital as a result of accidents in the home of children under 15 in 2007 in Scotland.

In the year ending March 2008, for females, there were 22 admissions of children under 1 for burns and scalds in the home, 90 aged 1-4 and 14 aged 5-9. For males these number of admissions for burns and scalds in the home were 25, 111 and 5 for those aged under 1, 1-4 and 5-9, respectively.

Emergency hospital admissions appear to be associated with deprivation. When compared to the total number of admissions the standardised discharge rate for accidents in the home was 132.4 (124.0 to 140.9) for the most deprived compared to 783.7 (66.8 to 80.6).

Table 1 Exposure time at given temperatures that causes deep second degree burn injury in adults *Source: Huyer et al. 1997*

Temperature (°C)	Exposure Time
44	6 hours
49	9 minutes
51	2-6 minutes
52	2 minutes
55	20-30 seconds
60	5-6 seconds
66	2 seconds
70	1 second

Table 2 Typical hot water temperatures in daily living *Source: Huyer et al 1997*

Temperature range (°C)	Activity
32-41	Infant and Toddler's bath
34-45	Adult's bath
39-41	Adult's shower
41-42	Hot tub
42-45	Too hot for activities – threshold for sensation of pain in adults

Table 3 Source J P Bull, Public Health Association of Australia (taken from DTI 1999)

Exposure	Temperature (°C)	
10 seconds	At 50	Redness
10 seconds	At 60	Very superficial burn
10 seconds	At 70	Full thickness burn
1 second	> 70	Partial thickness burn
1 minute	At 55-65	Partial thickness burn
5 minutes	At 50	Full thickness burn

2.3 DPSEEA maps

Table 4 has a summary of the 4 chains for scalds.

Table 4: Summary of chains for scalds in children

Chain	Drivers	Pressures	State	Exposure	Effect	Contexts
1. Hot water systems	Legionnaires Control; Cheap Fuel; Reluctance to control heating systems; Hot water systems that are hard to control; Culture of extremely hot water; Use of solar panels (provide very hot water)	Increasing use of hot water above scalding temperature	Tap water above scalding temperature	Skin or mucous membrane contact with hot water	Tissue damage (scalding) leading to morbidity and mortality	Age; Socio-economic; Behavioural
2. White goods and other appliances which heat fluids	Increased use of appliances; Reluctance to design or require safety features; Use of hidden boilers and tea urns; Use of primus stoves in homes	Heating of fluids by appliances in the home	Fluids heated beyond scald temperature in products or appliances which are within tipping distance of children	Skin or mucous membrane contact with hot water	Tissue damage (scalding) leading to morbidity and mortality	Age; Socio-economic; Behavioural; Families in temporary accommodation
3. Hot Drinks	Marketing of tea bags and hot drinks ‘to go’; Increasing consumption of hot drinks away from the table; lack of room for tables and lack of barriers in kitchen; Design of	Heating and transit of hot drinks	Hot drinks which are over heated, in transit, and or in unstable containers. Kettles and pots boiling on stove	Skin or mucous membrane contact with hot water	Tissue damage (scalding) leading to morbidity and mortality	Age; Socio-economic; Behavioural; Population density; Latch-key kids

	cups/mugs for hot drinks are unstable; Increased use of microwaves					
4. Formula Feeding	Historical and societal move away from breastfeeding; Marketing of formula feed; Limited acceptability if or facilities for breastfeeding; Early return to work for mothers; Increased use of microwaves	Overheating of formula feeds	Formula feeds above scald temperature for babies	Skin or mucous membrane contact with hot water	Tissue damage (scalding) leading to morbidity and mortality	Age; Socio-economic Behavioural

2.4 Discussion of chains from GBPH workshop

At the workshop it was agreed that the number of chains were sufficient to describe the situations in which scalds to children occur.

Some additions were made to the chains, particularly the addition of drivers to most of the chains discussed.

The chain that was seen to be of most importance was hot water systems and there was some debate over the drivers for having hot water systems, in particular the conflict between keeping the stored water very hot to eliminate legionnaires disease and keeping it cooler so that the water that comes from the taps is not at scalding temperature. It was realised that although we know people typically keep their hot water very hot it is unknown the reasons for this. This would be very useful information in deciding how to address the problem of very hot water at taps, particularly bath taps.

It was noted that policy aimed at reducing hot water temperature could work in line with climate change policy and could highlight the cost effectiveness of doing so.

It was agreed that burns should be looked into in addition to scalds.

Changes were made to the chains through the discussions in the workshop and additionally by participants after distribution of the initial report from the workshop. The discussion in this report is based on the updated DPSEEA maps.

2.5 Evidence

2.5.1 Chain 1 – Hot Water Systems

There is strong evidence that hot water systems, in particular bathing water, are a major cause of scalds in children.

The Department of Trade and Industry reported (1999) that every year 20 people die as a result of a scald from hot bath water, 2 of these deaths are children under 5. Five hundred and seventy people suffer serious injuries requiring admission to hospital and/or transfer to a specialist burns unit, 77% of these are in children under 5 (n=437) and 8% are in children aged 5-10. In fact hot bath water is the second most common cause of scalds in children under 5 in the UK with a high proportion requiring stays in hospital of more than 5 days and/or transfer to a specialist burns unit; 67% of those under 5 with severe injuries and 33% of those aged 5-10.

Bath water scalds in those under 5 are generally caused by children being left unsupervised and climbing into a bath of very hot water (29%) and by falling into hot water (37%). Falling into hot water is the most common cause of severe injury scalds in 5-10 year olds (59%). (DTI, 1999).

Those under 2-2.5 years old generally suffer burns on 20-50% of their total body surface, typically on their whole body. While those 2.5-3 years and upwards generally suffer burns on 10-25% of their total body surface, this is on feet and ankles if standing, whole body if prone.

Each year in the UK 2000 children attend emergency departments after a bath water scald and 500 are admitted to hospital for treatment, children under 5 account for about 86% of these admissions.

Ytterstad *et al.* (1995) reported that, in their study of a media campaign to reduce scalds in Norway, they found the most common causes to be hot water and hot coffee (two thirds of all injured under 2 years old).

Yeoh *et al.* (1994) found an incidence of bath scalds of 14.7 per 100,000 children aged under five and 1.7 per 100,000 children aged between 5 and 15 in a study of all children admitted to a burns unit in Chepstow between 1991 and 1993. They found that the most common cause of sustaining a bath scald injury was through falling into the bath (56% of 68 children studied). They suggested that the best way to reduce the hot water temperature would be to either turn down the thermostatic temperature in domestic hot water tanks or use thermostatically controlled mixer taps.

A number of studies have found that the average hot water heater temperature is above the temperature recommended by the Child Accident Prevention Trust, 46°C.

Huyer and Corkum (1997) and Kemp and Sibert (1995) found that the thermostats on hot water boilers in homes were frequently set at 60°C or above. Stephen and Murray (1991) found that 71% of 200 immersion heaters tested were set at temperatures above 65°C, while Georgieff and Maw (2004) found an average temperature of 60.4°C in a survey of 165 homes.

Actions

A number of possible actions have been suggested within the literature, and by accident and injury prevention groups, to reduce the risk of scalds caused by hot bath water. These include education about hot water safety, promotion and recommendations to turn down the temperature of hot water heaters, promotion and the fitting of thermostatic mixing valves.

There have been a number of studies aimed at educating families about the dangers of very hot bath water and encouraging them to test their water temperature. These have had limited success.

Towner *et al* (2001) noted that more evidence is needed to determine the impacts of legislation relating to hot water systems on burn and scald injuries.

They also reported that there is little evidence that campaigns involving fitting of devices to control hot water are an effective way of reducing the water temperature.

Education of parents

DiGuiseppi & Roberts (2000) investigated the impact of interventions to prevent injuries. They found that all of the five trials reported to have used an educational intervention aimed at getting parents to test their hot water temperature, and lower it if needed, found an effect of the intervention, compared to a control group.

Kelly (1987) found that, in addition to the usual well-child visit, a fifteen minute developmentally oriented child safety education, hazard assessment and handout by a research physician resulted in 74% of the intervention group having a safe water temperature, compared to 63% of the control group, who only received the well-child visit (OR = 1.72, 95% CI 0.76 to 3.91).

Williams (1988) evaluated the use of a one-hour safety lecture and handouts on burn prevention as well as the usual safety education, while the control group received only the usual; safety education. They found a safe water temperature in 56% of intervention homes and 31% of control homes (OR = 2.82, 95% CI 1.09 to 7.33).

The same type of intervention was investigated by Thomas (1984), they found that 76% of the intervention group had a safe water temperature post-intervention, compared to 23% of the control group (OR = 10.48, 95% CI 3.01 to 36.47). It was also reported that 66% of the intervention group lowered their temperature compared with 0% of the control group. DiGuiseppi (2000) noted that this study had weaknesses in all of the measured aspects of the study design and also that as this was one of the earlier studies concentrating on lowering hot water temperature the baseline likelihood of lowering hot water temperature would have been very low, both of these could explain the relatively high odds ratio.

Barone (1988) investigated the impact of a very similar educational intervention but with the added provision of a tap water thermometer to the intervention group. They found a safe water temperature in 41% of homes in the intervention group and 39% of the control group (OR = 1.16, 95%CI 0.46 to 2.91). They also reported that 44% of the intervention group lowered their water temperature, compared to 29% of the control group.

The study investigated by Shapiro (1987) gave both the control and intervention group pamphlets about scalds and a free tap water thermometer. The intervention group also received a one-minute education about the pamphlet

and thermometer. They found that 51% of the intervention group tested their water temperature, compared to 29% of the control group.

Katcher (1989) found that fewer than half of the families who had received counselling by paediatricians and a free thermometer actually tested their water temperature. They reported that 46% of the intervention group tested their water temperature; compared to 23% of control group and that 14% of the intervention group lowered their temperature, compared to 9% of the control group.

Webne *et al.* (1989) studied interventions aimed at reducing the thermostat temperature settings in Canada through the use of a pamphlet and liquid crystal thermometer as well as four home visits found that the intervention had no significant impact. They reported that there was no statistically significant difference in the proportion of heaters with safe hot water temperature post intervention.

Minkovitz (2003) investigated the use of the "Healthy Steps Programme" for the first three years of life in injury prevention in children. They found that this programme had no significant effect on the proportion of families who lowered the temperature of their water heaters (59.9% in the intervention group vs. 58.1% in the control group, $p = 0.26$)

Education through media

Katcher (1987) investigated the use of a mass media injury prevention program and its impact on risk awareness of hot tap water burns. They found an increase in awareness of the dangers of hot tap water, 72% to 89%, but found that there was no significant effect on the testing or lowering of hot water heater temperatures. They did find that there was a significant increase in the testing, and lowering, of hot water among those who had requested the LCD thermometers offered, free of charge, as part of the media campaign (61.5% of the requesters who were surveyed).

Waller *et al.* (1993) evaluated interventions to reduce hot water settings in Dunedin, New Zealand, comprising of a half-hour educational home visit which included measurement of the hot water temperature, discussion of how to lower the temperature and the offer of free advice from a plumber for those in the intervention group. There was also a national media campaign on the risks of hot water. They found that there was a significant decrease in the mean hot water temperature from 64.2 to 61.2. The proportion of homes with hot water below 60 degrees increased from 9.3% to 41.9% in the intervention group and from 10% to 30% in the control group (33% to 47% overall). Although there were significant decreases in tap water temperature as a result of the national media campaign the majority of households still had temperatures of higher than 55 degrees at the end of the study. They reported that an educational campaign was too time intensive and not very effective, while the media campaign was the best way to reach the public.

Education through plumbers

Jaye *et al.*, (2001) carried out a study interviewing plumbers about hot tap water temperatures. They concluded that plumbers can be a barrier to safe hot water temperature if they lack knowledge, skills or commitment to hot tap water safety. They noted that if plumbers were well informed skilled and committed they could be a useful tool in promoting hot water safety.

Legislation – water heater temperature and thermostatic mixing valves

It has been found that interventions that do not need families to actively participate are more successful. Legislation in the USA in 1983 required that new water heaters be set to 49°C; this was associated with a reduction in the percentage of homes with tap water temperature above 54°C from 80% to 23% over the five years post legislation (Erdman *et al*., 1991) and they also found a decrease in hospital admission rates from 5.5 per year before to 2.4 per year after the regulation came into effect. They reported that educational programs to reduce the hot water temperature were effective and that legislation resulted in a decrease in the number of homes with tap water higher than 54°C, and the mean water temperature was 50°C in 1988, compared with 61°C in 1977.

Scotland has changed their building standards in 2006 so that every new or refurbished home is now required to be fitted with thermostatic mixing valves (Scottish building standards, 2007), however there is, as yet, no such requirement in England and Wales.

Thermostatic Mixing Valves (TMVs) are fitted across the hot and cold water supply pipes to the bath. This allows the hot tap water temperature to be set at a fixed temperature.

One study in the US which fitted TMVs in 20 households found that they were very effective in reducing the temperature of the hot water tap in the bath. However, they also found that 19 of these had to be removed in the first 9 months due to the build up of sediment (Fallat & Rengers, 1993). They found that before the intervention although 90% of families had their water heaters set at warm (<=120°F) the actual temperature was actually above 130°F in 71%.

Cagle *et al*. (2006) studied the effectiveness of a scald prevention program which included fitting anti-scald devices in 37 homes. They found a lower hospital admission rate for scalds in the areas where the prevention program was implemented. But again they found that only 60% of the anti-scald devices fitted were still fitted and functional 6 to 12 months after being fitted.

A review by Towner *et al*. (2001) found that there was no evidence that devices to control temperatures of hot water are effective in reducing water temperatures.

Promoting Financial Benefits of Reducing Temperature

An extra benefit that can be achieved through reducing the hot water heater temperature is that energy can be saved by doing so. It has been found that as much as 10% can be saved on water heating by turning heaters down to 49°C (Feldman *et al*., 1978; Stanwick *et al*., 1981).

Driving Forces

Legionella Control

One reason for having high hot water temperatures is to reduce the risk of *legionella pneumophila*. The risk of water heaters being colonised by *legionella pneumophila* increases at temperatures below 60°C (Farrell *et al*., 1990; Murray, 1988; Stanwick, 1986; Stone *et al*., 2000; Weaver *et al*., 1993). A number of studies have found a drop in numbers of bacteria at about 50°C (Groothuis & Veenendaal, 1983; Groothuis *et al*., 1985; Patterson *et al*., 1997; Rogers *et al*., 1994; Yee & Wadowsky, 1982) while another group of studies have found that there is *legionella* present in water as hot as 66°C (Patterson *et al*., 1997; Rogers *et al*., 1994; Zacheus & Martikainen, 1994).

Although contamination of the water is not common in residential water heaters it does occur. However studies have shown that it does not appear to be an important source of infection in children and immunocompetent people (Huyer & Corkum, 1997) and that lowering the temperature of domestic water heaters will not cause a *legionella* epidemic (Alary & Joly, 1991; Joly, 1984; Skelton, 2002; Stone *et al.,* 2000; Zacheus & Martikainen, 1994). Waller *et al*. (1993) stated that education was needed to dispel the myths about household hot water, such as the threat of *legionella*.

There is an obvious conflict with the recommendation of high temperatures to control for *legionella* and lower temperatures to reduce the risk of scalds.

Studies have found factors that can affect the existence of *legionella* in hot water systems, such as; the use of copper pipes in plumbing has been associated with retarded growth of *legionella pneumophila* (Rogers *et al*., 1994; Zacheus & Martikainen, 1994), placing the heating element at the bottom of the hot water tank (Alary & Joly, 1991; Joly, 1985).

Hygiene

It is believed that for hygienic purposes, in particular in the use of dishwashers and washing machines, water temperatures should be high. In the past detergents were designed to be used at temperatures of 60°C. Recent studies, however, suggest that detergents will still operate effectively at much lower temperatures. Baptiste and Feck (1980) found that four out of six major washing detergents tested met public health germ kill standards and had good to excellent cleaning results at temperatures as low as 38°C; other studies have found similar results (Katcher, 1981; Feldman *et* al., 1978; Stanwick *et* al., 1981).

Additionally washing machines do not necessarily need to intake hot water but in fact heat the water internally so even if high temperatures are required for washing clothes etc it may be that the hot water heater does not have to be set at a very high temperature to achieve this.

Similarly keeping hot water above 60°C solely for use in dishwashers is no longer necessary either. There are dishwashers available with an internal heating element, these may be more expensive but studies have shown that there is a substantial reduction in the use of energy which could offset the cost (Feldman *et* al., 1978; Maley & Achauer, 1987; Baptiste & Feck, 1980).

2.5.2 Chain 2 – White goods and other appliances which heat fluids

There is strong evidence of a link between the use of kettles and pots and pans to heat water and scalds to children.

Table 5 lists the number of severe injuries, according to the DTI report (1999), in the UK from appliances which heat fluids. Kettles are the third most common cause of scalds in children under 5 in the UK, with 367 severe injuries occurring each year (DTI, 1999). They are also the cause of severe injury scalds to 87 children aged between 5 and 10 years old each year. Saucepans are the cause of over 120 severe injuries in children under 5 in the UK every year (DTI, 1999), 54% of these severe injuries resulted in a stay in hospital of over 5 days and/or transfer to a specialist burns unit.

For children under 5 years, scalds due to the appliances listed in the table generally happen as a result of children pulling the appliance or flex or knocking the contents over themselves. For kettles and saucepans this typically results in scalds over 10-20% of the total body surface area.

Table 5: Number of severe injuries and deaths due to scalds and the appliances listed as the cause of injury. *Source: DTI 1999 report.*

Appliance	Severe injuries (0-4)	Causes	Severe injuries (5-10)	Causes
Kettle	367	44% Grabbed kettle 18% grabbed trailing flex	87	37% Making hot drink and spilling contents of kettle
Chip pan / Deep fat fryer	59	33% Grabbed deep fat fryer or flex 33% grabbed chip pan from cooker	33	67% pulled chip pan/ deep fat fryer on self
Saucepans	122	63% pulling contents onto themselves	41	50% ran into parent holding pan 25% pulled pan onto themselves
Teapot / coffeepot	151	70% pulled coffee/teapot onto themselves 15% spilt hot tea on themselves	13	

Actions

The majority if the literature in relation to scalds focuses on bath water and hot drinks but the appliances listed in table 5 play a significant role in scald injuries.

There are many suggested actions that can be taken to prevent scalds from both pots and pans and kettles but no literature that evaluates any of these actions specifically has been found.

The Department of Trade and Industry report (1999) lists a number of suggested actions:

- Flex of the kettle – curly or short flexes
- Kettle, coffee pots, teapots and Deep far fryer - fully lockable lids
- Kettle - Traditional shaped kettles provide a larger base area – making the kettle more stable on the work surface than the smaller base of the jug kettle.
- Kettle - Plastic kettles which will have a lower outer temp.
- Kettle, coffee pots, teapots and Deep fat fryer - A safety release button which has to be pressed to allow liquid to flow.
- Pots and Pans – Cooker guard
- Use deep fat fryers rather than chip pans on cookers – they have built in thermo protection and are seen as more stable.
- Cool wall deep fat fryers
- Warning stickers about the dangers of scalds

Suggested education:

- Don't put receptacles which contain hot water or fat within the reach of children – don't put on floor and keep as far back on the worktop as possible.
- Ensure that the flex is not hanging down
- Only boil enough water for your immediate needs and empty kettle immediately
- Ensure young children are safely away form cooker
- Turn saucepan handles towards the inside of the cooker
- When possible use back rings rather than front on a cooker
- Microwaving or oven chips – basically eliminates the need for deep fat fryer.
- Never carry anything containing hot water when carrying small children

The facility to shorten the flex on deep fat fryers has been available since the 1980s, however it is not known whether customers are aware of this and use it.

Eadie *et al*. (1995) reported that scalds caused by kettles accounted for 28% of all scalds admitted to the Welsh Centre for Burns and Plastic Surgery.

The majority of the literature assesses the efficacy of interventions in the prevention of accidents in the home in general, of which scalds are a major contributor. Most of these interventions are home or community based education programs and they have had mixed success.

2.5.3 Chain 3 – Hot Drinks

Hot drinks are the number one cause of scalds in children under 5 in the UK, with 1094 severe injuries, defined as those that required admission to hospital (Department of Trade and Industry, 1999). Hot drink scalds are less prevalent in children aged 5 to 10 but are still the cause of 58 severe injuries a year.

Most accidents involving hot drinks involve children reaching up and pulling the contents over themselves (59%). Injuries for those aged 0 to 18 months typically suffer 15-20% of the total body surface, on the face, neck, shoulder, chest and arms, while those 18 months to 4 suffer scalds in the same location of the body but with only 5-10% total body surface scalds.

A cohort study carried out with over 14,000 children in Avon found that scalds accounted for 84 injury events, with the main cause of these being hot drinks (33%) and hot water (13%) (Warrington *et al.*, 2001).

Ytterstad *et al.* (1995) reported that, in their study of a media campaign to reduce scalds, they found the most common causes to be hot water and hot coffee (two thirds of all injured under 2 years old).

Actions

Throughout the literature there have been suggestions as to product designs that may help prevent scalds caused by hot drinks. These include; lids such as on takeaway cups, broad based slip resistant mugs and heat indicators. Education and safety advice is also a proposed intervention method. As with chain 2 the majority of the literature reports on interventions aimed at reducing scalds in the home in general.

Driving Forces

Studies comparing the pattern of scalds at the Welsh centre for Burns and Plastic Surgery (Eadie *et al.,* 1995) have found that scalds from teapots have fallen from a fifth of all scalds in 1956 to very few cases in 1991. They found, however, that scalds from hot drinks in cups and mugs has increased from one in 10 in 1956 to almost half of all scald injuries in 1991. This change may represent the change in drinking tea and coffee from pots to now drinking instant tea and coffee from mugs.

2.5.4 Chain 4 – Formula Feeds

There is strong evidence of a link between heating formula feeds and scalds. Scalding caused by the use of hot water to heat formula feeds only appears to be prevalent in those under five.

The Department of Trade and Industry (1999) reported that jugs of hot water are considered to be involved in severe injury scalds of over 130 children under 5 in the UK every year and that the majority of these jugs are being used to heat baby's milk bottles. 44% of severe injuries to those aged under 5 resulted in a stay in hospital of longer then 5 days and/or transfer to a specialist burns unit, with 46% of these accidents involving children less than 12 months old. Accidents occurring due to water being used to heat bottles are generally caused by children pulling the jug onto them (44%) or knocking the jug onto themselves (19%), while for 15% a parent or sibling knocked the jug over.

Typically accidents in which children reach up and pull a container with hot water in it over themselves occur when children reach a new developmental stage, i.e. learning to crawl, stand and walk.

Those under 5 experience burns on 20-40% of their total body surface (back, buttocks, chest, legs, arms) when the jug is pulled over onto themselves, and 5-15% (feet and legs) where accidentally kicked over.

The Department of Trade and Industry also report on incidents involving bowls or buckets of hot water – the report notes that these are being used to heat bottles but also for washing floors, or for inhaling steam. They say that 65 children under 5 receive severe injury scalds as result of buckets and bowls of hot water. It is noted that 26% of these are as a result of pulling bowls onto

themselves, half of which are being used to heat baby bottles. Baby bottles result in 54 severe injuries in those under 5 every year, 54% of these result in a stay in hospital of more than 5 days and/or transfer to a specialist burns unit. 46% are caused by babies pulling bottles over that are either being cleaned and are full of hot water or are full of very hot milk.

In an article in the British Medical Journal (BMJ), Jeffery *et al.* (2000) noted that in the space of three years (1995 to 1998) 23 children were admitted to their burns unit with scalds that had resulted from infants knocking or pulling over jugs or bowls of hot water that were being used to heat bottles of milk. They also noted that a previous audit had found that this was the cause of scalds in 18% of cases.

In response to this article a letter, also in the BMJ, quoted that 6% of children aged under 2 in Bristol were admitted for scalds caused by water from jugs being used to heat bottles (Thomas, 2000).

Driving Forces

Breastfeeding Rates

Although breast feeding rates are no longer at 100% there has been a steady increase in the rate of breastfeeding from 1990 to 2005 in all countries of the UK. The 2005 infant feeding survey found that there was an association between breast feeding and socio-economic status with 88% of mothers in managerial and professional occupations breastfeeding initially, compared with 77% of mothers in intermediate occupations, and 65% of mothers in routine and manual occupations. Breastfeeding rates among mothers who had never worked were similar to those found among mothers in routine and manual occupations (65%). The increase in breastfeeding rates from the 2000 survey was higher among the lower socio-economic groups. It was also found that there was an association between the rate of breastfeeding and the age of the mother, as well as the age at which the mother left full-time education (Bolling, 2006).

WHO guidelines on formula heating

The current guidelines from the World Health Organisation recommend that feeds should be prepared at water temperatures of no less than 70 degrees, quickly cooled, then used, or stored for up to 24 hours. The use of water at such high temperatures to prepare the feeds is recommended to reduce the risk of *Enterobacter sakazakii* and *Salmonella enterica*. They recommend that if re-heating formula feeds the bottle should be place in a container of warm water, it is stated that microwaves should not be used for the reheating of formula feeds as uneven heating may occur (World Health Organisation, 2007).

Actions

Education - prevention

As with chains 2 and 3, the interventions associated with scalds in the home would also be relevant to scalds due to heating baby bottles.

Education – encouraging breastfeeding

There are reviews available on interventions to encourage breast feeding.

The review carried out by Britton *et al*. (2007) on the impact of support for breastfeeding mothers found that all forms of extra support analysed together resulted in an increase in the duration of 'any breastfeeding' (partial and exclusive), the relative risk for stopping any breastfeeding before six months was 0.91 (95% CI 0.86 to 0.96).

All forms of extra support together had a larger effect on the duration of exclusive breastfeeding than on any breastfeeding (RR = 0.81, 95% CI 0.74 to 0.89). Lay and professional support together extended the duration of any breastfeeding significantly (RR before 4-6 weeks = 0.65, 95% CI 0.51 to 0.82; RR before 2 months = 0.74, 95% CI 0.66 to 0.83). Exclusive breastfeeding was significantly prolonged as a result of WHO/UNICEF training (RR = 0.69, 95% CI 0.52 to 0.91).

Another review carried out by Dyson *et al.* (2005) found that breastfeeding education had a significant effect on increasing initiation rates in areas of low income and typically low initiation rates in the USA, compared to the standard care (RR = 1.57, 95% CI 1.15 to 2.15). They also found that one to one, needs based, informal repeat education sessions and generic, formal antenatal education sessions were effective at increasing the initiation rates of breastfeeding among women on low incomes.

Encouraging use of bottle warmers

The Department of Trade and Industry recommended the use of bottle warmers and microwaves to heat bottles instead to rule out this scald risk. They also recommended that jugs should be placed out of reach and never on the floor.

Guidelines – Heating Milk

Costalos *et al.* (1979) investigated the effect of temperature of baby milk on gastric emptying after milk feeds in 31 infants, where some were fed milk at room temperature and some were fed milk at body temperature. Their work suggests that the temperature of the milk has no effect on gastric emptying. Work carried out in other studies suggested that the temperature of the milk made no difference to acceptance of feed by baby (Gibson, 1958), or to sleep patterns, vocalisations, motility, food or fluid intake, weight gain or amount of regurgitation (Holt *et al.*, 1962 and Illingworth, 1972).

2.5.5 Interventions to prevent scalds in the home

In the case of scalds in the home, with the exception of hot water heaters, the majority of interventions investigated in the literature concern prevention of all accidents in the home, although there are some that specifically target burns and scalds in the home.

Education interventions aimed specifically at scalds

The majority of the literature investigates methods of raising awareness of hazards and changing the behaviour of the parents so as to make the risk of accidents in the home, resulting in scalds, less likely.

A review carried out by Towner *et al* (2001) on what works in preventing childhood injury looked at the prevention of burns and scalds. They found that education campaigns have been partially effective in increasing knowledge of burn and scald prevention but they noted that there was little evidence that education alone has achieved reduction in injuries. They also noted that improved product design has been associated with reductions in specific burn and scald injury.

Turner *et al*. (2004) concluded that the research available to enable conclusions to be made about the effectiveness of community based injury prevention programmes on burn and scald injuries in children is limited.

The use of a single multimedia lecture on burn prevention increased knowledge scores for all age groups (Linares and Linares, 1979). Eckelt *et al*. (1985) also found that a one hour burn prevention lecture increased the knowledge scores of children, from 66 to 80%.

Project Burn Prevention in the US was evaluated through a number of papers (McLoughlin *et al*., 1979; McLoughlin *et al*., 1982 and McKay and Rothman, 1982). The project involved a public education programme to reduce burn injuries, through school and community activities. They found that there was no clear reduction in burn injury rates or injury severity following the intervention but that there was an increase in knowledge scores.

Elberg *et al*. (1987) evaluated a 10 year information campaign, consisting of press, radio and TV as well as product modification. They found a 50% reduction in all burn injuries.

Varas *et al*. (1988) found that a multimedia burn prevention presentation increased knowledge of children aged 6-10, from only 1% being able to answer all questions correctly pre to 61% post presentation.

Guyer *et al*. (1989) investigated the impact of the “Statewide Childhood Injury Prevention Program (SCIPP)” in nine cities in Massachusetts, where burns and scalds were targeted through an education program delivered through schools and the community. They found that the incidence of burns and scalds

increased in both the intervention (52.56 per 10,000 person years to 59.68) and control (75.01 to 106.03) communities. The socio-economic status adjusted odds ratio for a burn injury post v pre intervention was 1.26 (95% CI 0.84 to 1.90) in the intervention group.

A burns prevention programme aimed at schools found that there was no difference in the knowledge scores of the intervention and control group, although it was noted that the baseline scores were high (Grant *et al*., 1992).

Ytterstad (1995) studied the impact of a multi-faceted community campaign including the promotion of cooker guards and setting of tap water temperature at 55 degrees on injuries in children under 5. They found a 52.9% decrease in burn and scald injuries in the intervention group (from 52.4 to 24.7 per 10,000 person years), while there was a non-significant 9.9% increase in the control community. They also found a reduction in hospital admissions from 103.4 per 10,000 person-years to 48.6. The relative risk of burn injury in the intervention community was 0.47 (P = 0.045).

In 1998 Ytterstad *et al*., reported that the incidence of burns and scalds had decreased further to 57.5% (RR = 0.49, P = 0.04), compared to the baseline, and increased further in the control community by 18.1%, compared to baseline. They did report that the severity of thermal injuries recorded during this follow-up had decreased and that there were no injuries caused by tap water or from pots/pans etc being pulled from stoves.

King *et al.* (1999) evaluated a mass media campaign which included newspapers, radio, posters and flyers, aimed at Vietnamese, Chinese and Arabic families in Australia. They found that knowledge of correct first aid practices increased from 42% before to 63% after the campaign.

A schools-based scald prevention programme aimed at children aged 7 to 11, which included take-home exercises to encourage changes in the home found that those in the intervention group identified more hazards after the intervention (year 2 – 5.8 more, year 4 – 6.7 more and year 8 – 8.1 more), while the control groups hazard identification did not appear to increase (0, 0.3, 0.7) (Harré and Coveney, 2000). The children at the intervention school improved significantly more than the children at the control school (P<0.0005).

Peleg (2005) compared the rate of burn injuries in Israeli communities who had implemented a burn prevention program (intervention) with those that had not (control). They found that the rate of burn-related injuries decreased significantly by 25% in intervention communities (from 1.39 per 1,000 to 1.05 per 1,000 population) but remained unchanged at 1.26 per 1,000 population (P=0.03) in the control communities. They reported that the reduction was greater in the high socio-economic status communities (29%) than in the low socioeconomic communities (20%).

Product Modification

Sørensen (1976) identified products associated with burn injuries and through negotiation with manufacturers and political lobbying they attempted to improve the product safety of laundrette washers, vacuum cleaners and coffee filter machines. They observed that burn injuries associated with front-loading washing machines were eliminated as well as a reduction in injuries related to vacuum cleaners and coffee filter machines.

2.5.6 Reduction of injuries in the home in general

Reviews carried out by Towner *et al* (2001), Lyons *et al* (2006), Kendrick *et al* (2008) and DiGuiseppi and Roberts (2000) looked at interventions to reduce injuries. The interventions mostly consisted of education to raise awareness of hazards in the home with the aim of improving safety within the home and preventing injury.

DiGuiseppi and Roberts (2000) concluded that counselling and other interventions delivered in the clinical setting were effective at improving safety practices regarding smoke alarm ownership and safe hot water temperature but were not effective at reducing the occurrence of childhood injuries in the home. They noted that clinical interventions were most effective when combined with health education and strategies to change behaviour, such as counselling and the provision of safety devices.

Towner *et al*. (2001) reported that there is little evidence that campaigns to prevent general home accidents are effective and lead to a reduction in medically attended injuries in children. They did note that campaigns may be effective in changing the behaviour of parents and the environment in which the children lives and also that many families who were provided with safety devices did use them to try to make their home safer.

Towner *et al.* (2001) also reviewed the literature investigating the effects of mass media and training events and community based injury prevention programmes. They found that there was no evidence that general mass media or training events led to a reduction in injuries but that they were shown to increase knowledge of safety. They noted that community based interventions allowed injury prevention messages to be repeated in many forms and contexts.

The use of local surveillance systems is essential to target interventions, motivate participants and evaluate interventions.

Important elements of community approaches are long-term strategy, effective focused leadership, multi-agency collaboration, involvement of the local community, appropriate targeting and time to develop a range of local networks and programs.

Kendrick *et al*. (2008) reviewed parenting interventions for the prevention of unintentional injury in children. They reported that from twelve studies which reported on medically attended or self-reported injury, nine of which were Randomised Controlled Trials (RCTs), families which were in intervention groups had a significantly lower risk of injury (RR = 0.82, 95% CI 0.71 to 0.95, χ^2 = 9.01). They concluded that parenting interventions may be effective in reducing child injury but that the evidence mainly focuses on families at risk of adverse child health outcomes.

Lyons *et al*. (2006) concluded that there was not enough evidence to determine the impact of interventions to modify environmental home hazards and that more adequately designed studies needed to be carried out.

Education (including media, home visits, promotion of safety equipment)

A nurse-family partnership program was evaluated, where 743 low income pregnant women were randomly allocated to receive nurse-visits (intervention) or not (control). At the first follow-up, when the children were aged 2, it was found that the intervention group had 20% fewer health care encounters for children's injuries or ingestions (0.43 vs. 0.56, $p<0.05$) and 80% fewer injuries and ingestions requiring hospitalisation . They found a significant effect of home visits by nurses on the overall HOME score; 32.2 for the intervention arm and 30.9 for the control arm ($p = 0.003$). (Kitzman *et al*., 1997).

Olds *et al.* (1994) investigated a very similar intervention of home visits pre and post natal and found that intervention groups had fewer home hazards at 34 and 46 months, compared to the control group. It was also found that nurse-visited children had 40% fewer injuries and ingestions

Olds (1986) found that there were significantly fewer hazards in the home in the intervention group at both 34 and 46 months as compared to the control group (34 months - 0.22 intervention, 0.38 control, $p = 0.04$; 46 months – 0.21 intervention, 0.46 control, $p = 0.03$). The intervention in this study involved home visits both pre and post-natal.

Dershewitz and Williamson (1977) and Dershewitz (1979) evaluated clinic-based counselling, reinforced by telephone along with free safety devices (intervention) against the provision of safety devices only (control) and found that there was no difference in the number of hazards present in the control and intervention groups and that only 70% of mothers in the intervention group made some changes to promote safety in the home.

Larson (1980) found that mothers in the intervention group which received both an ante-natal and post-natal home visits (A) had significantly higher overall scores than those receiving post-natal home visits only (B) and those in the control arm, who received no home visits, (C) at 3 of the 4 assessment points. The means of group A at 6 weeks, 6 months, 12 months and 18 months were 29.3, 35.2, 40.1 and 41.2; for group B; 25.8, 33.7, 37.8, 38.6; and for group C; 26.7, 33.2, 37.8, 39.0. ($p <0.001, <0.005, <0.017, <0.041$).

Colver *et al.* (1982) investigated the impact of a multimedia campaign, locally designed safety education and home visits targeting home safety (the control group did not receive the home visits). They found that 60% of the intervention group made some changes to their home to improve safety compared to only 9% of the control group.

Williams and Sibert (1983) found that the 'Play it safe' television and mass media campaign resulted in no significant difference in the number of injuries before and after the campaign, in children under 15.

Minchom *et al.* (1984) investigated local campaign along with mass media events, lectures, leaflets and displays and health visitor home visits to families 'at risk' (the control group received no specific intervention). They found no significant difference in the injuries of the two groups.

Gallagher *et al.* (1985) found a 10% reduction in overall hazards as the result of the 'Statewide Child Injury Prevention Program (SCIPP)', which included enforcement of housing safety regulations, counselling on safety hazards and provision of free safety devices.

Kelly *et al.* (1987) found that a program of three 15 minute counselling sessions on child safety did not make any significant difference to the reported injuries or observed injuries (from hospital records). There was as significant difference in knowledge of home hazards; the mean number of hazards recognised by the intervention group parents was 9.4 (out of 13) compared to 8.4 for the control group ($P<0.05$).It was also found that, based on 9 possible hazards observed at home visit, the mean hazard score for the intervention group was 2.4 compared to 3.0 in the control group ($P < 0.02$). They reported an odds ratio for parent-reported accidents as 0.78 (95%CI 0.35 to 1.74), 1.60 (95% CI 0.53 to 4.84) for parent-reported ED visits, 1.47 (95% CI 0.60 to 3.60) for medically attended injuries and 0.98 (95% CI 0.06 to 16.11) for hospitalisations.

Schelp (1987) found that an accident prevention program based in Falköping, Sweden brought about a reduction in the number of home accidents (27%) and occupational accidents (28%) in the first three years while Svanström *et al*. (1995) found an increase in the number of hospital admissions increased by 8.7% in females and 4.9% in males in the following 8 years. It was found that the injury rates leading to hospital admissions decreased by 2.1% in girls and 2.4% in boys (intervention group) compared to an increase of 2.2% in girls and 0.6% in boys (control group).

Williams *et al.* (1988) evaluated the use of a pre-natal accident prevention education program against the usual pre-natal education. They found that 58% of the intervention group had water of temperatures lower than 130°F compared with 38% of the control group. They found no significant difference between the two groups in the use of car seats or smoke detectors.

Schwarz *et al*. (1993) investigated a project aimed at a poor inner-city community in America, where community workers and representatives were involved in home inspections and an education program. They found that intervention homes were significantly more likely to have smoke detectors and Ipecac but fewer differences were apparent for home hazards that were perceived to take much effort. They noted a clear difference in the safety knowledge of the intervention group compared to the control group.

Paul *et al*. (1994) found that individual counselling in the home, by trained volunteers, resulted in an increased knowledge of hazards and safety but there was no significant difference observed between the intervention and control groups in the observed hazards in the home.

Ozanne-Smith *et al.* (1994) and Hennessey *et al*. (1994) evaluated a similar intervention program in Australia, where one area was in the intervention group and another the control group. The program consisted of 113 preventive programmes with emphasis on training professionals, environmental modification, audit and advocacy. They found that there was little evidence of a reduction in injury morbidity but found some evidence, from phone surveys, of a reduction in minor injuries. They observed an increase in the use of safety devices and increased community awareness.

Sundelin (1996) investigated the use of a series of television programs to reduce the rate of a number of injuries (bicycle, poisoning, pedestrian, falls, fire/burn, suffocation). They found no difference between the intervention group and the control group in the number of two-parent families who watched at least one program (59%, intervention group vs. 43% in control group). They also found no difference in the number of programs watched or the number of safety behaviours undertaken between the two groups ($P>0.5$).

Gielen *et al*. (1996) evaluated an intervention consisting of two day visits to a village community life safety centre which consisted of exhibitions, videos, simulations, skills training, meeting police, fire fighters and education staff. They found that the knowledge of hazards increased from 58 and 67% (two intervention groups) before the visits to 78 and 74% post visit to 79 and 85% four months post-visit. They also found that one in three parents who participated reported making safety changes in the home.

Schlesinger (1997) investigated a parent and community education program and found no consistent difference in the trends between the control and intervention groups ($P>0.05$).

The ‘Greek Island Community Injury Prevention Project’ was evaluated by Petridou *et al* (1997). The project was a multi-faceted intervention involving local community leaders and activities for parents, teachers and children as well as home visit and counselling on home hazards. The control and intervention groups were communities from two different Greek islands. It was found that there was no significant difference in the accidents reported between the intervention and control groups, though the intervention group were more likely to improve the hazard variables (improvements on 11 out of 28) than the control group (improvements on 1 out of 28).

Marsh and Kendrick (1998) found that a one day multi-disciplinary workshop to increase knowledge of primary healthcare members resulted in a small but significant increase in knowledge in the trained group.

Clamp and Kendrick (1998) found an increase in the use of safety equipment in intervention families as a result of general practitioner safety advice, for low income families as well as subsidised safety equipment. They found that the intervention was at least as effective in families receiving benefits.

Thompson *et al.* (1998) investigated a home safety loan scheme and health visitor counselling and found that home accidents in children under 5 decreased by 10% between 1990 and 1994.

The 'Waitakere Community Injury Prevention Project (WCIPP)' used an all injury prevention programme with priority areas. The programme included promotion, education and awareness, advocacy and environmental change and a range of activities including promotion of specific safety equipment as well as burns and scald education. There was a decrease in admissions to hospital for injury in children aged 0-14 years, while in the two control groups (comparable community and the rest of Auckland) there was no decrease. There was no reduction in self-reported injury in either the intervention or control group 1, but fewer injured people required medical attention. They also reported significant increases in ownership and use of safety equipment such as stair gates and pool fencing, in the intervention group, compared to control group 1. (Coggan *et al*., 1998; Coggan *et al.,* 2000)

Kendrick *et al*. (1999) evaluated a program which involved specific advice at child health surveillance consultations, home safety checks, first aid training and low cost safety equipment for families on state benefits, compared to the usual child surveillance. They found no significant differences between the intervention and control groups for any medically attended injuries (OR = 0.97, 95% CI 0.72 to 1.30), attendance at accident and emergency department (OR = 1.02, 95% CI 0.76 to 1.37), primary care attendance (OR = 0.75, 95% CI 0.48 to 1.17) and hospital admissions (OR = 0.69, 95% CI 0.42 to 1.12). There were also no significant differences between the two groups for unsafe practices reported (P = 0.26) or perceptions of risk of injury (P = 0.81) or perceptions of risk of hazards (P = 0.25), they did note that these results are not very reliable due to the low numbers completing the follow-up questionnaire.

Frederick *et al*. (2000) investigated the use of activities targeting road, home and leisure injuries, delivered by teachers, in children aged 10 and 11 years old. This included first aid training and a hospital visit. They found that both the control and intervention groups increased their knowledge score at post-test. Additionally those in the intervention group increased their knowledge of first aid compared to the control group.

Klassen *et al*. (2000) reported that the impact of community based interventions on child safety practices and injuries is mixed. They said that successful

community-based programs share a number of common elements. The use of multiple strategies consistent with an underlying theory of behaviour change is critical to success.

Armstrong (2000) found that home visits (weekly for 6 weeks, 2 weekly until 3 months old and monthly from 3 months to 6 months) resulted in a significant difference in home safety (using the organisation of the home environment subscale of the HOME score) compared to the usual post-natal healthcare services (control). The intervention group had mean scores of 5.7 compared to the control groups mean scores of 5.1 ($p < 0.05$).

King *et al.* (2001) investigated the effectiveness of a home visit in reducing the risk of injury in children. The intervention group received an information package on injury prevention, the results of the safety assessment carried out in their homes were discussed and instructions were given on how to remedy any deficiencies in their home, as well as receiving money-off coupons for safety equipment. The control group only received a general pamphlet on safety. They found no difference in the change in the injury and safety awareness of the two groups. They did find a significant difference in the change in the number of homes with hot water not exceeding 54 degrees (OR = 1.31, 95% CI 1.14 to 1.50, P < 0.001) and those that had smoke detectors on some or all levels (OR = 1.45, 95% CI 0.94 to 2.22, P = 0.05). The intervention group had a rate of reported injury visits to the doctor of 0.23 per patient year (95% CI 0.19 to 0.29) while the control group had a rate of 0.31 per patient year (95% CI 0.27 to 0.37). The rate ratio between the two groups was 0.75 (95% CI 0.58 to 0.96). The number of people who reported home safety modifications was 62% at 4 months and 23% at 8 months.

Llewellyn (2003) investigated the impact of a Home Learning Programme (A) by comparing it to home visits without parental education (B), lesson only booklets without any face to face education (C) and usual care (D & E). They found that group A identified more dangers within the home (mean = 76.25, SD = 10.64) than those in group B (mean = 54.82, SD = 15.78), C (mean = 76.27, SD = 13.67) and those in groups D and E (mean = 55.70, SD = 8.06; mean = 57.33, SD = 19.22) (P < 0.001). Those in group A also identified significantly more precautions to reduce the risk of injury than all of the other groups (means – A-78.85, B-48.91, C-54.29, D-47.1, E-45.3; P <0.001). Those in group A implemented a greater number of the precautions to reduce the risk of injury (mean = 88.09, SD = 34.92) than group C (mean = 57.50, SD = 11.48; P<0.001). It was suggested that there was a beneficial effect of the parental education above that achieved from the home visit as well as benefits of face to face education as compared to written information.

King *et al.* (2005) carried out a follow up to this study to determine the long-term effects, this was done through a telephone survey three years after the study ended. They found that the rate of reported injury visits to the doctor per patient year was 0.20 (95% CI 0.18 to 0.23) for the intervention group and 0.27 (95% CI 0.24 to 0.30) for the control group, significantly less for the intervention group

as compared to the control group (rate ratio = 0.74; 95% CI 0.63 to 0.87). However during the 12-36 month follow-up period the effectiveness of the intervention seems to have waned (rate ration = 0.80; 95% CI 0.64 to 1.00).

Targeting specific safety practices

Kendrick *et al*. (2008) reported on five studies which had reported on specific safety practices, none of the safety practices reported, however, concerned scalds.

For interventions that have targeted specific safety practices, such as child restraints in cars, smoke alarms and

Enforcement

Where legislation is implemented to aim to reduce the incidence and/or severity of burns and scalds it is important for enforcement to be carried out in some way. The European child safety alliances report "Child safety: Good practice guide" reports that the level of enforcement of legislation will impact effectiveness (McClure *et al*., 2004). They also noted that legislation is more effective when teamed with educational activities (Christoff and Gallagher, 1999).

Context

Significantly higher numbers of burns and scalds are seen in those from lower socio-economic groups. It is estimated, based on qualitative estimates given by respondents in burns units rather on statistical analysis, that those from a C2DE background are 50% more likely to suffer severe injury from burns and scalds than those from ABC1 groups. This estimate is indicative only due to the nature of its calculation (DTI 1999).

The department of trade and industry suggest some possible reasons for higher incidence in lower socio-economic groups:

- Higher unemployment and lack of finances results in buying the cheapest products
- Overcrowding
- Lack of parental control/ supervision
- Poorer facilities used
- Fewer thermostats are thought to be used in hot water systems.

Roberts and Power (1996) reported that the death rate from injuries of children from social classes four and five is five times higher than that of children from social classes one and two and that the difference seems to be increasing. Roberts has since reported that the differences exist for most causes of injury including pedestrian injuries (Roberts, 1997).

Hippisley-Cox *et al.* (2002) found that the rate of admission to hospital, of children under 15, for injuries increased significantly as deprivation increased. The risk of burns and scald hospital admissions, for those under 15, was 268

times higher for those in the highest deprivation group, compared to the lowest (95% CI 3.01 to 4.51).

Reading *et al*. (2008) investigated risk factors associated with medically attended accidents and all accidents. For all accidents they found that there was a significantly higher risk for males (RR = 1.19, 95% CI 1.14 to 1.24) and for medically attended accidents (RR = 1.18, 95% CI 1.11 to 1.26).

They found that the risk of both all accidents and medically attended accidents increased from age 6 months to 2 years then decreased, relative to 6 month rate, significantly. All accidents; 15 months RR = 1.04, 95% CI 0.99, 1.09; 24 months RR = 1.21, 95% CI 1.15 to 1.27; 38 months RR = 0.65, 95% CI 0.62 to 0.69; 54 months RR = 0.40, 95% CI 0.37 to 0.42. Medically attended accidents; 15 months RR = 2.00, 95% CI 1.76 to 2.27; 24 months RR = 2.93, 95% CI 2.59 to 3.32; 38 months; RR = 2.27, 95% CI 2.01 to 2.57; 54 months RR = 1.62, 95% CI 1.43 to 1.83.

They found a significant difference in the risk of injury in a number of the socioeconomic status measures that they used, generally the risk increased as the socioeconomic status decreased. The significant measures included Rutter score, activity inside score, strengths and difficulties score, mother's age, mothers smoking status, mothers ethnicity, life events scores, financial difficulties scores, environmental problems scores as well as social support scores, mothers education level (the risk increased as the latter two increased). These results suggested that strategies and interventions aimed at alleviating deprivation may have a significant effect on childhood injury.

Emergency hospital admissions appear to be associated with deprivation, when compared to the total number of admissions the standardised discharge rate for RTA is 160.0 (134.5 to 185.4) for the most deprived quintile and 66.5 for the least deprived quintile (95% CI 49.8 to 83.1).

For accidents in the home this is 132.4 (124.0 to 140.9) for the most deprived compared to 783.7 (66.8 to 80.6).

According to the WHO GBD (2004) in high income countries children under the age of 5 are at highest risk of hospitalisation from burns. Almost 75% of burns in children under 5 are caused by scalds from hot water, liquid or steam. The burns suffered by those under one are generally caused by scalds from cups as well as contact with hot radiators and hot-water pipes.

3 Pedestrian road traffic accidents

3.1 Health endpoint definition

Unintentional physical injuries of any severity – fatal and non-fatal - to children aged 0-8 years as a result of a road traffic crash involving a vehicle (i.e. car, bus, lorry, motorcycle, bicycle or other) and a child who is walking, running or playing outside the home within or adjacent to the public road network.

3.2 Background

The Governments white paper 'Tomorrows roads: safer for everyone' set targets for road traffic injuries to be met by 2010. These include reduction of the number of fatalities and serious injuries by 40% overall and 50% in children specifically.

According to the WHO's global burden of disease tables (WHO, 2002), road traffic injuries is a leading cause of death in those aged 0-4 (13th on list) with over 49,000 deaths and in those aged 5-14 (2nd on list) with 130,835 deaths and is also a leading cause of burden of disease in those aged 5-14 (2nd on list).

When considering high income countries only it moves up the lists 4th for 0-4, 1st for 5-15 years (cause of death), 10th for 0-4 and 4th 5-15 (cause of burden of disease).

In 1990 road traffic incidents were 9th on the list of leading causes of global burden of disease, in terms of Disability Adjusted Life Years (DALYs), they are estimated to rise up the list to third place by 2020 (WHO world report on road traffic injury prevention, 2004).

There were 28,039 deaths as a result of RTA in males under 5 in the world in 2002, this increased to 83,520 for those aged 5 to 14. The number of deaths was lower for females for both age groups 22,075 and 49,186, respectively (WHO GBD, 2002).

The number of deaths occurring in Europe was significantly lower; males 898 under 5, 3,089 5 to 14; females 831 under 5 and 1,693 in those aged 5 to 14.

There were 633 admissions of children under 15 to hospital in 2007 caused by road traffic accidents in Scotland.

Road traffic incidents kill over 16,000 children and young people under 20 every year, in Europe. This accounts for 38% of all unintentional injuries in this age group and almost 6% of child deaths worldwide. In those aged under 15, 48% of all road deaths occur to pedestrians (WHO European report on child injury prevention, 2008).

The costs of road crash injuries is estimated at roughly 1% of gross national product in low-income countries, 1.5% in middle income countries and 2% in high income countries (Jacobs *et al*., 2000).

The number of road traffic casualties in pedestrians decreased from 1996 to 2003, from 926 to 708, from 33 core hospitals (TARN) (Ward *et al*., 2007). The response time of the emergency services has increased from 70.7% to 96% within 8 minutes, for category A, and decreased from 90.2% to 87.8% within 14 or 19 minutes, for category B urban and rural, respectively. These data are not split by type of emergency but it is believed that RTA will account for a minority of the calls.

The police statistics say that the rate of people killed or seriously injured on the roads fell from 85.9 per 100,000 in 1996 to 59.4 per 100,000 in 2004. The hospital admission rates for road traffic injuries, however, have not really changed (90.0 in 1996, 91.1 in 2004). It seems that the apparent fall in RTA related death rates represent a fall in completeness of reporting of these injuries (Gill *et al*., 2006). The rates for pedestrians, as reported by police, fell from 20.3 in 1996 to 12.8 in 2004 and as reported by the department of health's hospital episode statistics (HES), from 20.6 to 17.6 per 100,000.

Although declines have been seen in the death rates of those under 15 there is quite a difference in the numbers reported by the police and department of health. Seriously injured (56.5 to 32.9, police and 107.2 to 97.0 HES) and killed (2.3 to 1.5, police and 0.6 to 0.3 HES).

According to the Child Accident Prevention Trust, traffic causes half of all accidental deaths in childhood. They also note that if hit by a car at 40mph four out of five child pedestrians will die, if hit by a car travelling at 30mph four out of five will survive. A third of children and young people hurt crossing the road said they didn't stop before stepping out.

According to the Office of National Statistics the number of deaths caused by RTA in England and Wales in 2006 were 3 in those aged under 1, 27 aged 1 to 4 and 27 aged 5 to 9. In Northern Ireland there were 3 pedestrian deaths in those aged 1 to 4 and 2 aged 5 to 9 in 2007 (Registrar General Northern Ireland Annual Report, 2006). The number of children who suffer slight and serious injuries is very high also and increases as the age increases (Table 6).

Table 6: Child road casualties in Great Britain. ***Source: Road accidents Great Britain: 2006 The Casualty Report***

	0-4	5-7	8-11
Killed	13	12	19
Serious	239	308	557
Slight	1,121	1,485	3,021

Table 7: The burden of child pedestrian injuries in Great Britain 1998-2000 (0-14 years). ***Source: STATS 19 in Towner (2002)***

	1998	1999	2000
Killed	92	96	99
Serious	3,380	3,178	2,921
Slight	13,334	12,522	12,031
Cost to country	£775,217,800	£769,187,740	£776,256,210

According to Towner (2002) child pedestrian deaths have fallen by 63% and overall child casualties by 30% in 2000, compared to the 1981-1985 baseline average, and traffic increased by 54%.

The majority of child pedestrian injuries occur in built up areas, where the speed limit is typically below 40mph. Eighty percent of younger children within urban areas are injured on residential roads within 400m of their home, as children get older they are typically injured further from home (Towner, 2002).

The Department for Transport has invested in research into road safety. Some of the issues affecting pedestrians that have been looked at in 2008-2009 include; child-parent interaction, improving the delivery of safety education, the Avon longitudinal study of parents and children, road safety research and road user safety.

Roads are the leading cause of fatalities in children, motor vehicle accidents account for nearly half of all accidental injury fatalities in children (Towner and Dowsell, 2001). Pedestrian fatalities occur more frequently than cycling or passenger fatalities (Towner and Dowsell, 2001). In the UK the pedestrian RTA mortality rate is twice that in the Netherlands and nearly four times that in Sweden (BMA, 2001). What differs between English children and Dutch children is that in Dutch children half of pedestrian time is spent in traffic calmed/controlled areas whereas only 10% of English children are so protected (Bly *et al*., 1999, in BMA, 2001).

It has been suggested that the cost of road traffic crashes is 2.1% of the Gross National Product of the UK (Jacobs *et al*., 2000).

In Great Britain in 2004 there were 758 child pedestrians killed or seriously injured as a result of a road traffic accident (DfT, 2005). This was a slight decrease from 2003. In children aged 0-15 there were 77 fatalities, 2,262 serious and 9,895 slight injuries in 2004.

Thirty children, under the age of 15, were killed or seriously injured in 2004 where one of the drivers/riders involved was over the legal limit, 130 casualties overall. The slight casualty rate, per 100 million vehicle kilometres, was 12 for pedestrians on urban roads and 1.6 on rural roads.

In Scotland in 2007, the provisional number of casualties of child pedestrians was given as 3 killed, 173 killed or seriously injured and 861 overall on built-up roads. On non-built up roads these numbers were significantly lower; 1 killed, 6

killed or seriously injured and 12 overall (Statistical Bulletin; Transport Series, 2008/2).

Actions

Multi-faceted – engineering and education
The UK Urban Safety Project resulted in a reduction of road traffic accidents (Mackie *et al.*, 1990, in Towner, 2002).

The Gloucester Safer City Project involved changes to the road environment, safety education and enforcement over 5 years. They found a 13% reduction in child pedestrian casualties (Mackie and Wells, 2003).

3.3 DPSEEA maps

Table 8: Summary of chains for pedestrian road traffic injuries in children

Chain	Drivers	Pressures	State	Exposure	Effect	Contexts
1. Road Infrastructure	Transport policy on priorities for road and pavement maintenance; Planning prioritises needs of car drivers; Provision and maintenance of street lighting; Vandalism; Roads designed for lower traffic volumes; Road design guidance; Car parking; Decisions no to segregate traffic from vulnerable road users	Inadequate design, provision and maintenance of road and pavement infrastructure for pedestrians and cyclists; Parking of cars at roadside; Lack of resources to develop and maintain roads and pavements	Unsafe or unattractive neighbourhoods: Roads on which cars are driven at speeds inappropriate to line of sight or risks to other road users	Transfer of kinetic energy from moving vehicle to pedestrian	Unintentional pedestrian injuries	Most deprived have lowest car ownership, highest levels of pedestrian injury and more severe injury; Young are most at risk of accident or injury; Rural issues – lack of footpaths, long distance commuters, lack of street lighting
2. Traffic Levels	Distribution systems which result in high levels of road transport; Car-based society; Rush hour (commuters, school run etc); Development of low density housing where public transport is less	Increasing levels of traffic	Unsafe or unattractive neighbourhoods; High levels of traffic; Cars parked on roadside	Transfer of kinetic energy from moving vehicle to pedestrian	Unintentional pedestrian injuries	Most deprived have lowest car ownership, highest levels of pedestrian injury and more severe injury; Young are

	viable; Increasing distances travelled (work, shops, education)					most at risk of accident or injury; Rural issues – lack of footpaths, long distance commuters, lack of street lighting
3. Traffic Speed	Marketing of cars on speed and performance; Perceived need to travel quickly between locations; Busy lifestyle; Pressure to meet deadlines; Driver perception that they have priority; Heavy acceleration and braking; Insulation from external environment and quiet engines;	Increasing traffic speed	Unsafe or unattractive neighbourhoods; Vehicles driven at speeds inappropriate to line of sight or risks to other road users;	Transfer of kinetic energy from moving vehicle to pedestrian	Unintentional pedestrian injuries	Most deprived have lowest car ownership, highest levels of pedestrian injury and more severe injury; Young are most at risk of accident or injury; Rural issues – lack of footpaths, long distance commuters, lack of street lighting; Driver behaviour, experience and skill
4. Vehicle Drivers	Perceived priority over other road users and need to travel quickly; Busy lifestyle; Rush hour	Increasing levels and speed of traffic; “rat runs”	Unsafe or unattractive neighbourhoods; Traffic driven at	Transfer of kinetic energy from moving vehicle to	Unintentional pedestrian injuries	Most deprived have lowest car ownership, highest levels

	(commuting, school run etc); Acceptability of driving while using mobile phone; Occupational drivers under pressure to meet deadlines; Drivers with poor eyesight		speed inappropriate to line of sight or risks of other road users	pedestrian		of pedestrian injury and more severe injury; Young are most at risk of accident or injury; Rural issues – lack of footpaths, long distance commuters, lack of street lighting
5. Vehicle Design	Speed, performance, safety of occupants more important than of other road users; desirability of larger, heavier more powerful vehicles; desirability of vintage/classic cars; Bull bars and other optional extras; Cost of new cars; Old vehicles have less safety designs	Vehicles on road whose design, maintenance or age increases risk of injury to pedestrians on collision	Unsafe or unattractive neighbourhoods; Vehicles driven at speed inappropriate to line of sight, vehicle design or risks to other road users	Transfer of kinetic energy from moving vehicle to pedestrian	Unintentional pedestrian injuries	Most deprived have lowest car ownership, highest levels of pedestrian injury and more severe injury; Young are most at risk of accident or injury; Rural issues – lack of footpaths, long distance commuters, lack of street lighting; Driver behaviour, experience and skill

6. Pedestrians	Physical activity strategies; school day overlap with rush hour; Poor role models; Lack of safe accessible play areas; Impact of GMT vs. BST; Lack of free transport to school	Children on road or pavements who are not able to assess traffic associated risks, particularly those whose behaviour is considered erratic by other road users	Pedestrians on roads or pavements where traffic being driven at speeds inappropriate to road conditions; Children playing on streets	Transfer of kinetic energy from moving vehicle to pedestrian	Unintentional pedestrian injuries	Awareness of road safety; Other chains – Vehicle design; traffic levels; Traffic speed; Road infrastructure; Driver behaviour;

3.4 Discussion of chains from GPBH Workshop

For road traffic injuries, it was thought that the existing chains were sufficient to describe the risk factors associated with pedestrian road traffic accidents. Through discussion further drivers, actions and contexts were added to the chains. Some of these additions were considered to work in line with policy in other areas, while some might conflict with other policy.

An example of this is improving street lighting to make pedestrians more visible which may conflict with possible climate change policies to reduce street lighting. A number of additional actions were discussed, including the use of driver-education, such as 'Pass-Plus' and extra benefits that could be associated with this education to encourage new drivers to take part.

The issue of speed enforcement devices were discussed and the issue of whether they should be hidden and moved around or left in plain view, as in this country, and which method would work better at reducing the number of accidents and therefore injuries.

There was some agreement that road traffic accidents needed to be looked at in terms of car occupants and car safety. These are possible subjects for further workshops and would result in a number of additional maps.

3.5 Evidence

According to Racioppi *et al.* (2004) more than 50% of the total urban trips carried out in the EU by car are shorter than 5km, 30% are less than 3km.

A study has shown that 90% of parents are worried about traffic hazards on their child's journey to school (Rowland *et al*., 2003).

It has been shown that road traffic injuries, worldwide, are associated with the type of vehicle and its maintenance condition; the design of the highway infrastructure; weather condition and risk conduct of drivers (drug and alcohol intake, excessive speeding, lack of sleep, driver distraction and neglect of security measures) (Mock *et al*., 2005).

3.5.1 Chain 1 – Road Infrastructure

Drivers

The majority of injuries occur on weekdays, between 8 and 9am and between 3 and 7pm, the times where rush hour and the start and end of the school-day coincide (Towner, 2002). The number of child injuries is higher during the summer months, May to September, when children are on Summer holidays and probably more likely to be outside (Towner, 2002).

According to the national audit office (Department of transport, 2010) the number of deaths on the roads of Great Britain has fallen from 3,578 (in the five years to 1998) to 2,946 in 2007, while road traffic has increased by 18%. In 2007 over 30,000 pedestrians were injured and 646 were killed (9% were aged 0-15). In 2007, child pedestrian deaths were 23% lower than they were in 2003.

Between 1976 and 2006 the distance people walked declined from an average of 248 to 201 miles per person per year, while the average distance travelled by car increased from 3,200 to 5,700 miles per person per year.

A transport research laboratory review found that 20mph zones enforced by speed bumps reduced the average speed by 9 miles per hour compared to only 1 mph in areas where the 20mph zone is identified by signs alone (TRL Report 363, 1998 - Mackie).

A review carried out by Webster and Mackie (1996) concluded that 20mph zones have been successful in substantially reducing speeds and accidents. The average annual accident frequency fell by about 60% (comparing before and after accident data), specifically child pedestrian accidents fell by 70% (from 1.24 before to 0.37 after). The average speed ‘at a calming measure’ was 13.2mph and the average speed ‘between calming measures’ was 17.8mph. Overall vehicle speeds fell by 9.3mph, on average. There was a 6.2% reduction in accidents for each 1mph reduction in vehicle speed. Traffic flows reduced by 27%, on average, in the 20mph zones but increased by about 12% on surrounding roads. The review also concluded that despite an apparent migration of the traffic from the 20mph zones to the surrounding roads there was no migration of accidents. The review gives details of some of the 20mph schemes that have been implemented and their statistics. The proportion of accidents at/near junctions involving cars and pedestrians actually increased by 7%

There are a number of specific environmental factors which increase the risk of injury for children using the road system. These factors include:

- Sites with a volume of traffic exceeding 15,000 motor vehicles per day
- Poor planning of land use and road networks, including
    - Long, straight through-roads that encourage high vehicle speeds, together with mixed land use made up of

residential housing, schools and commercial outlets (Clifton *et al*., 2007; Bly *et al*., 1999).
        - A lack of playgrounds, resulting in children playing in the road
        - A lack of facilities to separate road users (Kweon & Shin, 2005; Roberts *et al*., 1995)
        - The existence of street vendor businesses, in which children may work
- A lack of safe, efficient public transportation systems
- Inappropriate speed, particularly in residential areas where children play or walk to and from school (Roberts *et al*., 1995; Mueller *et al*., 1990; Stevenson, 1997; Joly *et al*., 1991)

Beyer and Ker (2009) reviewed the use of street lighting and its impact on road traffic injuries. Three trials compared street lighting with an area control on total crashes (pooled rate ratio 0.45, 95% CI 0.29 to 0.69). Two trials compared street lighting with an area control on total injury crashes (RR = 0.78, 95% CI 0.63 to 0.97). The review concluded that there are suggestions that street lighting prevent crashes and injuries but that more research is needed in this area.

The European Report on Child Injury Prevention (2008) states that every Euro spent on improving street lighting is estimated to save about €10.70 in health care spending.

Daytime running lights for cars and motorbikes has also shown a 15% reduction in the number of pedestrian injuries (Elvik and Vaa, 2004).

The Child Safety Good Practice Guide states that area-wide engineering solutions to reduce pedestrian risk lead to a reduction in injuries and they are cost-effective. They say that traffic calming solutions have been shown to give accident savings of 60% in 30 km/h zones and that area-wide urban traffic calming schemes reduced the number of injury accidents by 25% on residential streets and 10% on main roads.

Area-wide traffic calming has been shown to result in absolute reductions in child pedestrian injury rates and reductions in relative inequalities in child pedestrian injury rates (Jones *et al*., 2005).

Actions

The World Report of Child Injury Prevention (2008) states that the safe environment of children walking and cycling should be a priority when developing roads, not an afterthought after the space for motorised traffic has been designed. The routes used by children to get to and from schools, playgrounds and shops should be considered and integrated into a safe and logical network for walking and cycling (Mohan, 2008).

Bunn *et al* (2003) reviewed the effect of area-wide traffic calming on traffic related injuries. They reviewed a number of controlled before-after trials. Eight of the trials reported in the number of road traffic crashes resulting in deaths and found a pooled rate-ratio of 0.63 (95% CI 0.14 to 2.59). Sixteen of the studies reported number of road traffic crashes that resulted in injuries resulting in a pooled rate ratio of 0.89 (95% CI 0.80 to 1.00). The pooled rate ratio from thirteen studies for the total number of pedestrian-motor vehicle collisions was 1.00 (95% CI 0.84 to 1.18). Although all of these rate ratios are below zero none of them are significant. The review concluded that, although it seems that traffic calming measures are promising in reducing the number of accidents and deaths more rigorous research is needed.

According to the WHO report, Preventing Road Traffic Injury: A public health perspective for Europe (Racioppi *et* al., 2004) the congestion charges in London resulted in many benefits:

- There was a 20% increase in cycle journeys with a 7% reduction in crashes.
- There was a 30% reduction in car traffic with a 28% reduction in crashes
- There was a 10-15% increase in moped and motorbike journeys with a 4% reduction in crashes
- 6% fewer pedestrian-motor vehicle crashes
- Total vehicle-kilometres reduced by 12% with a 34% reduction among cars
- Increased bus time reliability by up to 60%

Table 9 highlights the possible cost savings to healthcare by introducing some simple road design.

Table 9. Possible savings in health care costs from improving road design. ***Source: Cost effective EU transport safety measures (2003)***

Spending of €1 on road design measures	Savings (€)
Simple road markings	1.50
Upgrading marked pedestrian crossings	14.00
Pedestrian bridges or underpasses	2.50
Guard rails along the road	10.40

3.5.2 Chain 2 – Traffic Levels

Drivers

The majority of injuries occur on weekdays, between 8 and 9am and between 3 and 7pm, the times where rush hour and the start and end of the school-day coincide (Towner, 2002). The number of child injuries is higher during the summer months, May to September, when children are on Summer holidays and probably more likely to be outside (Towner, 2002).

Webster and Mackie (1996) found that for each 1mph reduction in vehicle speed accidents reduced by 6.2%.

According to the national audit office (Department for Transport, 2010) the number of deaths on the roads of Great Britain has fallen from 3,578 (in the five years to 1998) to 2,946 in 2007, while road traffic has increased by 18%. In 2007 over 30,000 pedestrians were injured and 646 were killed (9% were aged 0-15). In 2007 child pedestrian deaths were 23% lower than they were in 2003.

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It has been shown that there is a relationship between the levels of traffic on the road and the risk of injury as the result of RTA. The World Report on road traffic injury prevention (Peden *et al.*, 2004) states that a number of studies have found a correlation between motor vehicle growth and the number of road crashes and injuries.

The EU has seen a 37% increase in cars on the roads from 160 million in 1990 to 220 million in 2005 (WHO European child injury prevention report, 2008).

There has been a downward trend in child mortality in the EU due to RTI but the majority of this is due to moving children off pavements and bicycles and into cars (WHO European child injury prevention report, 2008).

DiGuiseppi *et al*. (1997) concluded that the significant decline in mortality, in those under 15, of pedestrians (35% 0-4, 40% 5-9, 30% 10-14) and cyclists (30% 5-9, 38% 10-14) apparent between 1985 and 1995 was associated with a decline in walking and cycling, where the average annual distance walked and cycled decreased by 20% and 26%, respectively. They found that there was no significant decline in the number of deaths of car occupants (25, 40, 7 decline). It was noted that the decline in deaths was associated with a decline in walking and cycling and that the average annual distance travelled by car increased by 40%.

The WHO European report on child injury prevention (2008) stated that the decline in walking and cycling and increase of travel by car could be affected by much wider availability of cars, parental choice of education meaning that children often have to be driven to school as it is further away, increased pace of family life and exaggerated fear of strangers by children out alone (Pooley *et al*., 2005).

The European Report on Child Injury Prevention states that if a safe and efficient public transportation service is in place the number of cars on the road would be reduced.

They also note that the provision of safe areas to play and walk as well as barriers to separate traffic from children are protective factors.

3.5.3 Chain 3 – Traffic Speed

Drivers

The majority of injuries occur on weekdays, between 8 and 9am and between 3 and 7pm, the times where rush hour and the start and end of the school-day coincide (Towner, 2002). The number of child injuries is higher during the summer months, May to September, when children are on Summer holidays and probably more likely to be outside (Towner, 2002).

Webster and Mackie (1996) found that for each 1mph reduction in vehicle speed accidents reduced by 6.2%.

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Pedestrians have an 80% risk of being killed in a collision with a car going about 50 km/h compared with a 10% risk at speeds of 30 km/h (Tingvall and Howarth, 1999).

Finch *et al*. (1994) reports that the influence of differential speeds on accident involvement rates for individual drivers follows a U shape. That is those driving much slower or faster than the other traffic are more likely to be involved in accidents.

They reported that there is little evidence available about the relationship between the posted speed limit and the actual speed, but what data there is suggest a change in the limit results in a smaller change in the mean traffic speed in the same direction. They suggest that drivers may disregard speed limits that they think are unreasonable for the road.

A look at the little data available in the area of relationship between speed and accidents suggested to Finch *et al.* (1994) that the lowering of a speed limit, or the imposition of a speed limit is usually associated with significant reductions in road accidents, and vice versa. A study in America found that an increase of average rural interstate traffic by 2-4mph resulted in an increase of between 19 and 34% in fatalities.

Taylor *et al*. (2000) reported on the effects of drivers' speed on the frequency of road accidents and concluded that in a given set of road and traffic conditions the frequency of accidents increases with the speed of traffic and the higher the speed the more rapidly the accident frequency increases.

They concluded that reducing the speed of the fastest drivers would give the greatest benefits in reducing death and injury. The scope for reducing accidents by means of speed management depends on the operational characteristics of the road. The general rule is that for every mph reduction in speed there is a 5% reduction in accident frequency. On urban roads at low average speeds this figure is 6%, 4% on medium speed urban roads and lower speed rural main roads while it is about 3% for higher speed urban roads and main rural roads. They noted that by applying reasonable but modest assumptions that an annual saving of 23,000 injury accidents could be expected, resulting from an average speed reduction of just 2 mph.

Actions

Wilson *et al*. (2006) investigated the use of speed enforcement detection devices for preventing road traffic injuries. Of the twenty six studies which they included in their review all of them, with the exception of one, reported an absolute reduction in pre/post average speeds. The reductions ranged from 5% to 70% depending on the speed threshold set. They found hat there was a reduction of between 50 and 65% in the proportion of speeding vehicles travelling faster than 15 km/h over the speed limit. Compared to controls there was a relative improvement of between 1 and 15% for average speed and 14 to 65% for percent speeding. In areas around camera sites there were reductions in crashes from 14 to 72%, injury crashes of 8 to 46% and crashes resulting in fatalities or serious injuries of 40 to 45%. Compared to controls the improvement in the number of pre/post crashes resulting in any type of injury was between 5 and 36%. The authors reported that there were methodological limitations of the studies but they concluded that the strength of evidence implied that speed enforcement devices are effective in reducing speeds and crashes.

The estimated costs of speed cameras is about £54 million, compared to the cost savings of £221 million (DfT, 2004) implies that speed enforcement devices are cost-effective.

The survival rate for pedestrians is significantly increased at collision speeds of lower than 30km/h (Peden *et al.,* 2004).

The World Report on Child Injury Prevention (2008) suggests that changes that can be made to affect the speed of traffic include:

- Traffic calming measures that reduce the speed of traffic through infrastructural engineering measures such as:
    - Speed bumps
    - Mini-roundabouts
    - Designated pedestrian crossings
    - Pedestrian islands
- Visual changes – such as treating the road surface and improving road lighting
- Redistribution of traffic – by blocking roads and creating one-way streets near schools

The European Report on Child Injury Prevention (2008) states that setting and enforcing speed limits and making the overall speed more consistent has been shown to prevent crashes involving pedestrians and cyclists.

Context

Clarke *et al*. (2008) investigated the differences in RTA fatalities by deprivation, including examination of causes of RTA (such as speed, drink, and age). They found that the percentage of deaths as a result of speeding was highest in the most deprived, this proportion decreased as deprivation decreased, with a very similar pattern seen when looking specifically at those that were considered to be deliberately risk-taking involving speeding.

3.5.4 Chain 4 – Vehicle Drivers

Drivers

The majority of injuries occur on weekdays, between 8 and 9am and between 3 and 7pm, the times where rush hour and the start and end of the school-day coincide (Towner, 2002). The number of child injuries is higher during the summer months, May to September, when children are on Summer holidays and probably more likely to be outside (Towner, 2002).

According to the national audit office (Department for Transport) (2010) the number of deaths on the roads of Great Britain has fallen from 3,578 (in the five years to 1998) to 2,946 in 2007, while road traffic has increased by 18%. In 2007 over 30,000 pedestrians were injured and 646 were killed (9% were aged 0-15). In 2007 child pedestrian deaths were 23% lower than they were in 2003.

Between 1976 and 2006 the distance people walked declined form an average of 248 to 201 miles per person per year, while the average distance travelled by car increased from 3,200 to 5,700 miles per person per year.

Drink-driving collisions don't affect pedestrians and cyclists as much as other road users (pedestrians and cyclists accounted for only 7.5% of all people killed or seriously injured as the result of a drunk driver road accident).

Quimby *et al*. (1999) investigated the factors that influence a driver's choice of speed using a questionnaire. They found that after taking age, sex and annual mileage into account the speed choice of drivers was affected by their willingness to commit driving violations, driving stress and sensation seeking propensity (although the latter was only significant for males). Models that did not include the psychological factors found that a driver's choice of speed was affected by their occupational group, the engine size as well as whether they were driving to/from work and driving without a passenger.

Roberts and Kwan (2001) investigated the use of school-based driver education in preventing traffic crashes. They reported on three trials which had examined the effect of driver education on road traffic crashes. The three trials found that there was no significant difference in the number of road crashes between the intervention and control groups (Strang – RR 1.01, 95% CI 0.83 to 1.23; Stock – RR 1.03, 95% CI 0.98 to 1.09; Wynne-Jones – RR 1.10, 95% CI 0.76 to 1.59).

They did find that although education did not result in reducing the number of road crashes it did result in earlier licensing of drivers who undertook it.

Ker *et al*. (2003) investigated the effect of post-licence education on the prevention of road crashes. They identified twenty-three trials which studied remedial driver education but noted that the methodological quality of the trials was poor. Fifteen trials reported on traffic crashes (pooled RR – 0.98, 95% CI 0.96 to 1.01), while four trials reported injury crashes (pooled RR – 1.12, 95% CI 0.88 to 1.41). They noted that no one form of education was better than another and that advanced education was no better than remedial education and there was an indication of a presence of publication bias.

The UK has an upper alcohol limit of 0.08 mg/dl, which is higher than the majority of the EU (0.05 mg/dl).

Zero-tolerance has been shown to reduce the number of alcohol related crashes involving youth by between 17 and 50% and there is evidence that graduated licensing has resulted in a reduction of all crashes, alcohol-related or not (CEREPRI and APOLLO, 2007). In states in Australia who have a zero-tolerance limit there has been a 22% reduction in night-time, single vehicle collisions, 17% in states with a limit of 0.02mg/dl and 7% in states with limits of 0.04 to 0.06 mg/dl (Zwerling *et al*., 1999).

There is evidence that deterrence policies reduce are effective in the short term but not the long-term, while for policies such as taxation on alcohol it is unclear of the effect on RTI.

There is evidence that the number of alcohol-related collisions, injuries and fatalities have been seen to reduce in most areas where the legal limit has been reduced to 0.05 mg/dl (Mann *et al.*, 2001). Removing a persons licence when they are caught driving over the legal limit or under the influence of drugs has been shown to be an effective deterrent (NHTSA, 2006).

There is also evidence that the higher legal drinking age of 21 reduces alcohol consumption and rates of crashes (Wagenaar *et al*., 2002). The increase of alcohol prices leads to a reduction in drinking as well as the consequences of alcohol use and abuse (Chaloupka *et al*., 2002).

Many countries have introduced policies which make it illegal to talk on a mobile phone while driving a car. The effect of this policy has not been evaluated in terms of number of pedestrian injuries. Enforcement of this policy is key to its effectiveness.

Context

Clarke *et al*. (2008) found that the proportion of fatal accidents in deprivation categories one and two are as a result of impaired driving (drink and drugs) and is slightly lower for the other deprivation categories. They also found that the

proportion of fatalities in the most deprived involving unlicensed drivers was significantly higher than in the other deprivation categories. The proportion of disqualified and provisional drivers was also greater in the least deprived group, decreasing as deprivation improved.

3.5.5 Chain 5 – Vehicle Design

Crandall *et al*. (2002) suggested that the improvements made to the exterior of vehicles could increase the safety of pedestrians in the same way that existing vehicle improvements help to protect the occupants.

The Child Safety Good Practice Guide states that vehicle modifications appear to reduce the risk of pedestrian fatalities. It has been estimated by the European Transport Safety Council (Breen *et al*., 2001) that over 2,000 deaths and 18,000 serious pedestrian and cyclist injuries could be prevented each year in the EU with modifications to the vehicle.

The design of cars has changed over the years to attempt to decrease the risk of the occupants experiencing a serious injury on impact. There have also been modifications to the outside of the car to lessen the severity of injury to adult pedestrians when hit by a car. There have recently been moves to modify vehicles even further so as to lower the risk of child pedestrians experiencing severe and fatal injuries.

Children aged between 1 to 3 years are at a higher risk of being hit by a car reversing from a driveway or parking lot as they are harder to see. According to Holland *et al*. (2000) and Fenton *et al.* (2005) the increase of sports utility vehicles has resulted in these types of accidents being more common. A number of vehicles are now being fitted with reverse backup sensors which could help to reduce the incidence of these types of accidents (Lovette, 2007).

Redesigning the car front has the potential to reduce injuries to pedestrians and to children, in particular, as they are vulnerable to head injuries on impact. The NCAP in Europe, US and Australia now include ratings for pedestrian protection but most vehicles still obtain low scores. A new European Directive will, by 2010, require that new models pass a crash test incorporating protection requirements for pedestrians.

The use of better visibility aids such as cameras and audible alarms could help to reduce the incidence of accidents caused by cars reversing.

Alcohol interlock systems, which require a driver to blow into a breathalyser before starting the car, have started to be used in many countries. The car will not start if alcohol is present. These devices have led to reductions of between 40 and 95% in the rate of offending under drink-driving laws (Peden *et al*., 2004).

Breen *et al*. (2001) made a number of suggestions about how cars could be improved in order to reduce the severity of injuries to pedestrians in the event of a collision. These are:

- Improvements to the bumper
    - The bumper is usually the first part of the car that makes contact with the pedestrian.
    - Most car bumpers are plastic but immediately behind the bumper is a heavy cross member. The European Transport Safety Council (ETSC) experts believe that the bumper needs to be moved forward or the parts behind the bumper moved back so that the bumper can crush about 5 to 7.5cm in an impact with a pedestrian's leg.
- Improvements to the bonnets leading edge
    - Second contact is typically between the pelvis and/or upper leg and the bonnets leading edge
    - Changes need to be made to the sheet metal work of the bonnet edge to reduce the stiffness and provide sufficient crush-depth
- Improvements to the bonnet top
    - The final contact is normally between the upper body and head striking the bonnet top, the area between the bonnet top and the windscreen, the windscreen or the windscreen frame.
    - To make the bonnet safe for head impacts they need a crush depth of about 5 to 7.5cm and suitable bonnet strength.

The European Enhanced Vehicle Safety Committee (EEVC) has developed a set of tests to assess the performance of cars when involved with an impact with a pedestrian. The European New Car Assessment Program (EuroNCAP), which provides information to consumers about the crash performance of cars, has been using the EEVC tests since 1996. In general, new cars do not perform well in the pedestrian tests.

The Honda Civic, on EU roads, meets over 80% of the EEVC tests without using new technology, in fact the UK Transport Research Laboratory (TRL) has estimated that the additional costs to the Honda Civic was just £6.50.

Intelligent speed adaption (ISA) is a system by which the vehicle knows the permitted speed of the road. The system can be advisory, voluntary or mandatory. It has been estimated that about 20% of pedestrian accidents could be reduced on urban roads from enforcement of urban speed limits by ISA (Carsten and Tate, 2000). Varhelyi (1996) estimated that using ISA to slow vehicles to 30km/h would result in a 78% saving in pedestrian injury accidents at pedestrian crossings.

In a small study of 25 drivers Almqvist and Nygard (1997) found that subjects that had driven with ISA for 2 months showed speeds that were reduced in line with speed limits.

Enforced ISA was tested in the Netherlands where the Dutch Ministry report that it was successful in reducing the speed on the residents who took part.

The first External Vehicle Speed Control (EVSC) project (1997-2001) reported that a mandatory system will achieve a 36% reduction in injury accidents and a 58% reduction in fatal accidents.

3.5.6 Chain 6 - Pedestrians

Drivers

The majority of injuries occur on weekdays, between 8 and 9am and between 3 and 7pm, the times where rush hour and the start and end of the school-day coincide (Towner, 2002). The number of child injuries is higher during the summer months, May to September, when children are on Summer holidays and probably more likely to be outside (Towner, 2002).

According to the national audit office (Department for Transport) (2009) the number of deaths on the roads of Great Britain has fallen from 3,578 (in the five years to 1998) to 2,946 in 2007, while road traffic has increased by 18%. In 2007 over 30,000 pedestrians were injured and 646 were killed (9% were aged 0-15). In 2007 child pedestrian deaths were 23% lower than they were in 2003.

Between 1976 and 2006 the distance people walked declined form an average of 248 to 201 miles per person per year, while the average distance travelled by car increased from 3,200 to 5,700 miles per person per year.

Actions

Thomson *et al* (1996) talk about the problems with road safety education and young children. They say that children need a variety of psychological skills in order to interact with the traffic and the ability to deploy those skills in different situations. They have highlighted that the training should be practical, conducted in the real road environment.

Thomson and Whelan (1997) evaluated the Kerbcraft project, which recruited volunteers to carry out roadside training of children in Drumchapel, Glasgow. They found that the judgements and behaviour of the children improved significantly after practical training ($P < 0.001$). They found significant differences in the improvement of the trained children and controls who received no training ($P < 0.01$) and suggested that those that had not been trained would not attain the level of knowledge of the trained children for several

years. They also noted that community volunteers achieved the same results as highly qualified staff.

Turner *et al*. (2004) concluded that community-based interventions are effective in reducing the incidence of childhood pedestrian injury, with the degree of success being cumulative depending on the complexity of individual strategies employed.

Duperrex *et al.* (2002) found that pedestrian safety education can result in improvements in children's knowledge and can change observed road crossing behaviour but it is unclear whether this actually reduces the risk of pedestrian motor vehicle collision and injury occurrence. There is evidence that changes in safety knowledge and observed behaviour decline with time.

The review split the results into age groups, as targeted by the studies. For those under 5, trained children were more likely to stop and look at line of vision than controls (RR = 1.71, 95% CI 0.62 to 4.70), and knew slightly more often that they had to 'walk or stay on pavement' than controls (RR 1.05, 95%CI 0.79 to 1.39).

For those aged 5-9 the review highlighted that trained children were more likely to stop and look (RR 1.79, 95% CI 1.18 to 2.72), to stop and look when crossing between parked cars (RR 1.73, 95% CI 1.39 to 2.14), to cross at cross-walks (RR 1.63, 95% CI 0.89 to 3.00), and are more likely to exhibit safe behaviour (RR 2.13, 95% CI 1.01 to 4.47).

Reading (2002) agreed that there is evidence that education improves knowledge but not that it results in a decrease in injuries.

Four community-based studies aimed at reducing child pedestrian injuries were reviewed. West (1993) investigated a home-based education intervention with parent facilitation in learning, in children aged 3 ½ to 4. They found that there was a significant improvement in the intervention group in road safety behaviours (from 82.3% to 74.3% of children running ahead at traffic in the intervention group compared with 79.4% to 79.9% in control group) but that there was no change in the parental supervision behaviours between the two groups.

Davidson (1994) found that a school-based education program, in conjunction with engineering and environmental improvements, economic incentives and community activities resulted in a post-intervention decrease in injury rates presented to hospital of 50% in the intervention group and 30% in the control group. The decrease in the intervention group for the targeted injuries (bicycle, car collision, pedestrian, falls and firearm) was significant ($P<0.001$).

According to the World Report on Child Injury Prevention (2008) safe play areas are needed to reduce RTI occurrence as if these are not available children will be tempted to play on the street.

The World Report on Child Injury Prevention (2008) suggests that increasing the visibility of pedestrians will reduce the risk of road traffic accidents. They suggest the use of retro-reflective clothing or strips on backpacks, although the effectiveness of these in reducing injuries still needs to be evaluated.

Drink-driving laws have been shown to reduce the incidence of road traffic accidents in general. The European Report on Child Injury Prevention (2008) reports that zero-tolerance alcohol laws, laws on minimum legal drinking age, and lower blood alcohol concentration levels are effective at reducing the number of road traffic injuries in children.

'Walking buses' is one way of getting children to school safely. They can teach children how to walk safely as well as teaching them the health benefits of walking as well as reducing the e traffic congestion and pollution, particularly near schools (Safe routes to school online guide, 2008). This type of intervention has been implemented in a number of countries but the effect on child traffic injuries has yet to be calculated.

Safety areas have been implemented around schools in many countries. This includes making the areas around schools car-free zones, speed reduction measures and adult supervision to cross the road.

The European Report on Child Injury Prevention (2008) also states that mass-media publicity is effective in reducing the number of road traffic injuries for children.

Interventions

Klassen *et al.* (2000) stated that the benefit of community-based education aimed at changing the behaviour of children in traffic situations is limited. Though there are some suggestions that improvements do occur it is modest and there is no evidence that children behave the same way in real-life situations.

West *et al.* (1993) investigated the use of home-based education to prevent pedestrian injuries in children ages 3½ to 4. They found that there was a significant improvement in the behaviour of the control group children, in terms of running ahead of parents (82.3% pre to 74.3% post, $p<0.01$). There was no significant change in the control group, same-age children in neighbouring counties, (79.4% pre to 79.9% post). They also found that there was no significant change in the supervision behaviour of the parents.

Rothengatter *et al*. (1984) evaluated school-based education aimed at children aged 4 to 6, where the instruction was given by parents and assistants. They found that the safety behaviour in traffic of the intervention group improved significantly, specifically the performance crossing quiet streets, between

parked cars and at junctions ($p<0.01$). There was no significant difference between parent and assistant training ($p>0.05$).

Renaud (1989) also investigated school-based education aimed at children aged 5 with attitude simulation, behaviour simulation and both attitude and behaviour simulation. They found that the intervention group did slightly better on measures of attitude, behaviour and transfer, using a quasi-real-life traffic setup.

Nishioka *et al*. (1991) again looked at school-based education aimed at children aged 4 to 6 and found that there were no differences in the observed behaviours regardless of presence vs. absence of a running motorcycle or detailed vs. vague verbal instructions ($p>0.05$).

In their updated systematic review of what works in preventing childhood unintentional injuries, Towner *et al*. (2001) reported on a number of interventions related to road traffic injuries.

Boxall (1988) reported on an evaluation of the effectiveness of crossing patrols by comparing the injury rates experienced at or near crossing sites and found that there was a lower rate at sites where there were school-crossing patrols. Towner *et al.* (2001) reported that there was reasonable evidence that school-crossing patrols are effective in reducing risks.

Towner *et al.* (2001) concluded that there is good evidence that area-wide engineering schemes and traffic calming measures reduce accidents and that they are cost effective.

Engel (1982) found a 15% reduction in injuries reported, in the general population, following the intervention of 25 engineering measures.

A number of reports on the Urban Safety Project, which included a package of engineering measures to redistribute traffic and improve safety of individual roads (Walker *et al*., 1989; Ward *et al*., 1989; Ward *et al*., 1989; Ward *et al*., 1989; Walker and McFetridge, 1989; Mackie *et al*., 1988, 1990; Tillman, 1992). They evaluated the effect of the project in 5 intervention areas, compared to 5 control areas. They found an accident reduction of 7% in I_1 compared to C_1. There was an initial increase in accidents in intervention area 2 but after some modification there was a reduction of between 4-15%. In intervention area 3 there was an accident reduction of 20-32%, while a reduction of between 10-25% was seen in intervention area 4 and 14% in intervention area 5. There was an overall 13% reduction on all accident types and reductions were more apparent in slight injuries than fatal and serious. Pedestrian injuries were reduced. Each scheme cost around £250,000 which resulted in a considerable accident cost savings.

Janssen (1991) compared three levels of road safety measures; a) measures to exclude through traffic from residential areas; b) more extensive measures to

exclude most local traffic and limit speed; c) complete reconstruction of pedestrian priority areas. They found that the measures adopted in b reduced injuries by up to 25% and that the most expensive option, c, was not as effective as b.

Vis *et al*. (1992) evaluated engineering measures to reduce traffic speeds to less than 30km/h. They found a 5% reduction in accidents and 25% reduction in injuries and that a combination of the measures adopted resulted in 85% of traffic travelling at mean speeds of less than 30km/h. Traffic volume was reduced by between 5 and 30%.

Webster and Mackie (1996) found that the introduction of 20mph zones resulted in a 61% reduction in total injuries, 70% reduction in child pedestrian injuries.

Towner *et al.* (2001) concluded that pedestrian skills programs have been shown to improve children's skills, provided that they are specifically targeted. They also noted that roadside experience is essential in pedestrian skills training. Although pedestrian skills training has been shown to be partially effective in increasing the skills, knowledge and behaviour of children at roads no studies have shown that this has resulted in a reduction in injuries and accidents.

Towner *et al.* (2001) evaluated the impact of traffic clubs and found that school-based traffic clubs have not been shown to be effective but that children's traffic clubs, using age-paced materials to promote parental teaching, have shown good evidence of behaviour change of parents and children. There has been some evidence that children's traffic clubs reduce the risk of injury but more evidence is needed.

Downing (1981) found that mothers in the intervention group, who received a booklet for parents to assist teaching road safety to children, were more likely to teach children about safety (80% in last 8 weeks compared to 50% in control group).

Antaki *et al*. (1986) evaluated the impact of the 'Tufty Club', a school-based education programme, on knowledge of road and safety advice and found that there was no difference in the test scores of the intervention and control groups.

West *et al*. (1993) investigated the 'General Accident and Eastern Region Traffic Club' (GAERT) and found little effect on the knowledge and reported behaviour of the children.

Towner *et al.* (2001) reported that the Children's Traffic Club reported by Gregersen and Nolen (1994) was ineffective or possibly even harmful as the risk of traffic accident was higher in the intervention group.

The Eastern Region Traffic Club and the GAERT, where children were invited to join on their 3rd birthday and materials were sent every six months, was

evaluated by a number of studies (Tucker, 1992; Bryan-Brown, 1994; Bryan-Brown, 1995). It was found that there were some improvements in behaviour as well as a 20% reduction in casualties involving children emerging from behind a vehicle. There were differences noted between the control and intervention groups but these were not all significant.

Towner *et al.* (2001) concluded that road safety programmes combining educational and environmental measures show some potential but more research is needed.

Preusser and Blomberg (1984) reported on school-based programme aimed at reducing mid block dart and dash accidents among children aged 4-14. They found that mid-block dart and dash incidents reduced by 21% in children under 15 and 31% in children aged 4-6 years.

Preusser and Lind (1988) evaluated a safety education film for children and found that the knowledge of safety decreased as time from watching the film increased; 86% correct after watching the film, 66% correct four months later compared to 42% correct for those who never watched the film at all.

Malenfant and van Houten (1989) found that a multi-faceted pedestrian safety education program aimed at encouraging drivers to yield to pedestrians at cross-walks as well as school and public education, engineering measures and police enforcement resulted in a reduction in injuries. Pedestrian injuries decreased 50% in one area, while they fell from 5.7/year to 2.5/year in another area. They also found that motorists yielding to pedestrians at cross-walks increased from 54 to 81% in area 1, 9 to 68% in area 2 and 44 to 71% in area 3.

Use of a simulation game to teach children to obey traffic safety rules resulted in the intervention groups having better reported behaviour scores than the control group on all tests (Renaud and Suissa, 1989).

Tziotis (1994) found that the 'Safe Routes to Schools' program resulted in a marked reduction in child casualties in 2 of the 8 intervention areas, some reduction in 3 and no trend in 2, so the results were inconclusive.

Burke *et al*. (1996) evaluated a program that aimed at education on safe bus boarding, where the intervention group also had safe areas painted on the pavements at the bus stops. It was found that children in the control group were twice as likely to exhibit unsafe behaviour (75/174) compared to children in the intervention group (38/145).

Kwan *et al* (2002) reported that fluorescent materials in yellow, red and orange improved the detection and recognition of pedestrians by drivers in the daytime, while at night lamps, flashing lights and retro-reflective materials in yellow and red increase recognition and detection. They did not find any reports that assessed the effect of visibility aids on pedestrian and cyclist-motor vehicle collisions and injuries.

Context

Most pedestrians are killed on roads with speed limits less than 40mph. Pedestrians are more than 5 times more likely to be killed or seriously injured on urban than on rural roads.

Understanding the reasons behind the high levels of road casualties in more deprived areas is complicated but some significant factors are though to be the immediate surroundings of where people live (e.g. no off-street parking, busy through-roads, limited places to play) and the social and economic environment (low levels of parental education, lower access to private cars, supervision of children).

Engström *et al*. (2002) found that socio-economic differences in injury risks are not necessarily constant over age. They found that for those aged 0-4 years had an increased relative risk of traffic injury as the socio-economic status decreased, with those in the lowest group, u8nskilled workers, having 25% higher risk of experiencing a traffic related injury , compared to the highest socioeconomic group (RR = 1.25, 95% CI 1.04 to 1.49). When adjusted for factors representing country of birth of parent, single parent home and receipt of welfare benefits the difference in injury risk was not as clear, the relative risk of those in the lowest group was 1.03 (95% CI 0.85 to 1.25).

In the age group 5 to 9 years the risk again increased as socio-economic status decreased (RR for those in lowest group compared to highest group = 1.54, 95% CI 1.40 to 1.69) the difference remained after adjustment was made (RR = 1.36, 95% CI 1.23 to 1.51).

They also found that the incidence of traffic injuries was very similar for both age groups 0 to 4 and 5 to 9 for girls across all socio-economic groups but that there was an increase in the incidence of traffic injuries for boys as the socioeconomic status decreased (0-4 years; 39.2, 39.1, 47.0, 50.0; 5-9 years; 133, 163, 190, 216).

Hippisley-Cox *et al.* (2002) found that the rate of admission to hospital, of children under 15, for pedestrian injuries increased significantly as deprivation increased. The risk of hospital admission for pedestrian injuries, for those under 15, was 330 times higher for those in the highest deprivation group, compared to the lowest (95% CI 3.49 to 5.28).

According to the WHO's global burden of disease data (2000) the incidence of road traffic injuries in children is more apparent in males than females. For males, aged 0-4, it is the 12th leading cause of death, while for males aged 5-15 years it is the 3rd leading cause of death and the 2nd leading cause of burden of disease. For females aged 0-4 and 5-15 it is 14th and 5th, respectively, on the list of leading causes of death, for the latter age group it is 5th on the list of leading cause of burden of disease.

It is clear that socio-economic differences are associated to risk of road traffic injury. Roberts (1996) show that, for children under 15, those in the lowest socio-economic class were four times more likely to die as pedestrians, compared to those in the highest class. Edwards *et al*. (2006) found that children of unemployed parents were 20 times more likely to die as pedestrians or cyclists as those in the highest social class.

Edwards *et al*. (2006) found that there was an association between the risk of injury and socioeconomic status, as defined by National Statistics Socio-Economic Classification (NSSEC). The rate of deaths per year of children aged under 15, from injury and poisoning, increased from 1.9 per 100,000 (95% CI 1.6 to 2.4) in higher managerial/professional occupations class to 5.0 (95% CI 4.3 to 5.8) in the routine occupations class to 25.4 (95% CI 22.9 to 28.1) in the never worked/long term unemployed class.

Roberts *et al*. (1996) found that a comparison of class specific child injury death rates in 1981 and 1991 shows that the decline in injury death rates in social classes IV and V (21% and 2%) was much smaller than those for those in classes I and II (32% and 37%).

DiGuiseppi (1997, 1998) gives some detail on differences in mortality between sex and age groups.

In the year ending March 2008, the admissions for females for road traffic accidents were 0 for those under 1, 17 for 1-4 and 26 for those aged 5 to 9.

For males the numbers of admissions to hospital were 1, 21 and 67 for pedestrian injured road traffic accidents. There were 5 deaths in children under 10 as a result of road traffic accident in the year ending March 2008 (ISD Scotland, 2008).

Emergency hospital admissions appear to be associated with deprivation, when compared to the total number of admissions the standardised discharge rate for RTA is 160.0 (134.5 to 185.4) for the most deprived quintile and 66.5 for the least deprived quintile (95% CI 49.8 to 83.1).

A study by Christie *et al* (2007) attempted to understand high traffic injury risks for children in low socio-economic areas and reported that parents believe that their children play in their local streets because they like playing with their friends near home; there are few safe, secure and well-maintained areas for children; children are excluded form affordable leisure venues because of their costs; insufficient parental responsibility. They concluded that interventions need to take the multiple reasons why children in low socio-economic areas become exposed to hazardous environments into account.

Towner *et al*. (2005) stated that child injury deaths rise steeply with deprivation and the likelihood of a child being killed or injured is associated with a number of factors such as single parenthood, young mothers, low education of mothers and poor housing.

An investigation of predictors of childhood accidents using multivariate logistic regression and found that the factors that were predictive of accidents were; Age (the odds of having an accident increased significantly with age); Scottish Index of Multiple Deprivation (This factor was significant for boys, though it did not show a clear trend); and NS-SEC socio-economic classification (This factor was significant for girls but as with SMID there was no clear trend).

Roberts and Power (1996) found that those form the lowest socio-economic class were 4 times more likely to die from road traffic injuries, this rose to five times among pedestrians.

Edwards *et al*. (2006) found that if the parent is unemployed children, between 0 and 15, are 5.5 times more likely to die as a car occupant and 20 times more likely to die as a pedestrian or cyclist than if the parent has a managerial or professional job.

Context - Pedestrians

Child-related risk factors associated with RTA (according to World Report on Child Injury Prevention, 2008).

Children are still growing and as a result they are more vulnerable to injury on impact with a car. They are also they are smaller and therefore harder to see and be seen. The sensory facilities of children are also not fully developed and they can miss signs of danger and this makes them more at risk of being involved in an RTA (European Report on Child Injury Prevention, 2008).

As children grow their ability to make safe decisions in traffic improves. Children between 5 and 7 can assess speed and distance of traffic (Siegler and Richards, 1979) but they still cannot recognise dangerous places to cross the road or assess the presence of oncoming traffic in places where there are 'obstacles' such as corners and road junctions. A large proportion of road traffic accidents involve a large number of what is termed as "dart and dash" cases. This is typically due to children not stopping or slowing down before crossing the road as children of this age generally lack the ability to switch attention from one task to another. Children over the age of 11 are able to recognise dangers and they are able to modify their behaviour when faced with two tasks when over the age of 12.

According to new research there is growing evidence that the visual processes needed to cross the road safely are present and fully developed in infants it is not until they are 10-12 years old that they are able to recognise visual signals and integrate them into a meaningful context.

Risk-taking behaviour is not typically associated with young children under the age of 9.

Males are involved in more accidents than females.

Lack of adult supervision has often been a risk factor among children for road traffic injury. There are differences in the understanding of parents of what activities are safe at what age. These could account for some of the variation in age, gender and socio-economic status in the patterns of child road traffic injury. Children's attitude to road use is generally developed by the age of 11, indicating that the attitude of parents could affect the attitude of their children but there has been little research into the effect a parent's risk perception plays on a child's risk for RTI. A study in Malaysia found that the risk of RTI was reduced by 57% under adult supervision (Fatimah *et al*., 1997) while another study carried out in Canada found that the lack of supervision increased the risk of pedestrian and bicyclist injury by a factor of 2.6 (Pless *et al*., 1989).

According to the WHO report (Racioppi *et al*., 2004) improving road safety, through methods such as reducing speeds, reducing transport demand and investment in safe infrastructure for pedestrians and cyclists would reduce crashes and in turn encourage people to walk as well as reducing pollution and noise.

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