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Injury is a leading cause of death among children and adolescents and accounts for around 16% of the world's burden of disease reflecting the disproportionate burden of injuries among young people and added years of life lived with disability. It is the poorest children in every country in the world that are at greatest risk of injury and the majority of deaths due to child injury occur in low-income and middle-income countries. The majority of injuries can be prevented or at least controlled and the costs of prevention are much lower than the costs of the consequences of injuries. But injury prevention requires good quality data monitoring and surveillance systems. This article provides an overview of child and adolescent injuries and their risk factors including socioeconomic inequality. Drawing on an original UK case study of data, it illustrates the crucial lack of data and injury surveillance systems to inform prevention.

Key words: injuries; children; adolescents; injury prevention; injury surveillance; injury data

Introduction

Injury is a leading cause of death among children and adolescents such that almost half of all deaths worldwide among 15- to 19-year olds are attributed to injury (World Health Organization, 2008a, page xv). According to the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) there are around 950 000 injury-related deaths each year in those aged under 18 years (WHO, 2008a, p. 1). It has been estimated that around 16% of the world's burden of disease can be attributed to injury reflecting the disproportionate burden of injuries among young people and added years of life lived with disability (Krug *et al*., 2000).

Unintentional injury is said to account for 90% of all fatalities from injury among those under 18 years with an average of 2270 children dying every day worldwide (WHO, 2008a, p. 1). Road traffic injuries (RTIs) are the leading cause of death from injury among children and adolescents accounting for 22% of all unintentional injuries worldwide followed by drowning (17%) and fire-related burns (9%) (WHO, 2008a, p. 6).

It is the poorest children in every country in the world that are at greatest risk of injury, the majority (95%) of deaths due to child injury occur in low-income and middle-income countries and the high costs of injury contribute to family poverty (WHO, 2006, 2008a, p. 1, 11, 145). It is estimated that Africa and South-East Asia have the highest unintentional injury mortality rates among under 20-year olds, 53.1 and 49.0 per 100 000 population respectively compared to a rate of 7.9 per 100 000 for high income European countries (WHO, 2008a, p. 165).

Child and adolescent injury mortality rates are also rising in low and middle income countries in association with urbanisation and motorisation (WHO, 2006, p. 1). Compared to other causes of child and adolescent mortality in the developing world, unintentional injury is growing in significance as infectious disease declines (Morrison *et al*., 1999a; WHO, 2006, p. 1; Harvey *et al*., 2009).

Child injuries are a growing public health problem and have implications for countries with poorly accessible and under-resourced health care systems (WHO, 2008a, page xv). There is an absence of

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literature on the economic burden injuries place on society, particularly in low and middle income countries (WHO, 2006, p. 8).

The majority of injuries can be prevented or at least controlled and some countries achieved reductions in child and adolescent injury mortality rates of over 50% via injury prevention (WHO, 2006, p. 9). Injury prevention strategies have proven to be extremely cost-effective; the costs of prevention are much lower than the costs of the consequences of injuries (WHO, 2008a, p. 148).

This article provides an overview of child and adolescent injuries and their risk factors including socioeconomic inequality. It is not intended to be comprehensive. It draws on an original UK case study of data to illustrate the crucial lack of data and injury surveillance systems to inform prevention.

What is an injury?

The WHO defines injury as 'the physical damage that results when a human body is suddenly subjected to energy in amounts that exceed the threshold of physiological tolerance – or else the result of a lack of one or more vital elements, such as oxygen' (WHO, 2008a, p. 1). Injury is commonly subdivided into the following categories:

- Unintentional
  - road traffic collisions
  - drowning
  - burns (fires or scalds)
  - falls
  - poisonings
  - other (includes smothering, asphyxiation, choking, animal or snakebites, hypothermia and hyperthermia)
- Intentional
  - interpersonal (e.g. assault and homicide)
  - self-harm (e.g. abuse of drugs and alcohol, self-mutilation, suicide)
  - legal intervention (e.g. action by police or other law enforcement personnel)
  - war, civil insurrection and disturbances (e.g. demonstrations and riots)
- Undetermined intent (WHO, 2001, p. 6; 2008a, p. 5)

Risk factors

Age

Injury as a cause of death increases in significance as a child ages (WHO, 2006, p. 6); however, according to figures from the WHO the highest unintentional injury mortality rate for children and adolescents under 20 years is found among the under 1-year olds (96.1 per 100 000 population) obscured by high mortality rates from other causes (WHO, 2008a, p. 165). The unintentional injury mortality rate halves for 1- to 4-year olds (45.8 per 100 000) and continues to decrease until rising again for 15- to 19-year olds (40.6 per 100 000). (WHO, 2008a, p. 165).

Age can be viewed as a proxy for a number of different changes taking place as a child grows including development, their interaction with the world and type of activities undertaken, societal factors and the legal framework in that society, for example, with regards to working age (WHO, 2006, p. 4; 2008a, p. 8, 145). Children are especially vulnerable to injury due to their small stature, developing neuromuscular systems and their dependence on adults for care and protection (Stone and Jeffrey, 2004, p. 5). The changes which take place all have a strong association with the type of injury they might sustain, poisoning for example is associated with the grasping and drinking behaviour among 1- to 3-year olds while falls are more likely when a child is learning to walk (WHO, 2008a, p. 8). Injuries classified as intentional make up a larger proportion of all injuries among older children, 15% among 10- to 14-year olds compared to only 5% among under 10-year olds (WHO, 2006, p. 6).

Gender

Males have a higher risk of mortality from unintentional injury than females at all ages below 20 years, apart from the under 1-year olds in low and middle income countries, and for all injury types except fire-related deaths, also in low and middle income countries (WHO, 2008a, pp. 164–177).

Studies have consistently found male children of varying ages to be more likely than female children to sustain an injury either requiring or not requiring attendance at hospital and to die as a result of injury (Morrison *et al*., 1999b; Reading *et al*., 1999, 2008; Haynes *et al*., 2003). Adolescent males are more likely to require medical treatment for injury than adolescent females and this result is shown in every one of the 35 countries which participated in the 2001/2002 WHO Health Behaviour in School-Aged Children survey (Pickett *et al*., 2005).

Local country data and routine data statistics also show this gender inequality; in Scotland boys under the age of 15 years are more likely to be admitted to hospital as an unintentional injury emergency than girls and this inequality appears to widen as the children get older with 10- to 14-year-old boys almost two and a half times more likely to be admitted to hospital as an unintentional injury emergency than 10- to 14-year-old girls (Information Services Division NHS Scotland, 2010).

Deprivation

Differences between rich and poor countries

The unintentional injury mortality rate among children and adolescents under 20 years in low and middle income countries is 41.7 per 100 000, three times higher than the rate of 12.2 per 100 000 in high income countries, as defined by the World Bank based on gross national income per capita (WHO, 2008a, p. 165; WHO, 2008c, p. 5). For children under 15 years the approximate intentional injuries mortality rate is 3.8 per 100 000 in low and middle income countries compared to 1.1 per 100 000 in high income countries (WHO, 2008c). Intentional injuries among under 15-year olds make up a slightly larger proportion (approximately 12%) of all injuries in high income countries than they do in low and middle income countries (7%) (WHO, 2008c). Even within Europe and the OECD group of rich nations there is wide variation in child and adolescent injury mortality rates, for example, in Europe the mortality rate ranges from 5.8 unintentional injury deaths per 100 000 population in the Netherlands to 22.4 per 100 000 in Latvia and 0.7 per 100 000 intentional injury deaths in Greece to 8.2 per 100 000 in Lithuania (Table 1)

Table 1 Unintentional and intentional injury mortality rates for children and adolescents (0–19 years) in 20 Child Safety Action Plan countries plus the average for 27 EU countries Adapted from Child Safety Report Card, EUROSAFE (2009)

Unintentional injuries		Intentional injuries	
Country	Unintentional injury rate per 100 000	Country	Intentional Injury rate per 100 000
Netherlands	5.83	Greece	0.74
United Kingdom	5.93	Italy	1.07
Ireland	6.52	United Kingdom	1.12
Sweden	7.04	Spain	1.16
Germany	7.86	Portugal	1.28
France	8.16	Netherlands	1.65
Israel	8.30	France	1.84
Hungary	8.43	Germany	2.08
Italy	8.63	Sweden	2.50
Finland	9.08	Czech Republic	2.53
Austria	9.42	Hungary	2.91
Slovenia	9.61	EU-27	2.93
Spain	9.71	Ireland	3.00
Czech Republic	10.44	Belgium	3.46
EU-27	11.25	Slovenia	3.51
Greece	12.44	Austria	3.64
Belgium	12.62	Israel	3.78
Portugal	13.70	Finland	4.01
Estonia	21.30	Latvia	5.69
Lithuania	21.90	Estonia	6.25
Latvia	22.43	Lithuania	8.21

(United Nation's Children's Fund, 2001, p. 4; European Child Safety Alliance, 2009, p. 2).

RTIs are the leading cause of death for 5- to 14-year olds in high income countries (mortality rate 4.9 per 100 000 population) and are the third leading cause (mortality rate 14.5 per 100 000) behind acute lower respiratory infections and malaria in low and middle income countries although the rate in the low and middle income countries is still three times that in the high income countries despite car ownership being around 6% in the developing world of what it is in the developed (Krug *et al*., 2000; UNICEF, 2001, p. 22).

Road traffic collisions followed by drowning are the single largest cause of injury death among children and adolescents under 20 years in high, low and middle income countries (WHO, 2008a, pp. 164–177). However, road traffic collisions make up a larger proportion of all unintentional injuries

among 0- to 14-year olds in high income countries (approximately 43%) than they do in low and middle income countries (23%) where poisoning, fire and drowning are more significant (WHO, 2008c, p. 68).

Differences within rich and poor countries

There is very little research looking into the association between childhood injuries and socioeconomic status and what little there is has mostly been carried out in developed countries (UNICEF, 2001, p. 15; WHO, 2008a, p. 11).

In Scotland, children under 15 years in the most deprived fifth of the population are two and a half times more likely to die as a result of unintentional injury than children in the least deprived fifth (ISD, 2009). In England low parental employment status has been found to be strongly associated with death from injury in children aged 15 years and under. Children, whose parents had never worked or were long-term unemployed, are 13 times more likely to die as a result of injury and 38 times more likely to die from exposure to smoke, fire and flames than children of parents with higher managerial/professional occupations (Edwards *et al*., 2006).

Child injury mortality rates have fallen in England and Scotland (Avery *et al*., 1990b; Roberts and Power, 1996; Morrison *et al*., 1999b; Edwards *et al*., 2006) and at least until 1993 across Europe (Morrison *et al*., 1999a). In Scotland between 1981 and 1995 a 58% decrease in deaths from injury and poisoning among 0- to 14-year olds occurred across all socioeconomic groups equally (Morrison *et al*., 1999b) whereas in England and Wales such falls in the 1980s were accompanied by a widening socioeconomic mortality differential between rich and poor (Roberts and Power, 1996). On the whole the unintentional child death rate in Scotland is estimated to be 30% higher than England and Wales (The Royal Society for the Prevention of Accidents, 2007). The numbers of fire-related fatal and non-fatal injuries in children also fell in England between 1995 and 2004 but the socioeconomic inequality remains with deprived areas having higher rates than the less deprived (Mulvaney *et al*., 2009).

In Scotland children under 15 years in the most deprived fifth of the population are one and a half times more likely to be admitted to hospital as an emergency than children in the least deprived fifth (ISD, 2009). In England a study of serious injuries resulting in hospital admission among children under 16 years of age found that after adjusting for ethnic differences, pedestrians in the most deprived tenth of the population were four times more likely to have been injured and admitted to hospital than the least deprived tenth; for cyclists the ratio was 3:1; and for car occupants almost 5:1 (Edwards *et al*., 2008). Two separate studies carried out on 0- to 4-year olds and 5- to 14-year olds in Norwich, England found a relationship between increasing numbers of children presenting to A&E with injuries and heightened area level socioeconomic deprivation (Reading *et al*., 1999; Haynes *et al*., 2003). This trend was shown to persist after accounting for individual risk factors. An earlier study carried out on child injury mortality data from England and Wales between 1975 and 1984 also found a correlation between child injury mortality rates and area level socioeconomic deprivation (Avery *et al*., 1990).

Other risk factors

Single parenthood, low maternal education, low maternal age at birth, poor housing, large family size and parent alcohol and/or drug abuse have been found to be associated with childhood injury mortality (WHO, 2008b, p. 10). Accident and emergency hospital admissions for injuries in the UK among 0- to 4-year olds have been found to be associated with having an increased number of elder siblings, having a young mother, having a lone parent and living near a hospital (Reading *et al*., 1999) and for 5- to 14-year olds with having a younger eldest female in the household and less adults in the household (Haynes *et al*., 2003).

Road traffic injuries

Of the leading mechanisms of unintentional injury to children, RTIs are the most fatal and are also a leading cause of traumatic brain and limb injuries causing long-term disability, with an estimated 2% of Disability Adjusted Life Years (one DALY = one lost year of healthy life) lost in children as a cause of RTIs (WHO, 2008b, pp. 15, 20).

Along with house fires, road traffic collisions are the most common reason for simultaneous multiple child fatalities (Avery *et al*., 1990). Death and injuries from road traffic crashes are forecast to rise worldwide by 67% between 1990 and 2020 (WHO, 2008a, p. 4). Experiencing road traffic is an everyday part of a child's life as they travel to school, home, social events, etc., but the evidence suggests that children are particularly vulnerable road users, and risk of mortality from RTIs increases with age in high-income countries (WHO, 2008b, p. 15). This trend may be partly attributable to children becoming more adventurous, in addition to reduced supervision, as they move towards adolescence. Children may be injured as pedestrians, which is the most common type of RTI in those under 15 years within Europe, or whilst cycling, or as passengers in cars (WHO, 2008b, p. 15). Between the age groups of 10–14 and 15–19 years there is a significant rise in mortality from RTIs, which may reflect the age at which it is legal to drive being between 15 and 19 in many countries (WHO, 2008b, p. 15).

There is profound social inequality with regard to RTIs within the UK where children of lower socioeconomic class are at much greater risk of RTIs than more advantaged children, for example emergency admissions for RTIs are two and a half times higher in the most deprived quintile of the population in Scotland compared with the least deprived quintile and one a half times greater among the most deprived fifth of children than any other fifth (ISD, 2009).

There are numerous reasons that have been identified to explain such social differences, and it seems that these add cumulatively to create the huge gap between the social classes. Children from more deprived families are likely to live in deprived urban neighbourhoods with few safe play areas and where roads are more likely to be unsafe with high-speed traffic (WHO, 2008b, p. 19). Such children are less likely to have a garden than those children from more affluent families and may be inclined to play outside their homes with close exposure to traffic on roads. In addition, those living in more deprived areas are less likely to live within close proximity of a green space where children can play safely. A study conducted by Macintyre *et al*. (2008) in Glasgow showed that almost 13% more of those residents in the least deprived data zones lived within 500 m of a public green space in comparison to the most deprived.

A study conducted in New Zealand observed that schoolchildren from deprived backgrounds had significantly increased exposure to street crossings on a daily basis in comparison to wealthier counterparts (Roberts *et al*., 1996). Consequently disadvantaged children have more exposure to road traffic as pedestrians and inevitably are at a greater risk of experiencing an RTI.

Data, data quality, injury surveillance and injury prevention

Local, regional and national injury surveillance systems are required to provide the data needed to plan and deliver effective injury prevention programmes (WHO, 2001, p. 14). Injury prevention measures include primary prevention measures to prevent injury from happening and secondary prevention measures to reduce the severity of injury (WHO, 2006, p. 9). Local surveillance systems play an essential role in targeting and evaluating unintentional injury prevention initiatives in children and young adolescents, and in motivating participants (Towner *et al*., 2001, p. 82). In many high income countries it has been shown that child and adolescent injuries can be prevented through careful analysis and appropriate action (WHO, 2006, p. 1). Towner *et al*. (2001) found good evidence that the health promotion initiatives: 20 mile per hour speed zones; smoke detector promotion programmes; and child resistant packaging reduce injuries among 0- to14-year olds. They also found that 20 mile per hour speed zones; bicycle helmet educational campaigns and legislation; child restraint loan schemes and legislation and smoke detector promotion programmes induce behaviour change conducive to injury reduction.

The vast majority of injury prevention health promotion evaluation studies on children have been carried out in the developed world in a few high income countries and may not be easily transferable to low and middle income countries although many will have relevance worldwide (Towner *et al*., 2001, p. 88; WHO, 2006, p. 10). Over half have been carried out in the United States and most studies relate to injuries in the road environment including cycling injuries (Towner *et al*., 2001, p. 88).

What data are required?

UNICEF has a commitment from 2002 as part of its vision of 'A world fit for children' to reduce injuries by developing and implementing appropriate preventive measures (UNICEF 2002, p. 11). There are, however, a lack of good quality data to inform strategy (Kirkwood and Pollock, 2008) and a need for reliable estimates of child and adolescent injury and death, particularly in the low and middle income countries (WHO, 2006, p. 11). This will require an increase in the volume, quality and availability of national and regional data from better data collection systems including improved hospital surveillance and community surveys (WHO, 2006, p. 11).

Sources of data on injury

Data on injury-related morbidity can be derived from a number of sources including hospital admission/discharge data, data on RTIs, poison centres, fire statistics, workplace injury statistics as well as surveys (Stone *et al*., 2003; Kisser *et al*., 2009). There are currently three specially designed European-wide injury surveillance systems in operation (Table 2) (Stone *et al*., 2001; Stone *et al*., 2003). In 1999 there were also a number of systems operating in individual European countries including the UK, Sweden, Norway, the Netherlands, Greece and Denmark as well as injury surveillance systems in existence in the USA, Canada, Australia and New Zealand (Stone and Morrison, 2001; Stone *et al*., 2003). The European Injury Database (IDB) and the USA National Electronic Injury Surveillance System (NEISS) are considered to be the gold standard by those managing surveillance systems, both requiring routine data collection to be supplemented by patient interview (Ward and Healy, 2008, p. 30). Also of note are the Australian Victorian Injury Surveillance System and the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) (Kisser *et al*., 2009).

The IDB collects accident and emergency hospital data from member countries including the UK but since the discontinuation of the HASS & LASS UK wide hospital sample-based injury surveillance system in 2002 the UK data has come only from Wales, the only country in the UK to have a fully functional A&E attendance-based surveillance system (Ward and Healy, 2008, p. 30). The UK is now one of the few high income countries that does not collect accident and emergency attendance data but this situation may be rectified with pilot studies

Table 2 European wide injury surveillance systems (Stone *et al*., 2003; CARE, 2007; Ward and Healy, 2008; Kisser *et al*., 2009)

Database	Source	Collected by	Years available	Casualty reporting
European Injury Database (IDB) European Home and Leisure Accident Surveillance System (EHLASS)	European Commission	Trained staff at participating hospitals	1986–1999 (EHLASS) 1999 to present (IDB)	Home and leisure injuries presenting to participating departments (from 2007 onwards most countries have extended data collection to all injuries)
Community Database on Road Traffic Accidents (CARE)	European Commission Road Safety	Member countries – compiled from national datasets based on police reports	Fully operational 1999 to present	Road 'accidents' resulting in death or injury
International Road Traffic and Accident Database (IRTAD)	Organisation for Economic Co-operation and Development (OECD)	Police authorities in OECD countries	1996 to present	Road traffic incidents reported by police authorities

currently taking place in both England and Scotland (Ward and Healy, 2008, p. 4).

Mortality data

Mortality data are the most basic data required to monitor injuries. Mathers *et al*. (2005) found that only 115 out of 192 WHO member countries had supplied the WHO with death registration data and of these, only 64 had supplied data that was complete and only 23 countries had supplied data that was deemed to be of high quality (Mathers *et al*., 2005). Only four African countries out of 46 had supplied any useable data since 1990 and only one of these countries, Mauritius, had supplied data which was complete (Mathers *et al*., 2005).

Even within the EU, data are not integrated and vary in completeness. All EU countries collect mortality data routinely as part of vital registration (Stone *et al*., 2003, p. 13); however, Mathers also found that 12 of the countries which supplied only medium quality mortality data to the WHO were high income Western European countries and Greece and Portugal were two of the countries supplying low quality data (Mathers *et al*., 2005). Also socioeconomic status is not included on death records, one exception being Scotland (Stone *et al*., 2003, p13).

Much of the WHO data relies on surveys and local country sources. WHO Europe uses a range of databases from which it extracts key health statistics, of which the primary data source for international comparisons in Europe is the European Health for All Database (HFA-DB). The data for this are compiled from a range of sources including a WHO network of country experts, WHO Europe's technical programmes and other partner organisations such as the statistical office of the European Union (EUROSTAT), the Organisation for Economic Co-operation and Development (OECD) and the United Nations (UN) (WHO Europe, 2008b).

Focusing only on mortality data are insufficient for injury prevention purposes as the cause of injuries which lead to death and those which do not vary; for example, falls are the most common childhood injury found in emergency departments in most countries accounting for at least 25% of child patients (WHO, 2008a, p. 101) and are the leading cause of DALYs for 5- to 14-year olds (Krug *et al*., 2000) but account for less than 5% of fatalities (WHO, 2006, 2008a, p. 6).

The WHO provides data on incidence of injury severe enough to require medical attention and prevalence of short and long-term disability resulting from injury but the data are not split by age (WHO, 2008d). Even hospital admission and discharge data may be inadequate and an unreliable information source for morbidity; datasets based on this will only contain the more serious injuries and will reflect the country-specific way of organising healthcare (Ward and Healy, 2008, p. 35; Kisser *et al*., 2009). Accident and emergency attendance data, possibly supplemented by interview, is more useful (Ward and Healy, 2008, p. 35).

The economics of injury

Data are often poor and incomplete and this affects studies attempting to look at the costs of injury.

Some studies show the economic burden to society of injuries in high income countries to be significant, for example, each year in Scotland unintentional injuries to children alone are estimated to cost the National Health Service (NHS) £40 million while the cost to society as a whole is estimated to be around £400 million (RoSPA, 2007, p. 3). The cost to society of injuries to children just in and around the home in the UK in 2002 was estimated to be in the region of £9.46 billion in a single year while RTIs were estimated to cost society £1.23 billion (Ward and Healy, 2008, p. 1).

In developing countries the cost of RTIs alone are estimated at about US$100 billion each year, between 1% and 2% of gross domestic product and twice the total amount received in development aid (WHO, 2008a, p. 20).

Injury prevention measures are known to be cost effective (The Council of the European Union, 2007). It is estimated that the financial saving of healthcare costs from installing a smoke detector/alarm in the home as a result of reduced child injury incidence, is almost 70 times more than the initial expenditure for the safety device (WHO, 2008b). The estimated annual cost of a UK injury surveillance system once it is up and running is said to be not much more than £1.75 million, a fraction

of the estimated overall cost to society of injuries (Ward and Healy, 2008, p. 5).

A case study of child and adolescent sport injury data in the UK

It is often taken for granted that data in high income countries are comprehensive and complete but the following case study shows this is not the case. Here we highlight the inadequacy of UK data for injury surveillance.

Sport and recreation are major causes of child and adolescent injury (RoSPA, 2002; Scottish Health Survey, 2003a; CAPIC, 2004; Kuratorium für Verkehrssicherheit, 2009, pp.18–19). In the case study below we report on a review of UK wide data for children and adolescents, under 20 years of age which we conducted in 2009–2010. We reviewed routine data collected either as a by-product of clinical care or as a statutory requirement; data collected via injury surveillance systems and national survey data based on samples to supplement an earlier report of child injury data sources in Scotland (Chishti, 2002). We also searched the following databases for surveillance systems and surveys relating to injury:

- UK government websites on routine data sources
- MEDLINE using the search terms 'injury' AND 'surveillance' in the title
- Cochrane database (Cochrane reviews, Other reviews, Technology assessments and Economic Evaluations) using the MESH search term 'wounds and injuries'
- Collaboration for Accident Prevention and Injury Control (CAPIC) systematic review database using the search term 'surveillance'

In addition we contacted various experts in the field as well as the agencies responsible for collecting the data and for producing reports based on the data. We did not include special local registers such as spinal injuries data.

We describe the data sources according to the agency responsible for data collection, the source of funding, the data collection method and the population coverage or sample size. We also describe how each dataset compares against the WHO core minimum dataset guidelines and data standards for injury surveillance and the International Classification of External Causes of Injury (ICECI) recommendations for sport injury surveillance in terms of data collection and reporting.

WHO data standards – core minimum dataset for injury surveillance

The WHO has issued injury surveillance guidelines to 'help people design, establish and maintain good injury surveillance systems' worldwide (WHO, 2001, p. 2). The core minimum dataset for injury surveillance recommended by the WHO as the basic international standard for comparison between countries comprises eight variables: a unique identifier to identify the injured person; their age; their sex; whether intent was involved in the injury; where the injury occurred; the activity taking place when the injury occurred; the cause and the nature of the injury (WHO, 2001, p. 25). Age should be categorised for children and adolescents as 0–4 years, 5–14 years and 15–19 years separately (WHO, 2001, p. 30); however, the UN definition of children is 0–17 years and should be acknowledged in any data provided according to EUROSAFE which contradicts the WHO recommendations (EUROSAFE, 2009, p. 35).

International classification of external causes of injury recommendations for sport injury surveillance

The ICECI define a 'sports injury event' as 'any incident taking place while participating in sports and exercise-related activities and resulting in injury' and define 'sports and exercise' as 'physical activity with a described functional purpose, for example, competition, practicing for competition, improving physical health' (WHO–ICECI, 2004, p. 257). If the injury occurred during a sports activity then the following should also be recorded (Table 3).

Results

We identified nine sources of injury data across the UK with potential for collecting data on sporting

Table 3 WHO International classification of external causes of injuries (ICECI) version 1.2 (WHO–ICECI, 2004) S - Sports module

Data element	Definition	Example of coding structure
S1 – Type of sport/exercise activity	The type of sport or exercise activity in which the injured person was engaged at the time of the injury. Participation in a sport or exercise activity includes practice, training, and competition, as well as pre-event (e.g. taping, dressing), warm-up, cool down, and post-event (e.g. showering, dressing) activities. It does not include travel to and from the event or activity	... 2. Team bat or stick sports 2.01 Baseball 2.02 Cricket ... 4. Boating sports 4.01 Canoeing 4.02 Jet skiing ...
S2 – Phase of activity	The phase of a sport or exercise activity during which the injury occurred	1. Training/practice ... 4. Competition/participation ...
S3 – Personal countermeasures	Equipment used or worn by a participant to protect against injury. Does not include environmental safety devices	... 3. Rigid taping of joint ... 9. Mouth guard ...
S4 – Environmental countermeasures	Measures in the competitive or recreational environment that are designed to protect against injury. Does not include protective equipment worn or used by participants, except in the case of vehicle safety restraints	... 3. Padded goal posts, corner markers ... 5. Safety restraints/vehicle restraints ...

injury in children and adolescents. Table 4 describes the datasets in terms of the agency responsible for data collection, the source of funding, the data collection method and the population coverage or sample size. Tables 5 and 6 describe how each dataset measures against the WHO core minimum dataset standards for injury surveillance in terms of data collection and reporting respectively. Table 7 describes how the datasets comply with the ICECI recommendations on sport injury data collection.

Seven of the data sources comply with the WHO core minimum dataset standards for injury surveillance in terms of data collection while the other two which are surveys do not collect information on the activity when injured. However, in terms of what is actually reported from these data sources only two of them, HASS & LASS and Y-CHIRPP, comply with the WHO standards although HASS & LASS reports use different age categories. Both these surveillance systems have been discontinued for some years, HASS & LASS ceased to operate in 2002 and Y-CHIRPP in 2006. Only AWISS and HASS & LASS collected any information on sport injury and this was only the type of sport/exercise activity undertaken at the time of injury and none of the other recommended sport injury fields were collected by any of the systems.

In addition HES, PEDW and ISD data are based on hospital admission only and will therefore only contain the most serious injuries. AWISS and Y-CHIRPP are A&E attendance-based systems and will therefore pick up a wider range of injuries; however, AWISS only covers Wales and Y-CHIRRP a single children's hospital in Glasgow presenting problems in terms of the representativeness of the data. Finally, the Health and Safety Executive data could potentially be useful as it is population based and covers the whole of the UK but no reports of school data are made routinely available. This study shows the limited range of data collected, the lack of integration and consistency.

Table 4 Description of UK injury data sources which cover children and adolescents (0–19 years)

Dataset	Agency responsible for data collection	Source of funding	Data collection method	Population coverage/sample size
NHS Hospital Episode Statistics (HES)	Secondary Uses Service (SUS) [under the National Programme for IT]	UK Government	Routinely collected	Every NHS inpatient in England
Patient Episode Database for Wales (PEDW)	Health Solutions Wales	National Assembly for Wales	Routinely collected	Every NHS inpatient in Wales and Welsh patients in NHS hospitals in England
SMR datasets	Information Services Division NHS Scotland (ISD)	Scottish Government	Routinely collected	Every NHS inpatient in Scotland
Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR)	Health and Safety Executive (HSE)	UK Government	Routinely collected	Working population of Great Britain plus off shore oil and gas industry including all school pupils/students
All Wales Injury Surveillance System (AWISS)	Health Solutions Wales	National Assembly for Wales	Surveillance system	All injured people attending A&E departments across most of Wales
Home and Leisure Accident Surveillance System (HASS and LASS)	Department of Trade and Industry (DTI), data now held by The Royal Society for the Prevention of Accidents (RoSPA)	UK government via the former DTI (RoSPA funding for 5 years 2003–2008)	Surveillance system	All injured people attending sample of between 16 and 18 hospitals (excludes road traffic and work injuries)
Discontinued in 2002				
Y-CHIRPP	A&E department, Royal Hospital for Sick Children, Yorkhill, Glasgow	NHS	Surveillance system	All children under 16 years presenting to Yorkhill A&E with an injury
Discontinued in 2006				
Health Survey for England	Department of Health (DH)	DH	Survey	There were 3993 children aged 0–15 years interviewed in 2001 and 8067 interviewed in 2002
Scottish Health Survey	Scottish Executive Health Department (SEHD)	SEHD	Survey	There were 3324 children under 16 years interviewed in 2003 (non-fatal injuries which do not result in long-term hospital admission)

Discussion

While the scale, risks and causes of injury are fairly well established our case study shows the absence of data and systems for monitoring and surveillance to inform prevention is not just a problem for low and middle income countries. The UK lacks data and in addition the capacity to analyse existing data. There is a need to develop robust integrated data systems, which include vital registration and hospital, school, transport and the workplace. Unless and until this is done the effectiveness of injury prevention strategies and public awareness about the risks and costs of injury will remain a low priority for citizens and for government.

Table 5 How do UK datasets compare with WHO core minimum dataset standards for injury surveillance with respect to children and adolescents (0–19 years) in terms of data recording

Dataset	Unique identifier	Age	Sex	Intent	Location	Activity when injury occurred	Cause of injury	Nature of injury
HES (2010)	There are a number of identifiers used including 'Patient ID (hesid__orig)' which uniquely identifies a patient across all data years	Yes	Yes	Three character ICD-10 codes within chapter XX 'External causes of morbidity and mortality' can be used to record intent	Four character ICD-10 codes within chapter XX can be used to record location	Three character ICD-10 codes within chapter XX can be used to record activity	Three and four character ICD-10 codes within chapter XX can be used to record cause of injury	Three and four character ICD-10 codes within chapter XIX can be used to record nature of injury
PEDW (Macey, 2010)	The patient's encrypted case record number which is unique to that patient within a hospital or health care provider. Pseudonomised patient NHS number	Yes	Yes	As for HES				
SMR (ISD, 2007)	There are a number of identifiers used including 'Patient Health Record Identifier' which is used to uniquely identify a patient within a health register or a health records system	Yes	Yes	As for HES				

(continued)

Table 5 Continued

Dataset	Unique identifier	Age	Sex	Intent	Location	Activity when injury occurred	Cause of injury	Nature of injury
RIDDOR Health and Safety Executive (2005,2009)	Identifying information collected including name and home address	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AWISS (WIGSB, 2009) (Macey, 2010)	Unique identifier is called Anonymised Linking Field (ALF) which not only links records within AWISS but allows AWISS records themselves to be linked to other datasets, such as inpatient and outpatient datasets which also include the ALF identifier	Yes	Yes	Two character code within Emergency Department Data Set (EDDS)	Two character code within EDDS	Two character code within EDDS	Two character code within EDDS	Three character code within EDDS
HASS and LASS (RoSPA, 2004)	Casualty number collected	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Y-CHIRPP (Shipton and Stone, 2007; Y-CHIRPP, 2008)	Surname, post code, date of birth and sex collected	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Health Survey for England (2002a)	Name and address recorded	Yes	Yes	Only asks about unintentional injuries	Yes	No	Yes	Yes
Scottish Health Survey (2003b)	Name and address recorded	Yes	Yes	Only asks about unintentional injuries	Yes	No	Yes	Yes

Table 6 How do UK datasets compare with WHO core minimum dataset standards for injury surveillance with respect to children and adolescents (0–19 years) in terms of routine data reporting

Dataset	Unique identifier	Age	Sex	Intent	Location	Activity when injury occurred	Cause of injury	Nature of injury
HES (2009)	Data reported in aggregated form at the three character level ICD-10	0–14 and 15–59 years	By sex but not within age	Data available at three character level ICD-10 code	Not routinely available	Data available at three character level ICD-10 code	Data available at three character level ICD-10 code	Data available at three and four character level ICD-10 code
PEDW (Health Solutions Wales, 2009)	Data reported in aggregated form at the three character level ICD-10	0–14 and 15–59 years	By sex but not within age	Data available at three character level ICD-10 code Also separate tables of injuries split by intent available	Not routinely available	Data available at three character level ICD-10 code	Data available at three character level ICD-10 code	Data available at three and four character level ICD-10 code
SMR (ISD, 2009)	Only aggregated data for deaths and emergency admissions for all unintentional injuries is reported	<15 years and 15–24 years	By sex within these age groups	Aggregated totals classified as unintentional injuries	Reported as road traffic, home and other	Reported as road traffic, home and other	Reported as road traffic, home and other	Top 10 diagnoses
RIDDOR	No routine reporting of RIDDOR data from schools							
AWISS (CAPIC, 2004)	Data reported in aggregated form	0–4, 5–9, 10–14 and 15–19 years	By sex within age groups	No	Reported as home, work, school, RTA, sport, public, other and unknown	No	No	Reported as diagnoses

(continued)

Table 6 Continued

Dataset	Unique identifier	Age	Sex	Intent	Location	Activity when injury occurred	Cause of injury	Nature of injury
HASS and LASS (RoSPA, 2002)	Data reported in aggregated form	0-4, 5-14 and 15-64 years	By sex within age groups	Unintentional injury by definition	Yes	Yes	Yes	Yes
Y-CHIRPP (Shipton and Stone, 2007)	Data reported in aggregated form	0-4, 5-9, 10-15 years	By sex within age groups	Yes	Yes	Yes	Yes	Yes
Health Survey for England (2002b)	Data reported as rates and percentages	0-15 and 16-24 years	By sex within age groups	Survey only asked about unintentional injuries	Yes	No	Yes	Yes
Scottish Health Survey (2003a)	Data reported in aggregated form and as rates and percentages	Age reported either as 2-year age bands 0-1, 2-3 to 14-15 years or 0-5, 6-10 and 11-15 years as well as 0-15 years for under 16s. Also 16-24 years and 16-44 years	By sex within age groups	Survey only asked about unintentional injuries	Yes	No	Yes	Yes

Table 7 How do UK datasets compare with WHO ICECI recommendations for sport injury surveillance

	Data collection				Routine data reporting			
Dataset	Type of sport/ exercise activity	Phase of activity	Personal countermeasures	Environmental countermeasures	Type of sport/ exercise activity	Phase of activity	Personal countermeasures	Environmental countermeasures
HES	No	No	No	No	No	No	No	No
PEDW	No	No	No	No	No	No	No	No
SMR	No	No	No	No	No	No	No	No
RIDDOR	No	No	No	No	No	No	No	No
AWISS	Yes	No	No	No	No	No	No	No
HASS and LASS	Yes	No	No	No	No	No	No	No
Y-CHIRPP	No	No	No	No	No	No	No	No
Health Survey for England	No	No	No	No	No	No	No	No
Scottish Health Survey	No	No	No	No	No	No	No	No

Injury research is the poor relation of health research funding, despite unintentional and intentional injuries combined contributing 6.6% of UK DALYSs; this area only attracts 0.3% of health research funding, the largest funding gap found to exist of any 'disease' area (Nicholl, 2006).

Very little use is made of injury data in the UK and there appears to be a lack of imagination and vision of the potential such data has to reduce mortality and morbidity. For example the UK's only nationwide surveillance system HASS & LASS (discontinued in 2002) was primarily focussed on product safety (i.e. commercial risks) and did not include RTIs (the main mortality-related cause for children and adolescents) nor workplace injuries (Stone *et al*., 2003, p. 20; RoSPA, 2004, p. 3). Injury data has a rich potential and could be used to inform national and regional policy, research, injury prevention as well as product risk assessment and service development (Ward and Healy, 2008, p. 29). Failure to use the data collected effectively can undermine the case for the continued operation of data collection systems (Stone *et al*., 2001, p. 13).

Across Europe there are a number of initiatives underway or recently completed which have the aim of improving injury data collection and the quality of data collected but it is not clear what level of integration exists between them. These projects include: the EU funded INTEGRIS project which aims to validate the potential of integrating the IDB with existing hospital discharge data to fulfil the requirements of the European statistical system (INTEGRIS, 2007); the recently completed Anamort project which developed tools, methods and indicators to allow an analysis and Europe-wide comparison of injury mortality (ANAMORT, 2008); and the also recently completed APOLLO project which looked at the health and financial burden of injuries as well as useable indicators and how to overcome the barriers in applying existing best practices (APOLLO, 2005). The overarching EUROSAFE project exists to provide a one stop information centre for EU injury data (Kisser *et al*., 2009).

The public health observatories in the UK along with the virtual Injury Observatory for Britain and Ireland (IOBI) can play a key role in pulling together important and relevant information and making it available to injury prevention practitioners (Ward and Healy, 2008, p. 4, 47). To improve mortality data quality, a framework to

aid uniform analysis and presentation of mortality data across the world has been developed by the International Collaborative Effort (ICE) on Injury Statistics sponsored by the Centers for Disease Control and Prevention's (CDC) National Center for Health Statistics (NCHS) (Stone *et al*., 2003).

But the real issue is one for governments, which must begin to prioritise injury surveillance as a crucial step to meeting their legal obligation of injury prevention as signatories of the 1989 United Nations Convention on the Rights of the Child (UNICEF, 1989).

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