Review 1:

Current practice and innovative approaches to prevent childhood unintentional injuries: An overview and synthesis of international comparative analyses and surveys of injury prevention policies, legislation and other activities

An overview and synthesis of international current practice to prevent unintentional injury in children

FINAL REPORT for consideration at PDG meeting 1

Report commissioned by: NICE Centre for Public Health Excellence

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ABOUT THE CPHE Collaborating Centre

This project was conducted by a joint team from LSE Health/PSSRU and PenTAG. Most of this review work was subcontracted to the two-person team at LSE Health/PSSRU because of (a) their expertise in conducting international comparative analyses, (b) their experience and interest in injury prevention research, and (c) constraints on the availability of other researchers/reviewers at PenTAG during December 2008 and January 2009.

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PenTAG is part of the joint West Midlands Health Technology Assessment Collaboration/PenTAG CPHE Collaborating Centre. The team members, and their roles on the review, were:

A-La Park, Research Assistant (LSE Health)	Summarising and critically reviewing identified reports and surveys (including: data extraction of international data relevant to unintentional injury prevention in children). Writing and editing drafts and final report.
David McDaid, Senior Research Fellow (LSE Health, & European Observatory on Health Policies and Systems)	Senior researcher involvement in summarising and critically reviewing the included reports/surveys, in particular: guidance on (a) identifying opportunities for comparative analysis or synthesis, and (b) with RA and CPHE lead team, to develop some principles for identifying potential lessons for the UK. Writing and editing drafts and final report.
Rob Anderson, Deputy Director (PenTAG)	Overall responsibility for delivery to NICE, ensuring report meets agreed protocol, discussing and agreeing any divergences from protocol, finalising (with CPHE team) the "master list" of reports to be included in the review. Writing and editing sections of report and editing final report.
Tiffany Moxham, Information Specialist (PenTAG)	Conducting any formal bibliographic searches (web-based, grey literature) for relevant reports, advising on search process.
Zulian Liu, Associate Research Fellow (PenTAG)	Helped to compile the graphs and tables of national injury rates and injury mortality rates in Section 2.2.

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Competing Interests of Authors

None

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The content of the report is, of course, entirely the responsibility of the authors, and those people whose help we have acknowledged above should not be seen to have endorsed either our methods or our interpretations of the findings.

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Abbreviations and Acronyms Used

AAP	American Academy of Paediatricians
ATVs`	All Terrain Vehicles
CPSC	US Consumer Product Safety Commission
EHLASS	European Home and Leisure Accident Surveillance System
EU	European Union
GB	Great Britain
IDB	European Injury Database
IRTAD	International Road Traffic Accident Database
KSI	Kills and serious injuries
LREC	Legislation, Regulation, Enforcement and Compliance
OECD	Organisation for Economic Cooperation and Development
UNICEF	United Nations Children's Fund
WHO	World Health Organization

Glossary of terms

All terrain vehicles	Informally referred to as a quad bike or quad, an ATV is defined by the American National Standards Institute as a vehicle that travels on low pressure tires, with a seat that is straddled by the operator, along with handlebars for steering control.
Ecological study	An observational study in which the association (or correlation) between two or more variables is investigated**.** They are descriptive rather than analytical and cannot be used to estimate the relationship between cause and effect.
Exposure to risk	The amount of time spent in a particular activity or at a particular location where there may be a risk of injury. Exposure data has, in particular, been collected in respect of child contacts with the transport system e.g. time on busy roads or time/distance cycled.
European Directive	A legislative act of the European Union, which requires member states to achieve a particular result without dictating the means of achieving that result. Directives can be adopted by means of a variety of legislative procedures depending on their subject matter.
Haddon matrix	Develop by William Haddon, this consists of two complementary conceptual frameworks for understanding how injuries occur and for developing strategies for intervention. Haddon's matrix considers both the proximal causes of injuries, in terms of interactions between the host, the agent and the environment, and the distal causes of injury, such as the socio-political milieu affecting the process, which could include cultural norms and mores and the political environment.
Home safety assessment	A systematic assessment of a home to

	identify potential hazards, evaluate the risk, and provide information or advice on appropriate actions to reduce those risks. The assessment may either be by a trained assessor visiting the home, or by a householder assessing their own home
In-line skates	Also referred to as rollerblades, inline skates have two, three, four or five wheels arranged in a single line. Some inline skates, especially those used for recreation, have a "stop" or "brake" which is used to slow down while skating; most inline skates have a heel stop rather than a toe stop.
Legislation	Laws usually enacted following debate and amendment within a national or regional legislature.
Regulation	A statement issued by a statutory body that may often be legally binding but does not require the need for new legislation at national, regional and local level.
Relative risk	A summary measure which represents the ratio of the risk of a given event or outcome in one group of subjects compared to another group. When the 'risk' of the event is the same in the two groups the relative risk is 1. In a study comparing two groups, if one group had relative risk of 2, this would indicate that they had twice the risk of an undesirable outcome compared to the other group.
Road environmental modifications	One or more physical adaptations to the road and its immediate environment which are intended to alter pedestrian and road user behaviours. It can include the use of various markings and signing, specific speed control zones, the installation of pedestrian crossings and traffic calming measures.
Traffic calming measures	Adaptations to the road intended to reduce the speed of traffic. Measures may include speed humps, the use of roundabouts, traffic lights, curved roads, road narrowing and pedestrian refuge islands.

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Summary

1.1. Background

Legislation (that is laws usually enacted following debate and amendment within a national or regional legislature) and regulations (sometimes legally binding statements that can be issued without the need for new legislation at national, regional and local level) are held to be important policy tools for encouraging safe environments, promoting safety behaviours and reducing unintentional injuries to children (Towner et al., 2001, Schieber et al., 2000).

Some, like the mandatory wearing of bicycle helmets, can be targeted at the general population or at specific sub-population groups. Laws and regulations requiring fencing around domestic swimming pools in some countries are examples of an action where injuries to children are more specifically targeted. Others, like housing design and construction standards, or those concerning road design and vehicular speed limits, often provide a more generic backdrop to safety in a particular environment, and will generally aim to improve safety for both adults and children.

In general, the same laws and regulations will cover whole countries, or in the case of federal countries, specific sub-national jurisdictions such as states or provinces. In all countries some laws will also differ at a very local level, such as the municipality or county. These differences in the use of laws and regulations potentially allow us to compare rates of unintentional injury (or relevant safety behaviours, like helmet wearing among cyclists), across countries.

However, the conclusiveness of evidence from such international comparative analyses may be undermined by a number of factors including:

- Differences in the exact form and content of legislation or regulations.
- The varying extent to which laws and/or regulations are enforced or complied with (e.g. according to the political structures, and the social and cultural norms in a given country or region).

- How long the relevant laws or regulations have existed in a given country.
- Differences in methods of collecting and reporting data (including possible international differences in definitions of children, or definitions of unintentional injuries).
- International variations in societal and environmental factors to do with exposure to the risk of injury.

These are just some of the factors that can make it challenging to draw policy lessons from international comparisons in the area of injury prevention.

1.2. Aims and objectives

To locate, review and synthesise international comparative analyses or surveys looking at current practice and innovative approaches to prevent unintentional injuries to children and young people under 15, with particular reference to road environment modification and road design, the use of safety equipment and assessments in the home and interventions in the wider environment.

Current practice/policies or innovative approaches could relate to:

- strategies, policies, legislation, regulation and enforcement
- mass-media campaigns and initiatives (where these relate explicitly to enforcement or encouragement in complying with legislation or regulations)
- legislation and regulation on professional support and workforce development
- the use of national monitoring systems to help assess the impact of laws and regulations

In making use of such comparative analysis of legislation and regulation, together with measures to help in enforcement and compliance with such legislation or regulations, we have two objectives: first to determine what lessons can be learned from countries with different rates of childhood injury in the road, in the home and in the wider environment; second to identify factors that appear to be associated with between-country differences in rates of childhood injuries.

1.3. Review methods

A rapid systematic review of published and unpublished studies was undertaken. We defined international comparisons to include, not only those studies that assessed programmes and interventions across more than one country, but also in the case of federal countries, studies that compared differences in injury outcomes and legal, regulatory, enforcement and compliance mechanisms across states/provinces. We however excluded studies that made comparisons across smaller areas within a country, e.g. between cities/regions of less than one million people. This exclusion criterion represents an important limitation to our analysis; laws and regulations may often be covered at a very local level alone; many of these will be of use to national policy makers but are excluded from this specific review.

For road-related injuries we focused on legislative, regulatory, enforcement and compliance mechanisms that were intended to modify road design and or road environment. These included various traffic calming measures, speed zones, home zones, signing, walking and cycling networks and safe routes to school. We have included studies looking at the use of speed cameras, both visible and hidden as a way of changing driver behaviour, where these were explicitly intended to reduce child injuries. Studies focusing on lighting and visibility, restraints including seat belts and child seats, legislation in respect of safety measures such as air bags and bicycle helmets, and laws governing blood alcohol limits were excluded. Studies comparing legislation and regulation of driver education, training, licensing and revalidation in different countries were also excluded.

In the home environment we focused on two areas: international comparative analysis of legislation and regulation, as well as enforcement and compliance mechanisms for legislation and regulation, on the use of home safety equipment, which (as defined in the final version of the home intervention scope) includes smoke alarms, hot water temperature restrictors, stair gates and oven, window and door guards and locks, and on the use of “home safety assessments”. In the wider environment we focused on legislation, standards and guidelines on sports activities and leisure, including playgrounds and other play activities. Studies focussing on restricting access to firearms in order to reduce unintentional injuries to children were however excluded given their limited relevance to UK context.

We also searched for publications that assess the merits of interventions that monitor and evaluate child injuries across countries and regions, where this data was intended to influence the development of childhood injury prevention policy. In addition, we sought international comparative studies looking at the use of legislation and regulation for workforce development, such as requirements for mandatory injury prevention training in professional curricula.

Search strategies

For bibliographic and web-based searching, we combined a range of terms for children and adolescents with injury or accident prevention and legislation, regulation, enforcement and compliance for a number of databases: Pubmed/MEDLINE; the International Bibliography of the Social Sciences; Econlit;, ASSIA; Geobase; Transport Research Information Service; SportsDiscus and Theses.com. We also searched the Safety Lit database which specialises in multi-disciplinary work relevant to preventing unintentional injuries, violence, and self-harm. We looked at citations of papers that met our inclusion criteria to identify additional papers, and undertook a hand-search of key journals.

We recognised that the nature of this particular topic would mean that potentially much relevant literature is likely to appear in reports of international agencies, governments and non-governmental organisations rather than in academic journals. We therefore searched the websites of a large range of governmental departments, non-governmental organisations, injury, public health and child related websites, augmented by contacts with experts and a narrow Google search. We also made contact with relevant experts and hand- searched the entire set of abstracts from a recent European Conference on Injury Prevention.

Study assessment

Included studies had standard detailed information extracted from them (see Evidence Tables in Appendix 3) and were also quality-assessed (and scored) using a set of questions developed specifically for this review. Their applicability to the UK policy-making and child safety context was not systematically assessed with a standard tool or scoring.

1.4. Review findings

1,340 references were identified through our search of electronic databases and our search of the grey literature. After further filtering, 306 potentially includable papers were examined in full text version. Ten relevant papers were founds, as two papers provided additional analysis and/or commentary on two of the eight previously published studies.

Five papers included international comparative surveys of road-related child injury data (and which included the UK or GB as a comparator country) and three had comparisons between US States of safety legislation and policies on off-road leisure vehicles (All-terrain vehicles (ATVs) or 'quad bikes', and one study on snowmobiles). The other two papers were more comprehensive assessments of variations in national injury prevention or safety legislation across a range of areas spanning injury on the road, in the home, and in other environments, alongside data on actual child injury rates.

Only two studies (discussed in four papers), both on road-related unintentional injuries to children, conducted any kind of adjustment for exposure to risk (Bly et al., 1999, Bly et al., 2005, Christie et al., 2004, Christie et al., 2007). However, even in these studies there were restrictions on the extent to which this could be done: only a limited selection of countries had relevant data to do this for different child and adolescent age groups.

No international comparative studies were identified which explicitly examined variations in child injury rates or safety behaviours in relation to: mass media campaigns (to promote compliance with laws or regulations); the use of injury surveillance and monitoring systems to strategically direct national injury prevention policy, or on: workforce support related policies, such as guidance or requirements to do with safety or injury profession within professional training or accreditation programmes. In respect of the latter we did though identify one US based analysis which did look at differences in regulations governing child care centre workers across US states, but this did not provide state level comparative data (Currie and Hotz, 2004).

Evidence statement 1: There remains a lack of comparable and in depth exposure to risk information to help in analysis of the relative impact of different legislative, regulatory, enforcement and compliance interventions (Towner and Towner 2002 +; Christie 2007 +; Christie et al 2004 +).

Evidence Statement 2: Two ecological studies (Mackay and Vincenten 2007 +; ENHIS 2007-) in high income countries were unable to associate variations in child morbidity and/or mortality rates across countries to differences in legislation, regulation, enforcement and compliance for road environment modification, road design, home and leisure environment interventions. However for road safety, evidence from two ecological studies, one of moderate quality and the other strong, (Christie et al 2004+; Bly et al 1999 ++) suggest a weak trends towards better performing countries (in terms of child fatality rates) having more road environment modification and road design measures in place.

Evidence Statement 3: Evidence from one well-conducted ecological study (Bly 1999 ++) indicates that differences in the distribution of exposure in the road environment for child pedestrians (in particular relating to time spent near busy main roads) can explain some of the difference in severe child injury and fatality rates between Great Britain and two other northern European countries, France and the Netherlands.

Evidence statement 4: No international comparative studies of specific road design and road modification interventions that focused on child injury prevention were identified; area wide comparative studies at a local level were identified but excluded from this review process.

Evidence statement 5: No international comparative studies of specific home safety equipment were identified; area wide comparative studies at a local level were identified in some areas but excluded from this review. No international comparative studies looking at the role of regulation and legislation for home safety assessments could be identified

Evidence statement 6: Few international comparative studies looking at the role of legislation, regulation, enforcement and compliance in preventing specific leisure related injuries could be identified. One area where studies were identified referred to all terrain vehicles (ATVs). Weak evidence from one ecological study (Helmkamp 2000) suggests that US states with legislation to reduce the risk of injury from all-terrain-vehicles have lower rates of fatal accidents than US states without legislation. Evidence from another ecological study (Keenan et al 2004 +) suggests that helmet wearing when using ATVs is significantly greater in one US state with a long standing law than in another state without any legislation. ATV related studies are of some relevance to the UK where quad bikes are used and child injuries have been reported. Weak evidence from one ecological study (Rice 2001 -) indicates that legislation in US states with high childhood fatality rates from snowmobiling does not comply with longstanding guidelines which recommend a ban on the use of snowmobiles by the under 17s. Snowmobiles are of very limited direct relevance to the UK, although they are used in the winter in parts of Scotland, while children from the UK may use them elsewhere if on winter holidays.

Evidence statement 7: No international comparative studies looking at the role of surveillance and monitoring systems in influencing the use of legislation, regulation, enforcement and compliance interventions could be identified. International databases had though been used as a source of injury data in studies identified (Christie 2004 +; Bly 1999 ++; Mackay and Vincenten 2007 ++). Other reports indicate the use of international surveillance systems to assist in determining and monitoring progress on targets for injury prevention (International Transport Forum, 2008, Petridou, 2000).

Evidence statement 8: No international comparative studies looking at the association between the use of legislation and regulation in respect of professional qualifications and ongoing training for professionals who come into contact with children and rates of childhood injury were identified in this review.

1.5. Conclusions

While much evidence has been collected to strengthen the evidence base on child injury prevention e.g. (Bunn et al., 2003, Kendrick et al., 2007, Turner et al., 2004, Wilson et al., 2006, Peden et al., 2008), there appears to be little cross-national analysis of legislative, regulatory, enforcement and compliance-related policies. Moreover, what is available is dominated by road safety related policies, and much of this focuses on the use of safety belts, other child safety restraints and the use of cycle helmets, all of which are beyond the scope of this review.

Several comparative studies have documented international differences in legislation, regulations and other national level strategies aimed at preventing unintentional injuries in children. Likewise there are several of major reports (e.g. from the OECD, UNICEF and WHO) that have presented international comparative data on child injury rates. However, few studies appear to have combined these types of information in the same international comparative analysis.

We found only ten papers, covering eight international comparative analyses which met our review's inclusion criteria. Two papers represented additional analysis or further discussion of a data previously collected for an earlier publication. Of the six papers that included the UK or Great Britain as a comparator country, four were focused exclusively on road-related injuries (Christie et al. 2004 & 2007; Bly et al. 1999 & 2005). The other two, by Towner and Towner (2002) and more recently in 2007 by Mackay & Vincenten, cover a wider range of types of child injury and injury settings spanning the road, the home and other environments together with documenting relevant national legislation or policies for preventing those types of child injury.

Only two of the includable studies focused exclusively on injuries in non-road and non-home environments, and these were both on safety legislation applying to off-road motorised vehicles (ATVs or 'quad bikes', and snowmobiles), and compared levels of legislation and child injury rates between US states.

A lack of international comparative evidence should not be taken as a lack of research evidence on the possible associations between legislation, regulations, and/or policies to promote enforcement and compliance with such legislation or standards. There is, more specifically, a lack of international comparative studies which have collated and presented comparable data on BOTH child injury rates or child injury fatality rates (or relevant safety behaviours), AND reliable data on corresponding national-level policy activity or legislation. Despite having broader inclusion criteria, which would include comparative studies of large sub-national jurisdictions (e.g. US States or German *Lander*), this led to only three additional studies being included (on the use of off-road motorised leisure vehicles). In addition to consistently collected cross-sectional data on child injuries and national policies or legislation there is a clear need for proper baseline information to strengthen inferences based on geographical variations with temporal (e.g. time-series or before-and-after) information. We did identify additional small-scale comparative studies looking at the impacts of legislation across different municipalities, counties, towns etc, as well as before and after analyses of the impact of LREC interventions in one jurisdiction. Although not meeting our inclusion criteria, they may nonetheless be of relevance to policymakers, particularly given that in many jurisdictions legislation and regulation, particularly in respect of safety standards may be developed at a very local level.

Another, possibly more obvious, weakness of the current evidence base is the low 'sample size' of countries included in each comparative study. With so many potential factors affecting the documented level of child injuries in a given country, and many factors also mediating the effectiveness of any prevailing legislation, regulations or other national policies (e.g. levels of enforcement activity, prior levels of compliance, publicity to promote compliance/awareness), it is reasonable to expect that any meaningful patterns of association would only become apparent when consistent data from a large number of countries is compared. There is clearly a methodological trade-off here though, because widening the net of included countries in a given survey will almost inevitably create more problems for assuring (a) data collection and reporting consistency and (b) the increased impact of socio-economic, cultural, geographical (urban/rural mix, climate), and other factors on the risk of child injury.

Having said that, because of the specific problem of assessing, and potentially adjusting for, exposure to different levels of injury risk in different countries, there also seems to be value in conducting detailed studies in small groups of countries which have been selected for the comparability in some respects, or the resources that they can apply to consistent data collection. The insights from the two studies by Bly *et al* (1999, 2005), which only focused on data from Great Britain, France and the Netherlands is a good example of this.

It is also important to note that much might be learnt about the potential impact of legislative, regulation, enforcement and compliance interventions by looking at experience in other areas. This may include studies eliminated from our analysis which looked at the role of LREC interventions in impacting on the use of bicycle helmets, seat belts and car seat restraints (Dowswell et al., 1996, Brown et al., 1997), e.g. recent work supporting the effectiveness of mandatory seat belt laws in reducing youth fatalities across different US States (Carpenter and Stehr, 2008). For instance one systematic review prepared by the US Taskforce on Community Preventive Services that looked at the comparative effectiveness of interventions to increase the use of child safety seat restraints reported that child safety seat laws, distribution plus education programmes, community-wide information plus enhanced enforcement campaigns, and incentive plus education programmes were effective. In contrast education only programmes aimed at parents, young children, health care personnel or law enforcement personnel did not have enough evidence to prove efficacy (Zaza et al., 2001) .

Another issue may be to examine factors which are likely to make LREC prevention and public health related measures successful. Laws may be more effective, if similar statutes have been on the books for some time (Lacey et al., 2000) while a critical level of public acceptance of the importance of an issue may be needed in order for a law to be effective in changing individual behaviours. The role of the media in influencing compliance might also be considered (Cowan Jr et al., 2009, Potts and Swisher, 1998, Ramsey et al., 2005). Other factors that needs consideration include the extent to which different approaches are required to reach different communities and help reduce inequalities in the rate of injuries across communities (Kendrick et al., 2009, Graham et al., 2005), and the extent to which subsidies and financial

incentives might be used alongside legislation and regulation to increase uptake of safety devices (Hendrie et al., 2004).

The forthcoming reviews of evidence for the PDG will have an opportunity to gather and assess some of the studies which were excluded by this review, for example because they compared jurisdictions which were judged too small (e.g. comparisons between cities, or comparisons between municipalities or districts within cities). Also, with the recently completed APOLLO project (see Appendix 3) and major current initiatives like the European Child Safety Report Card, more information involving a larger group of countries with more consistent data collection is going to be available in the public domain. In the Child Safety Report Card project, 27 country partners (including all four UK constituent countries) have completed updated assessments to July 2008 and updated 'Report Cards' and profiles and a further European summary was due to be released in April 2009. This may be in time to feed into the PDG's deliberations and NICE guidance development.

2. Background

2.1. Introduction

Legislation (that is laws usually enacted following debate and amend within a national or regional legislature) and regulations (sometimes legally binding statements that can be issued without the need for new legislation at national, regional and local level) are held to be important policy tools for encouraging safe environments, promoting safety behaviours and reducing unintentional injuries to children (Towner et al., 2001, Schieber et al., 2000).

Some, like the mandatory wearing of bicycle helmets. Interventions can be targeted at the general population or at specific sub-population groups. Laws and regulations requiring fencing around domestic swimming pools in some countries is one example of an action where injuries to children are more specifically targeted. Others, like housing design and construction standards, or those concerning road design and vehicular speed limits, often provide a more generic backdrop to safety in a particular environment, and will generally aim to improve safety for both adults and children.

In general, the same laws and regulations will cover whole countries, or in the case of federal countries, specific sub-national jurisdictions such as states or provinces. In all countries some laws will also differ at a very local level, such as the municipality or county. These differences in the use of laws and regulations potentially allow us to compare rates of unintentional injury (or relevant safety behaviours, like helmet wearing among cyclists), across countries.

However, the conclusiveness of evidence from such international comparative analyses may be undermined by the following factors:

- The **exact form and detailed content of laws or regulations** will usually be different between countries, potentially altering their impact on child injury rates.

- The **types and intensity of activity to enforce laws or regulations, or encourage compliance** with those laws/regulations may vary (both between jurisdictions and within jurisdictions) (Towner and Towner, 2002).

- The extent to which people comply with laws and regulations, and the strength of their enforcement, will also vary according to the **political structures, and the social and cultural norms** in a given country or region. Levels of enforcement and compliance may also be related to how long the relevant laws or regulations have existed in a given country.

- Some international or inter-regional variations in reported rates of unintentional injury or safety behaviours may be due to **differences in methods of monitoring and reporting the data** (e.g. for non-fatal injuries, definitions and/or rates of help-seeking by the public, to hospitals or to the police, will typically vary between countries) (Fingerhut, 2004).

- International or inter-regional variations in rates of unintentional injury will also reflect international **variation in societal and environmental factors to do with exposure to the risk of injury** (Christie et al., 2007).

These are just some of the factors which, according to Towner and Towner, make drawing policy lessons from such international comparisons so difficult, and why they seem so often to produce very “mixed messages” (Towner and Towner, 2002).

2.1.1. Context of this review

This review is the first in a series of reviews of evidence (probably six) that will inform NICE Public Health Guidance on Strategies to reduce unintentional injuries in children. These reviews, and the Guidance that will be developed from them, intend to complement a series of other reviews of more specific public health interventions that are also being conducted in the first half of 2009, on preventing unintentional injuries to children:

- **Preventing unintentional injuries to children on the road** (through road and street design measures, such as traffic calming or 20 mph zones; also,

cycle and pedestrian networks and routes will also be covered, including related initiatives under the Safe Routes to Schools programme).

- **Preventing unintentional injuries to children in the home** (either through the supply and installation of safety devices or equipment, or through "home safety assessments")

- **Preventing unintentional injuries to children in the external environment** (Public Health Intervention Guidance to be developed in mid- to late-2009 and published in 2010; Scope expected in April 2009). It could focus on child injuries whilst at play or during other leisure activities that take place outside the home and not on roads.

Importantly, a key focus of the public health *programme guidance* Scope - on legislation, regulation, enforcement and compliance – has also been restricted to legislation, regulation, and standards which may affect the uptake or implementation of those activities or measures which are the focus of these three pieces of public health intervention guidance[1]. This was decided in order to increase the complementarity of the different pieces of guidance, and to attempt to limit the focus of the work to a manageable task.

In a sense, the present evidence review can be seen as an attempt to seek out and summarise studies similar to that published by Towner & Towner in 2002 on the association between levels of relevant legislation in a country, and child injury mortality rates (Towner and Towner, 2002). They used the UNICEF child injury league tables and expert respondents in a number of countries to try and tease out possible associations between the extent and form of legislation in countries and their overall position in the child injury league table. In contrast to that study however, we hoped to discover studies which had been able to explore possible associations between national rates of *specific types of child injury*, and the nature and degree of enforcement of the *specific forms of legislation or regulation* that are intended to reduce those injuries.

[1] In actual fact, the final Scope for the Public Health Programme Guidance now also aims to complement a fourth planned piece of Public Health Intervention guidance on preventing unintentional injuries.

The Programme Development Group (PDG) should note that the protocol for this review - and most of the searching and selection of studies - necessarily took place before the finalisation of the programme's Scope by NICE in mid-to-late January. This partly explains the general lack of focus on legislation for professional support and workforce development or on national (injury) monitoring systems (see aims below), although we did perform some targeted searches for international comparative analyses/surveys on these topics. It may also partly explain the less defined focus (in our original searching) on legislation/regulations designed to impact upon injuries to children "in the external environment".

2.1.2. Aims of the review

To locate, review and synthesise international comparative analyses or surveys looking at current practice and innovative approaches to prevent unintentional injuries to children and young people under 15, with particular reference to the home, road and wider environment.

Current practice/policies or innovative approaches could relate to:

- strategies, policies, legislation, regulation and enforcement
- mass-media campaigns and initiatives (where these relate to the enforcement or encouragement to comply with legislation or regulations)
- legislation and regulation on professional support and workforce development
- the use of national monitoring systems to help assess the impact of laws and regulations

2.1.3. Review questions

- What lessons can be learned from countries with different rates of childhood injury in the road, in the home and in the wider environment?
- What factors appear to explain between-country differences in rates of childhood injuries?

These questions were answered particularly in relation to the main focus of the Public Health programme, that is: legislation and regulation, as well as enforcement and compliance measures for such legislation and/or regulations.

2.1.4. Definitions

Children: For the overarching purpose of the developing the public health guidance, and to guide the selection of relevant studies, children are defined as those aged 15 and under. However, many studies included in this review will report findings for children as defined by a different age-range, so the findings from each included study – and the evidence statements derived from them - will need to be interpreted with this in mind. (For example, much of the international comparative data reported in the recently published WHO *European Report on Child Injury Prevention* is for 0-19 year-olds; (Sethi et al., 2008)).

2.2. International variation in rates of unintentional injuries to children

In the remainder of this chapter we report international comparative data on various types of injury, where we have been able to find it in published sources, in order to:

1. Provide an indication of the range of rates of specific injury types in different countries, but especially those at a similar level of socio-economic development to the UK.

2. Allow the possible identification of countries which have consistently low child injury rates relative to countries at a similar level of socio-economic development to the UK, and

3. Provide an indication of whether child injury rates in the UK (or its four constituent countries) are high or low relative to countries of similar socio-economic development.

To keep this much data from being too daunting for the reader, and to allow the relative differences and rankings of countries to be more apparent, we have presented them as graphs (even where the original data were presented as a table). In the style of a “chart book”, we provide minimal or no narrative description of the information presented in the graphs, except where we felt some clarification of the

nature of the information or the data source was necessary. Nor have we made any attempt to reconcile any apparent inconsistencies between data collated from different sources, or to try and explain conspicuous statistics (e.g. apparently no child road deaths in Finland in 2007, according to Figure 14) [2].

We also hope - since this is the first in the series of reviews for this PDG - that this international injury data will provide a useful context for discussions throughout the guidance development process.

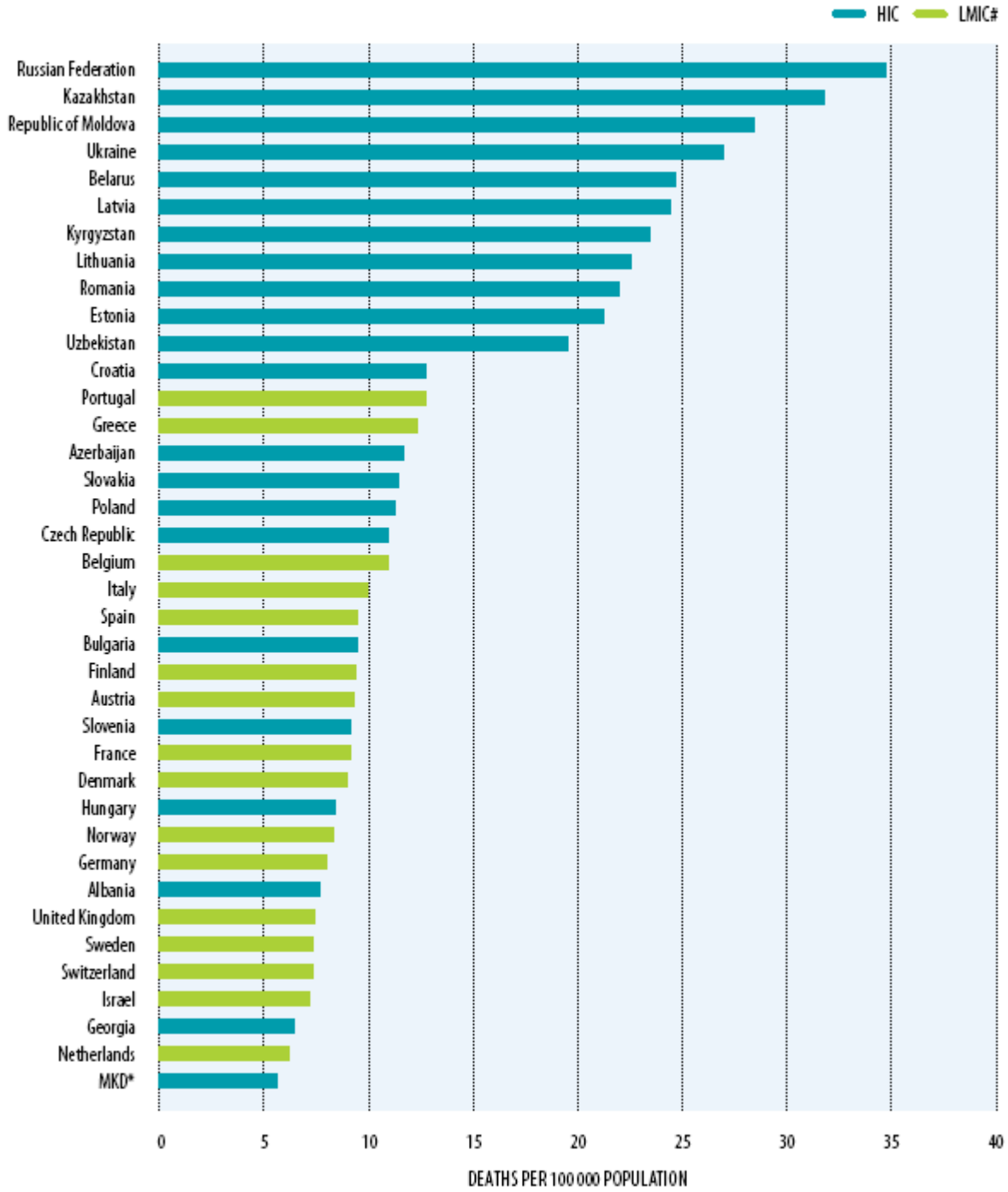
A note of caution is warranted as (a) we have not been able to systematically assess the extent to which data in different countries has been collected and reported consistently within each original source, and (b) in most cases the data are unadjusted for any measure of exposure to given risks (e.g. road injuries adjusted for national levels of car ownership or amount of car kilometres travelled, or injuries to cyclists not adjusted using some population measure of bicycle use).

2.2.1. All types of child injury

Figure 1 and Figure 2 on the following pages show that the UK has the 7th lowest standardised mortality rates due to unintentional injuries amongst all 32 countries in the WHO European Region, for 0-19 year olds. Within the Nordic and Western European countries however, the UK is 3rd behind Netherlands and Sweden. Slightly older (2000-2002) published data for 0-14 year olds, suggests that the UK, along with Sweden, might have the lowest rates of child mortality rates due to injuries in Europe (see Figure 3)

[2] It was beyond the time and scope of this review to delve deeply into the original sources from which these international injury data come, and to make a systematic assessment of their consistency.

Figure 1. Average standardised mortality rates for all unintentional injuries in children aged 0–19 years in the WHO European Region 2003–2005, or most recent three years



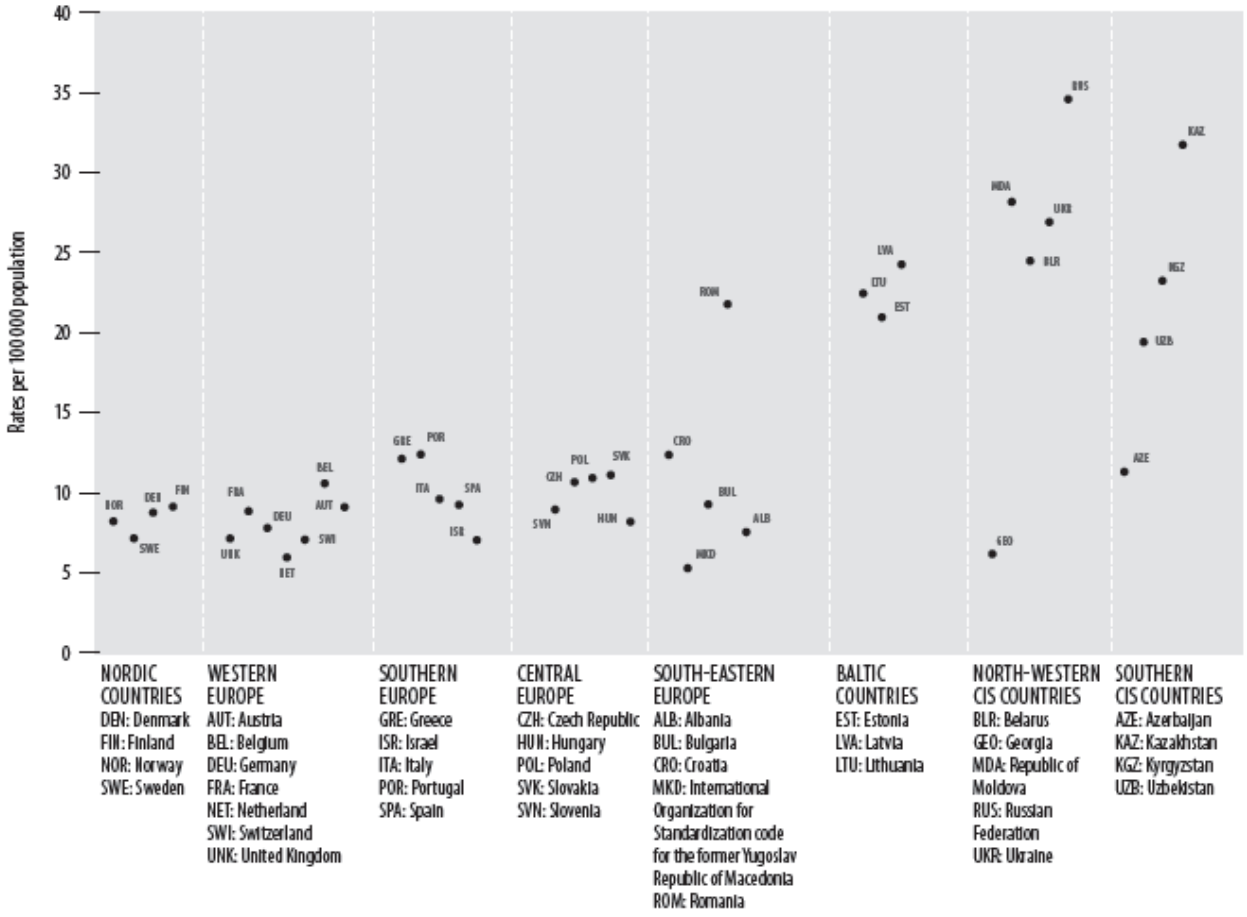
Source: (Figure 2.1, page 8) Dinesh Sethi, Elizabeth Towner, Joanne Vincenten, Maria Segui-Gomez and Francesca Racioppi. European report on child injury prevention. WHO Regional Office for Europe. 2008.

Original source: WHO European Health for All mortality database. Copenhagen, WHO Regional Office for Europe.

*MKD = International Organization for Standardization code for the former Yugoslav Republic of Macedonia.

HIC = high-income countries; LMIC = low- and medium income countries (as defined by World Bank)

Figure 2. Average annual standardised mortality rates of all unintentional injuries among children and adolescents aged 0–19 years, by subregion, 2003–2005 (or last available 3 years)

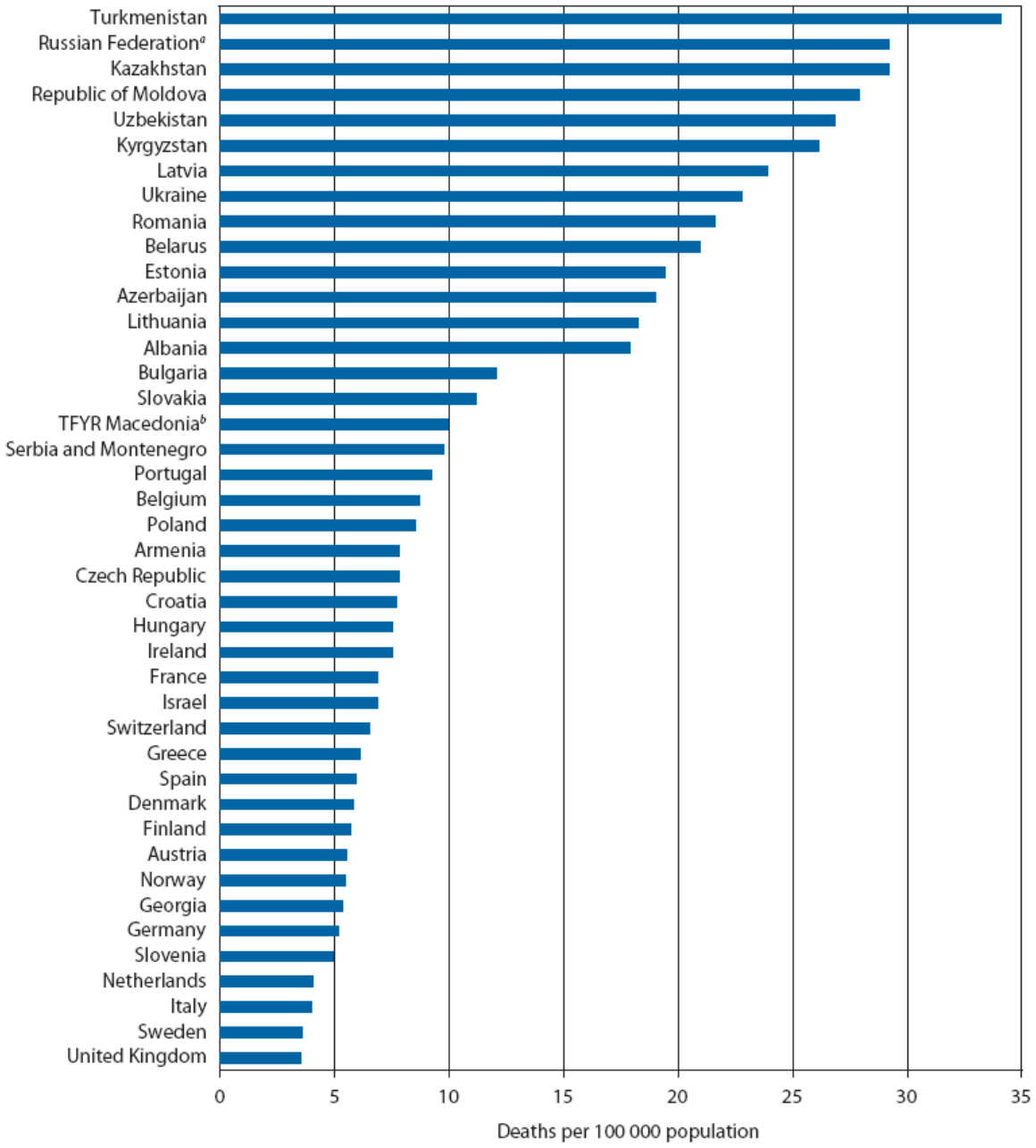


Source: (Figure 3, page 84, ANNEX 4) Dinesh Sethi, Elizabeth Towner, Joanne Vincenten, Maria Segui-Gomez and Francesca Racioppi. European report on child injury prevention. WHO Regional Office for Europe. 2008.

Original source: WHO European Health for All mortality database. Copenhagen, WHO Regional Office for Europe.

CIS = Commonwealth of Independent States (of the former Soviet Union (USSR))

Figure 3. Standardised mortality rates for injuries in children aged 1–14 years in the WHO European Region, averages for a three-year period, 2000–2002 or most recent three years



a Data from the Chechen Republic of the Russian Federation were not available and are therefore not reflected in the above figures.

b The former Yugoslav Republic of Macedonia.

Source: (Fig 2, page 56) Sethi D, et al. Injuries and violence in Europe: why they matter and what can be done. Violence and Injury Prevention, WHO Europea for Environment and Health, Rome. WHO Regional Office for Europe. 2006.

Figure 4, shows the proportion of deaths by unintentional injury from different causes in children and adolescents (age 0-19). It shows that, in the UK, child and

adolescent deaths due to drowning, poisoning, fire and falls each account for 4% or less of the overall number of deaths from unintentional injuries. In contrast, deaths due to road traffic injuries account for over half (53%), and those due to other causes almost a third (32%) of the total number of child and adolescent deaths due to unintentional injuries in the UK. Correspondingly, looking at national standardised mortality rates due to these "other causes" (see Figure 5), the UK has the 14th lowest rates in Europe for these injury types. Interestingly, Sweden also performs poorly relative to other countries on this measure (19th), while the Netherlands has the lowest mortality rates of all for these types of other unintentional injury.

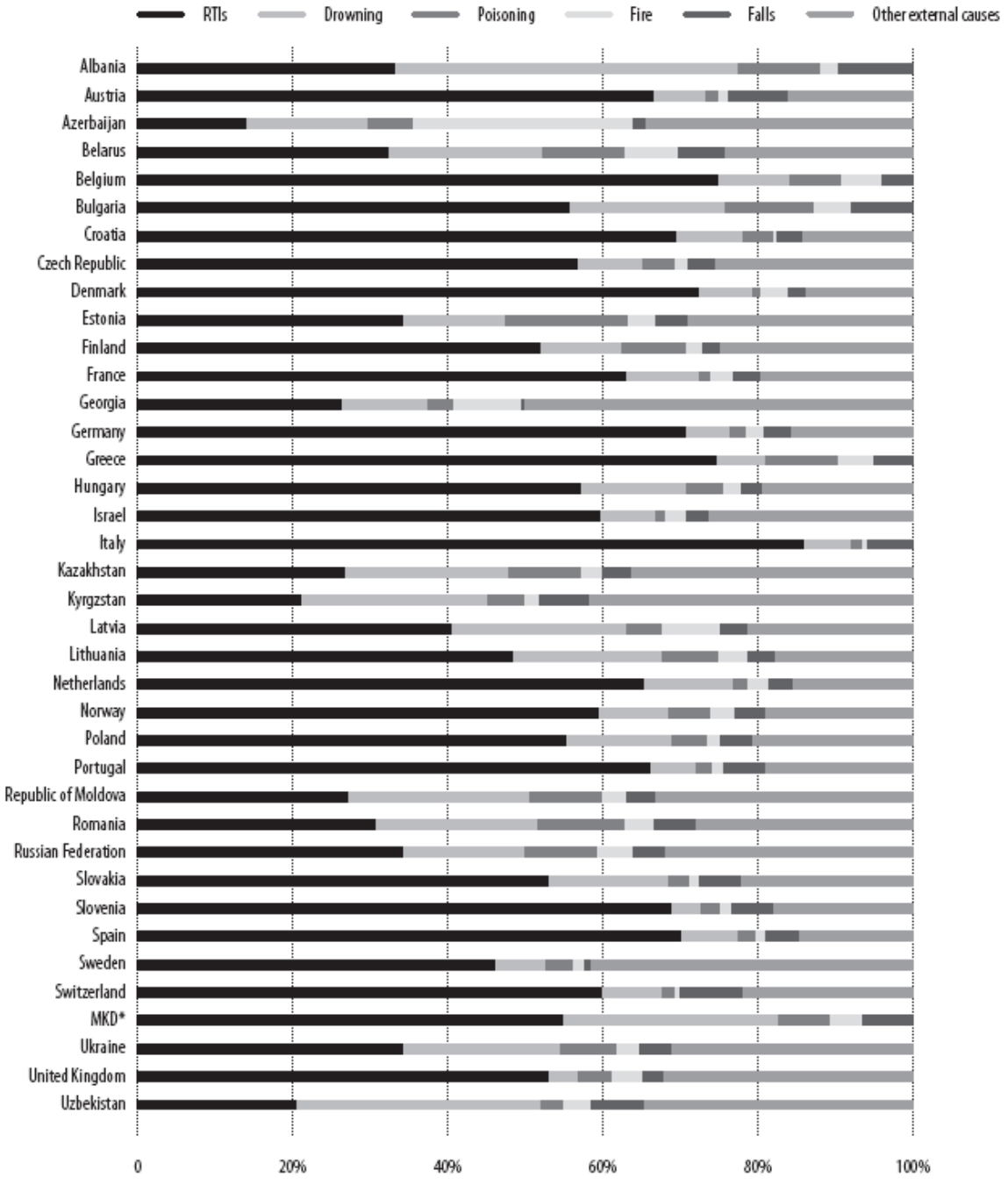
As well as fatal injuries due to "other causes" comprising a relatively high *proportion* of all fatal child injuries, this is also an injury category for which the UK fares poorly in absolute terms compared to socio-economically similar countries, when assessed by standardised mortality rates. The UK is ranked 14th,with a rate of around 2.5 deaths per 100,000 – which is a worse rate than in the Netherlands (1st), Germany (3rd), Spain (4th) Switzerland (7th) and France (10th); (Figure 5). In other words, the data on injury mortality due to other causes presented in Figure 5 are not affected by overall rates of child mortality (which is the case in Figure 4); the UK's high proportion of child injury deaths due to other causes is therefore not an artefact of having low overall child unintentional injury mortality.

The types of injury which are included in the category of "other unintentional injury causes" in this recent WHO report, are (with ICD code ranges): water transport/watercraft or air transport/aircraft accidents/injuries (V90-V98); children being struck by objects or equipment (W20-W31); firearm discharge or explosions (W32-W40); foreign body entering body or animal bites/kicks (W44-W59; W64); accidental suffocation or strangulation (W75-W84); electrocution or exposure to other excessive heat/electro-magnetic/radiation etc. (W85-W99); contact with hot liquids or appliances/machines (X10-X19); venomous animals or plants (X20-X29); victims of floods, lightning or other "forces of nature" (X30-X39); drug overdoses/medication errors, or other medical or surgical adverse events/reactions (Y40-Y86); sequelae of other accidents or external causes (Y85-Y86; Y88-Y89).

Since these categories, together, comprise almost a third of unintentional child injuries which result in death, it would be very useful to know which of these

categories of unintentional injury have the highest rates of incidence for children in the UK, and also which contribute the most to child injury fatalities.

Figure 4. Estimated proportion of deaths by unintentional injury by cause of injury among children and adolescents aged 0–19 years in the WHO European Region (2003–2005 or last available)

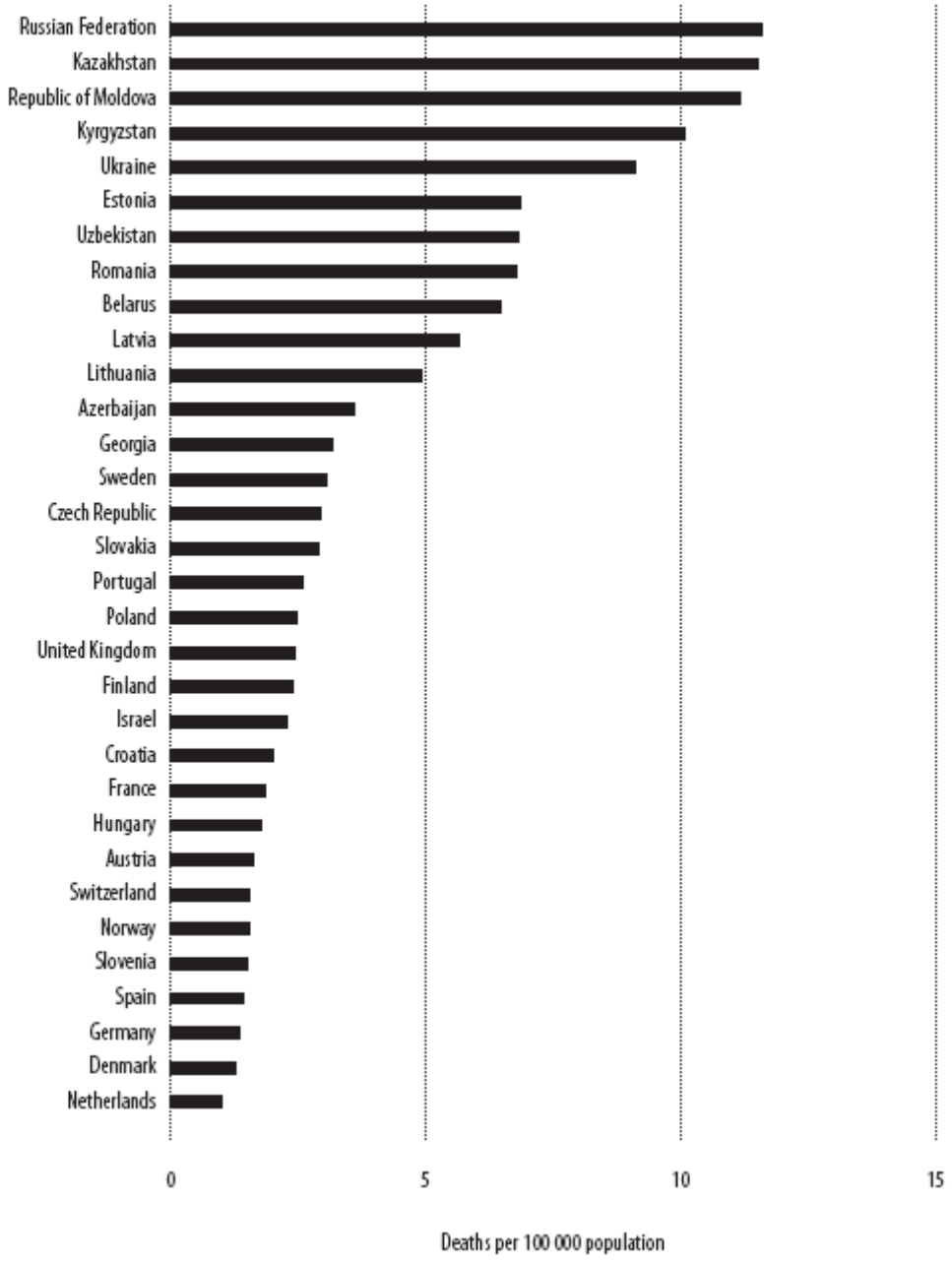


*International Organization for Standardization code for the former Yugoslav Republic of Macedonia.

Source: (Figure 2, page 83, ANNEX 4) Dinesh Sethi, Elizabeth Towner, Joanne Vincenten, Maria Segui-Gomez and Francesca Racioppi. European report on child injury prevention. © World Health Organization 2008

Original source: WHO European Health for All mortality database. Copenhagen, WHO Regional Office for Europe.

Figure 5. Average annual standardised mortality rates for all other unintentional injury causes among children and adolescents aged 0–19 years in the WHO European Region, 2003–2005 or most recent three years



Source: (Figure 4, page 85, ANNEX 4) Dinesh Sethi, Elizabeth Towner, Joanne Vincenten, Maria Segui-Gomez and Francesca Racioppi. European report on child injury prevention. © World Health Organization 2008

Original source: WHO European Health for All mortality database. Copenhagen, WHO Regional Office for Europe.

Data on hospital discharge rates due to injury (from the APOLLO project) show a more mixed picture (but do not include data from the UK; Table 1 and Figure 6.

Hospitalisation rates for children with unintentional injuries by age category for selected European countries, 2004)

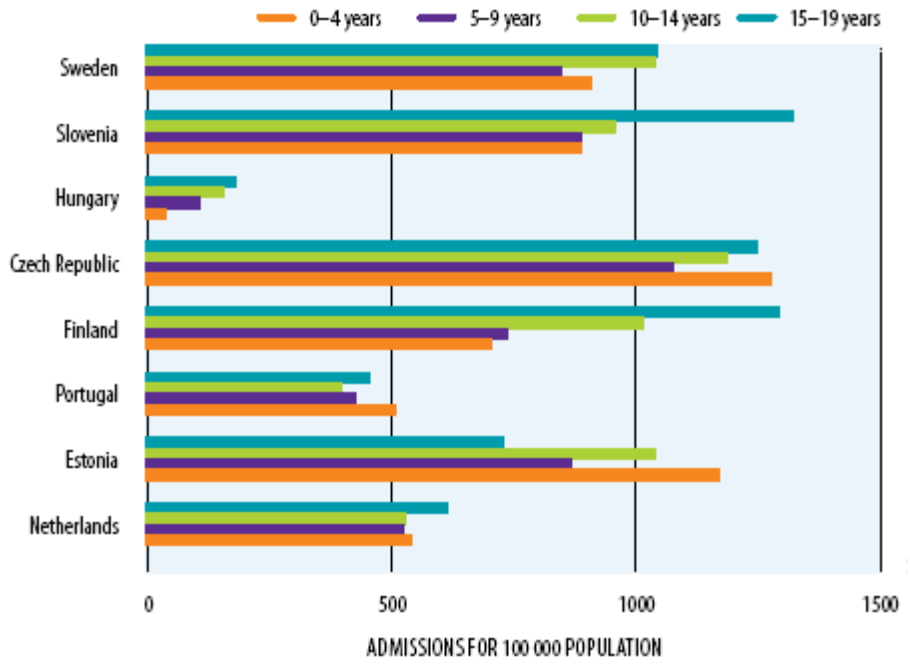
Table 1. Hospital discharge rates per 100 000 population among children and adolescents aged 0–19 years by age group and sex, selected European countries, 2004

Country	All	Males	Females	Males				Females			
		1–19 years	1–19 years	1–4 years	5–9 years	10–14 years	15–19 years	1–4 years	5–9 years	10–14 years	15–19 years
Austria	2993	3411	2599	2455	2093	2777	5130	2006	1443	1652	2222
Bulgaria	592	737	456	815	793	1031	877	626	499	463	397
Czech Republic	1265	1015	1527	1397	1389	1667	1974	1210	942	956	936
Denmark	1216	1289	1145	892	954	1190	1752	707	650	715	794
Estonia	1212	1652	837	1367	995	1506	1289	1052	763	680	498
Finland	2021	2256	1796	853	920	1376	2255	623	604	776	859
Germany	1880	1930	1820	1890	1630	1870	2720	1580	1170	1200	1360
Hungary	1270	1617	956	1488	1455	1719	1641	1238	942	924	768
Italy	1469	1057	1611	996	965	1464	2498	774	590	582	823
Netherlands	672	690	653	641	576	670	960	502	474	432	504
Norway	1599	1682	1517	1059	1105	1336	2260	704	733	861	1225
Portugal	608	712	510	608	552	571	793	450	322	279	261
Slovenia	1431	1798	1080	1301	1172	1440	2180	897	751	690	912
Spain	539	593	487	563	502	579	778	411	283	239	232
Switzerland	1358	1340	1375	1032	1026	1320	1561	788	703	833	847

Source: (Table 6, page 94, ANNEX 4) Dinesh Sethi, Elizabeth Towner, Joanne Vincenten, Maria Segui-Gomez and Francesca Racioppi. European report on child injury prevention. World Health Organization 2008

Original source: APOLLO Hospital Discharge Database [online database]. Navarre, University of Navarre, 2008 (https://www.unav.es/ecip/apollo/asistente).

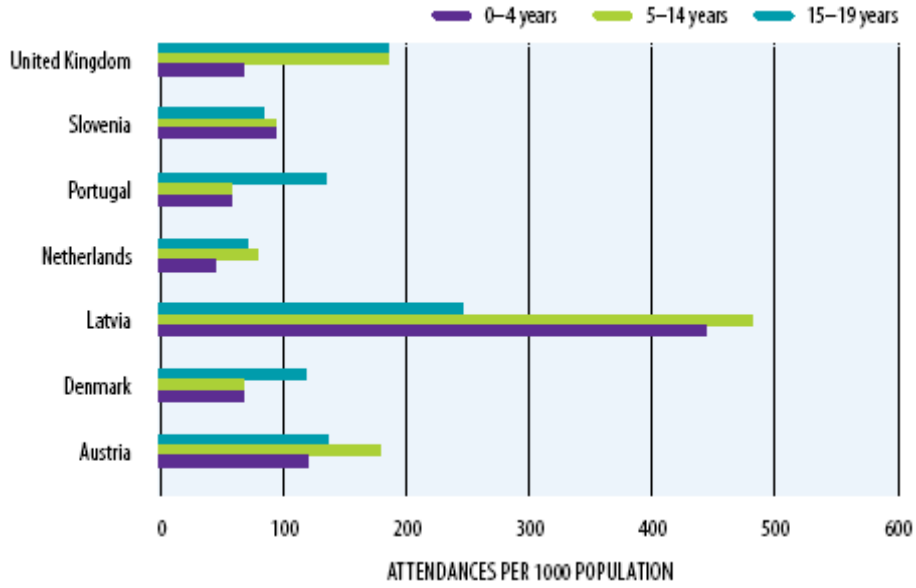
Figure 6. Hospitalisation rates for children with unintentional injuries by age category for selected European countries, 2004



Source: (Figure 2.6, page 11, Chapter 2) Dinesh Sethi, Elizabeth Towner, Joanne Vincenten, Maria Segui-Gomez and Francesca Racioppi. European report on child injury prevention. World Health Organization. 2008

Original source: APOLLO Hospital Discharge Database - Segui-Gomez M, et al. APOLLO Hospital Discharge Database. University of Navarra, Navarra, 2008 (http://www.unav.es/ecip/apollo/asistente, accessed 10 November 2008).

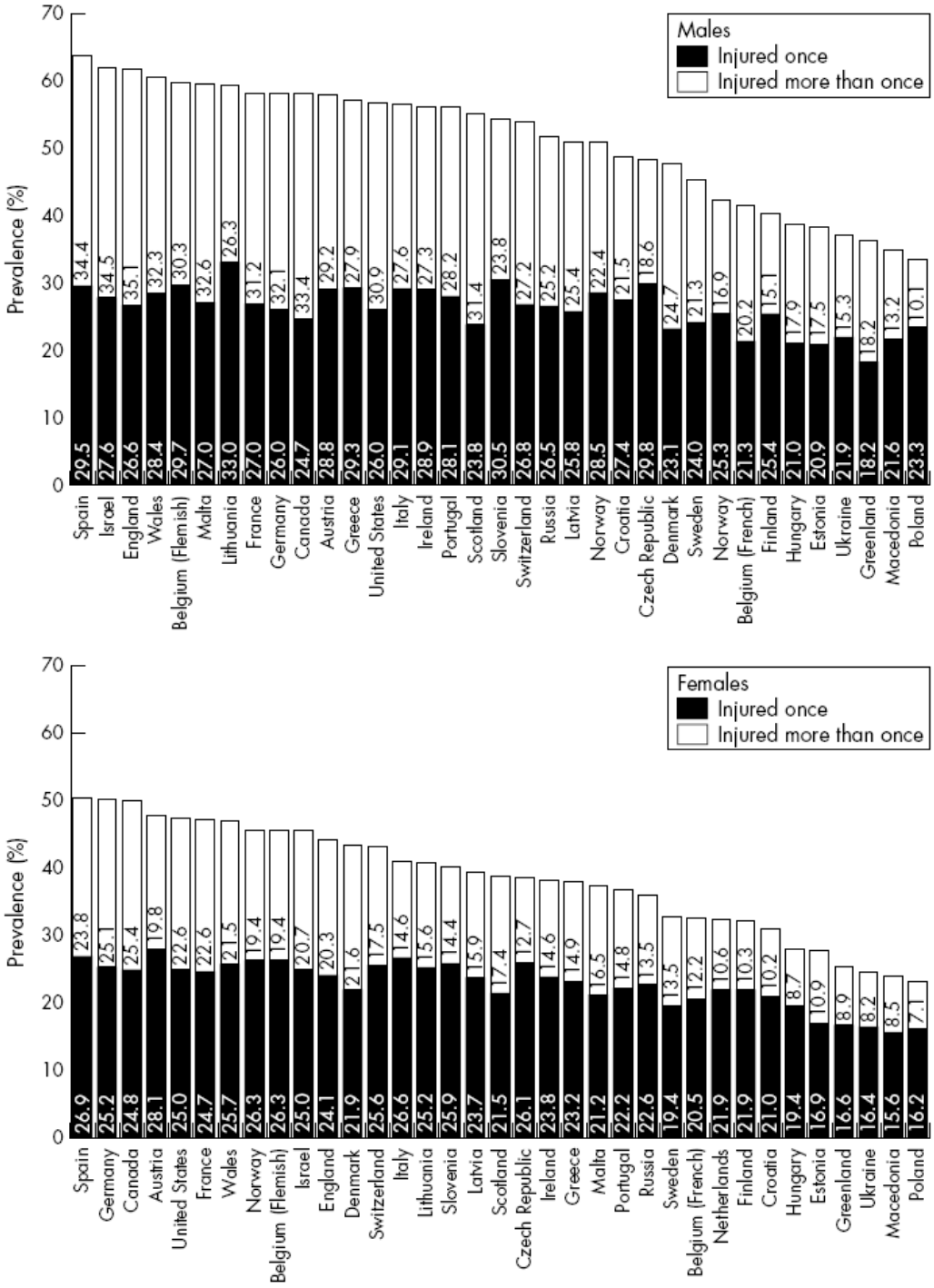
Figure 7. Emergency department attendance rate for home and leisure injuries per 1000 population per year by age for selected European countries, 2000–2004



Source: (Figure 2.7, page 11, Chapter 2) Dinesh Sethi, Elizabeth Towner, Joanne Vincenten, Maria Segui-Gomez and Francesca Racioppi. European report on child injury prevention. World Health Organization, 2008

Original source: Adapted from Polinder et al. - Polinder S et al. APOLLO: the economic consequences of injury. Final report. Amsterdam, EuroSafe, 2008.

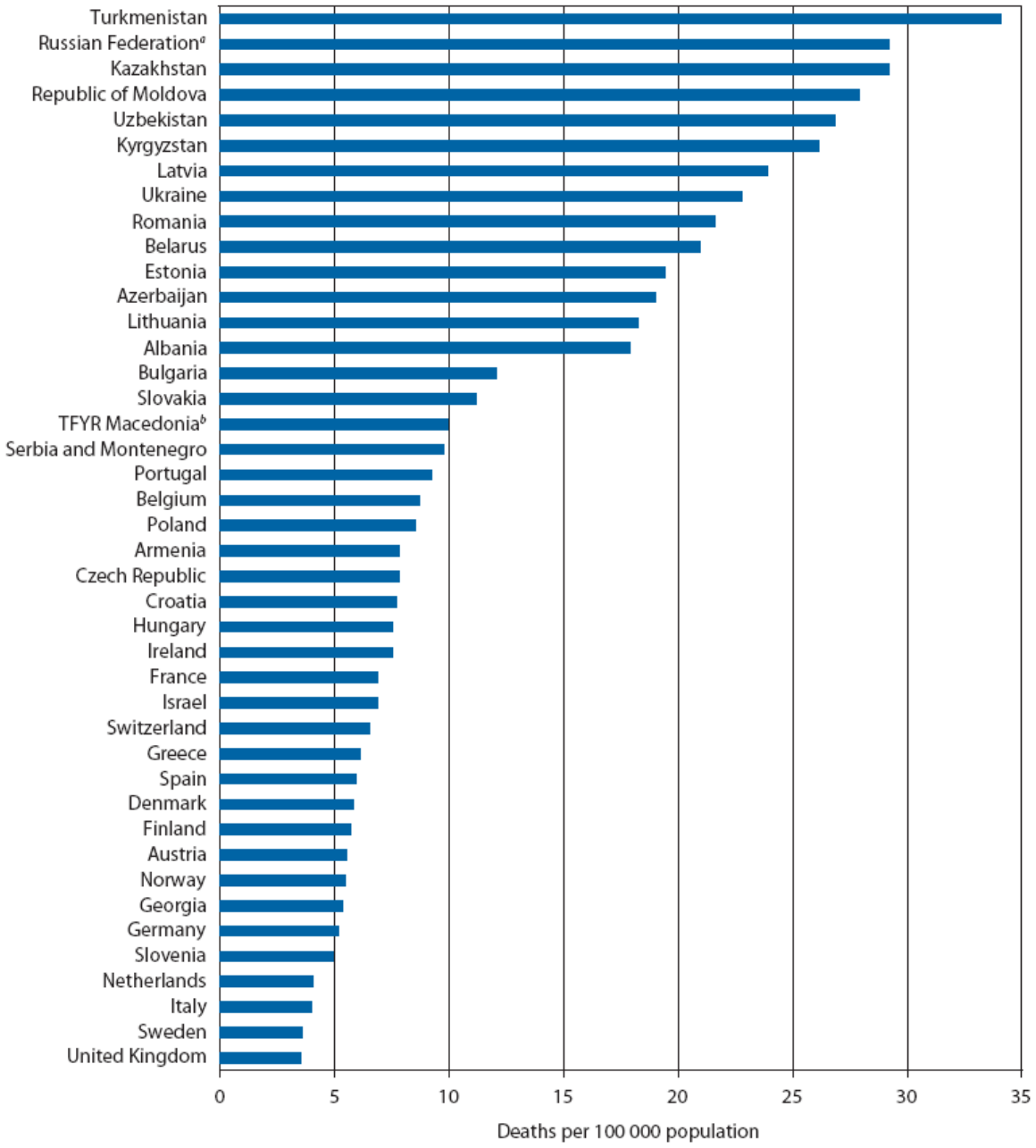
Figure 8. Annual prevalence of medically treated injuries among adolescents in 35 countries, by sex (based on international records from the 2001/2002 Health Behaviour in School-Aged Children survey)



Source: (Fig 1, page 216) Pickett W. et al. Cross national study of injury and social determinants in adolescents. Injury Prevention 2005;11:213–218.

Data from a survey of over 146,000 children in 35 countries. Age range 10-17 yrs, but mean age (for data from different countries) of 11-15 years. NB. Includes all types of injury, unintentional and intentional.

Figure 9. Standardised mortality rates for injuries in children aged 1–14 years in the WHO European Region, averages for a three-year period, 2000–2002 or most recent three years



a Data from the Chechen Republic of the Russian Federation were not available and are therefore not reflected in the above figures.

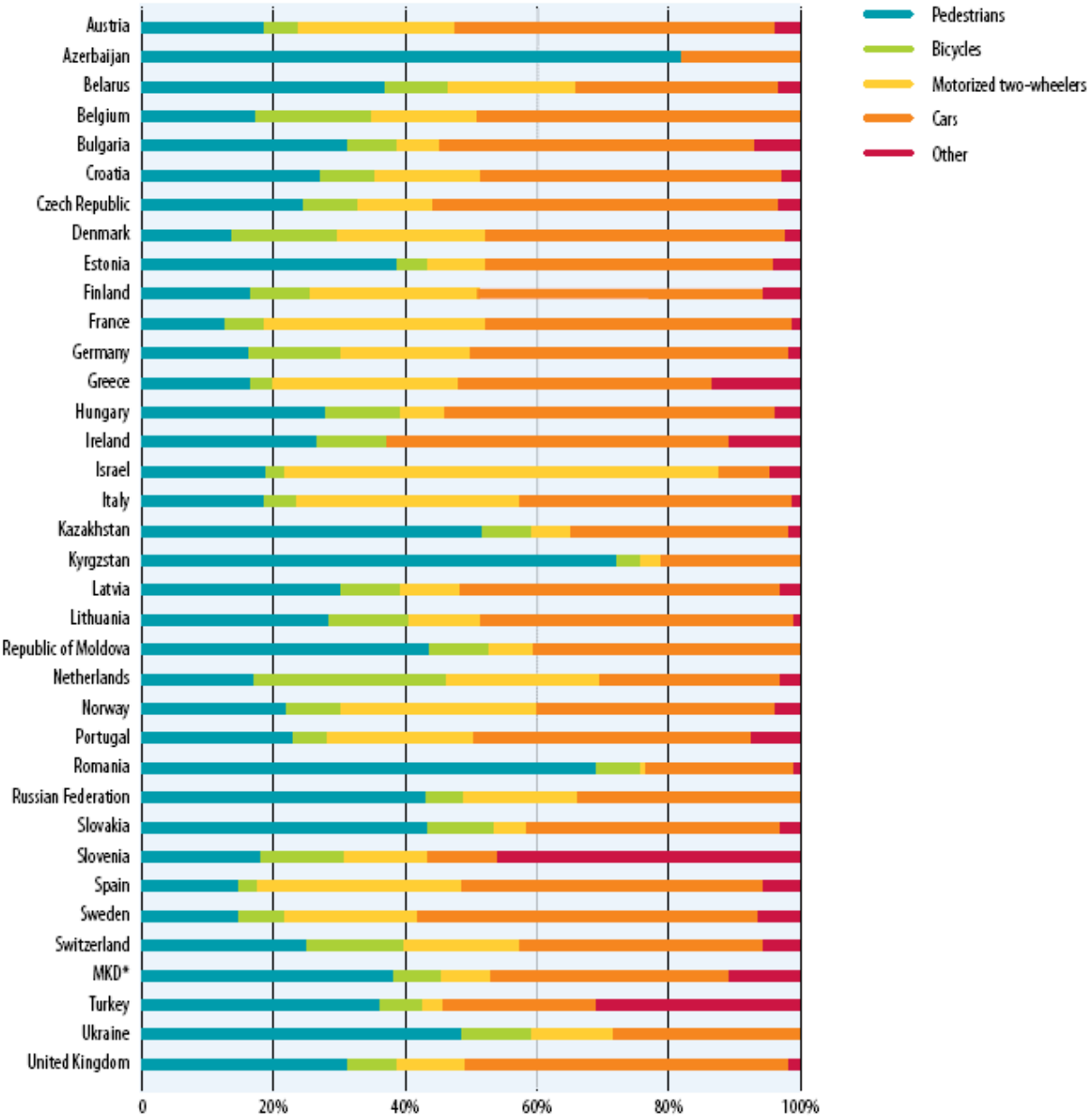
b The former Yugoslav Republic of Macedonia.

Source: (Fig 2, Annex 3, page 56) Sethi D, et al. Injuries and violence in Europe: why they matter and what can be done. Violence and Injury Prevention, WHO Europe for Environment and Health, Rome. WHO Regional Office for Europe, 2006.

2.2.2. Injuries the road environment

2.2.2.1. Road-related injuries to all types of road user

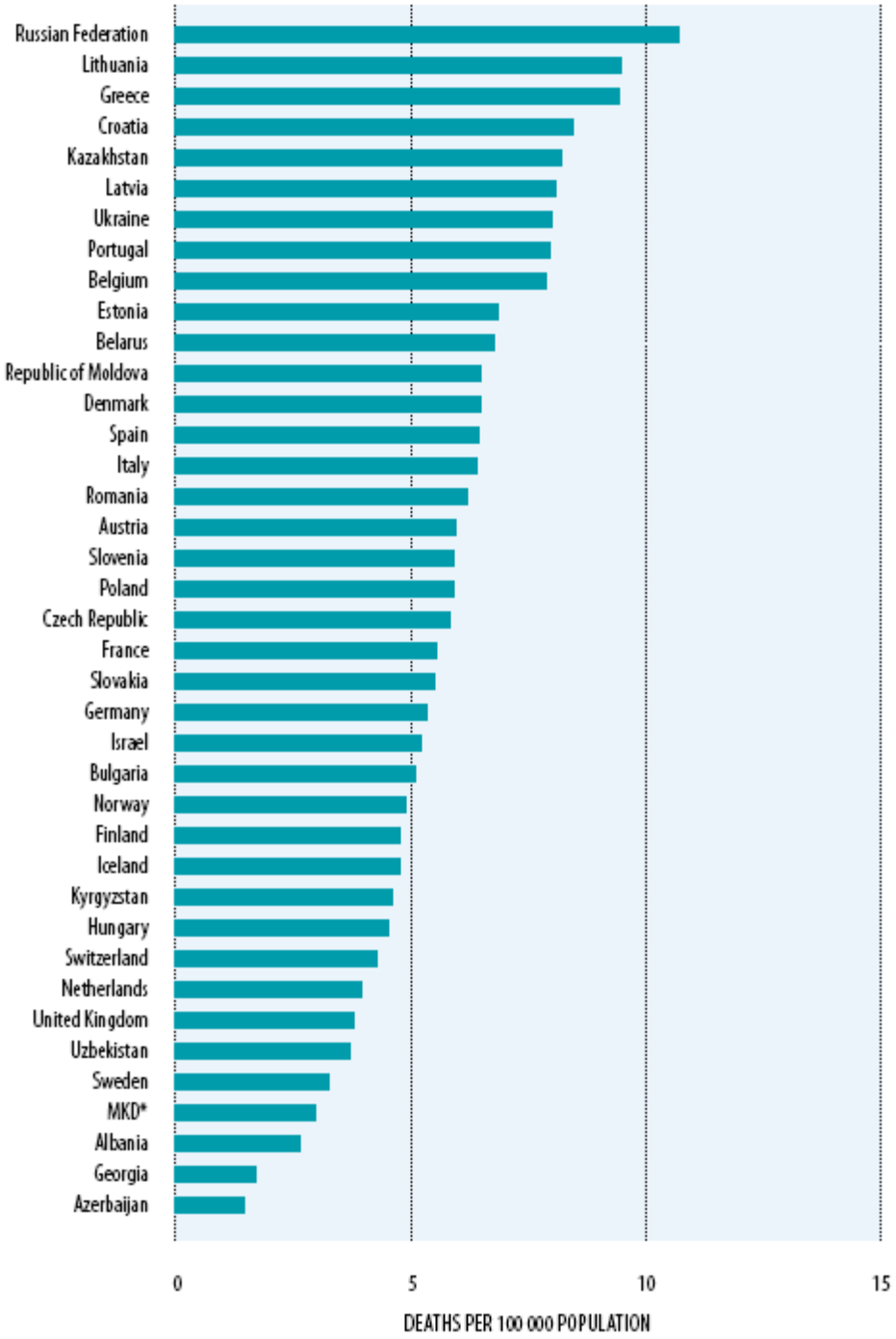
Figure 10. Proportion of deaths by mode of road transport among children aged 0–17 years in selected European countries, average for 2002–2004 or most recent three years



Source: (Figure 3.3, page 18, Chapter 3) Dinesh Sethi, Elizabeth Towner, Joanne Vincenten, Maria Segui-Gomez and Francesca Racioppi. European report on child injury prevention. World Health Organization 2008

Original source: UNECE transport database - UNECE transport database. Geneva, United Nations Economic Commission for Europe, 2007 (http:77w3.unece/pxweb/Dialog/, accessed 10 November 2008)

Figure 11. Average standardised mortality rates for transport injuries in children aged 0–19 years in the WHO European Region, 2003–2005 or most recent three years



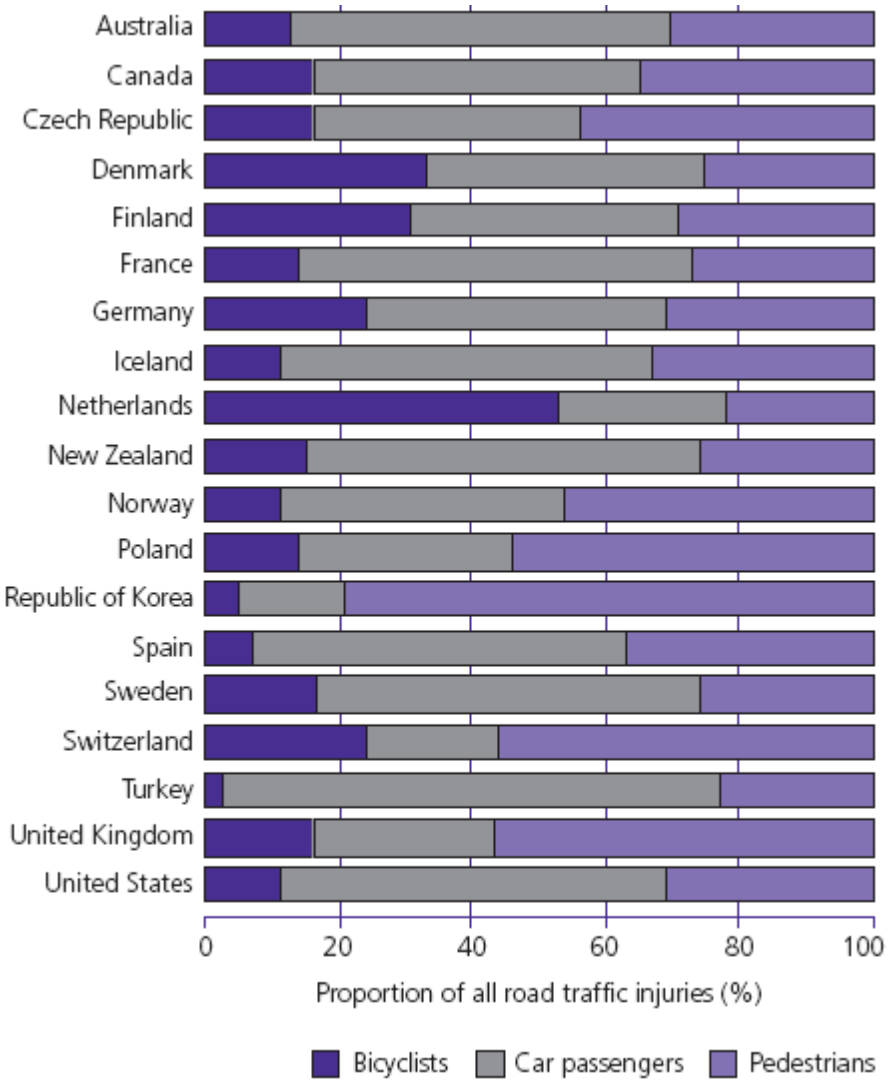
*International Organization for Standardization code for the former Yugoslav Republic of Macedonia.

Source: (Figure 3.1, page 16, Chapter 3) Dinesh Sethi, Elizabeth Towner, Joanne Vincenten, Maria Segui-Gomez and Francesca Racioppi. European report on child injury prevention. World Health Organization 2008

Original source: European detailed mortality database - The global burden of disease: 2004 update [web site]. Geneva, World Health Organization, 2008 (http://www.who.int/healthinfo/global_burden_disease/2004_report_update/en/index.html, accessed 10 November 2008).

The following graph reports injuries for bicyclists, car passengers and pedestrians.

Figure 12. Proportion of fatal road traffic deaths among children (aged <15 years) by type of road user in selected OECD countries.

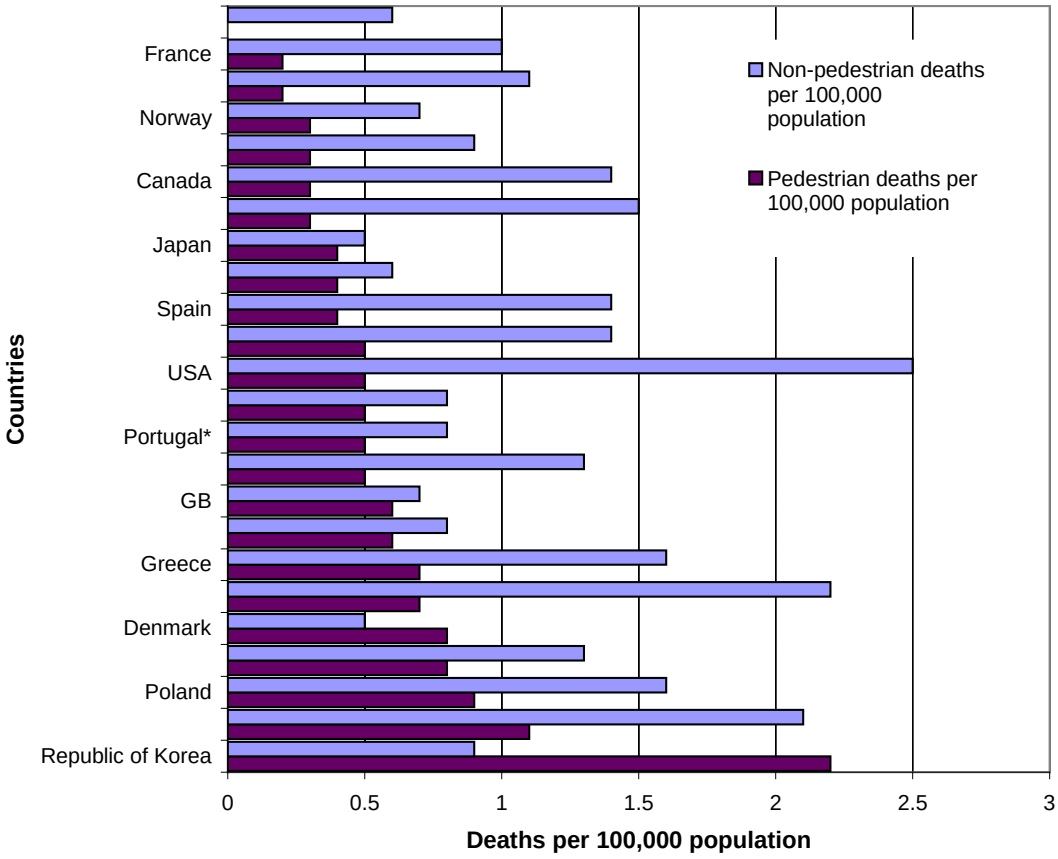


Source: (Figure 2.5, page 35) World report on child injury prevention. WHO, 2008 http://whqlibdoc.who.int/publications/2008/9789241563574_eng.pdf

Original source: Christie N et al. Children's road traffic safety: an international survey of policy and practice. London, Department for Transport, 2004 (Road Safety Research Report No. 47) (http://eprints.ucl.ac.uk/1211/1/2004_4.pdf , accessed 22 January 2008)

2.2.2.2. As pedestrians

Figure 13. International comparisons of road deaths: rates for pedestrian by selected countries: 2006

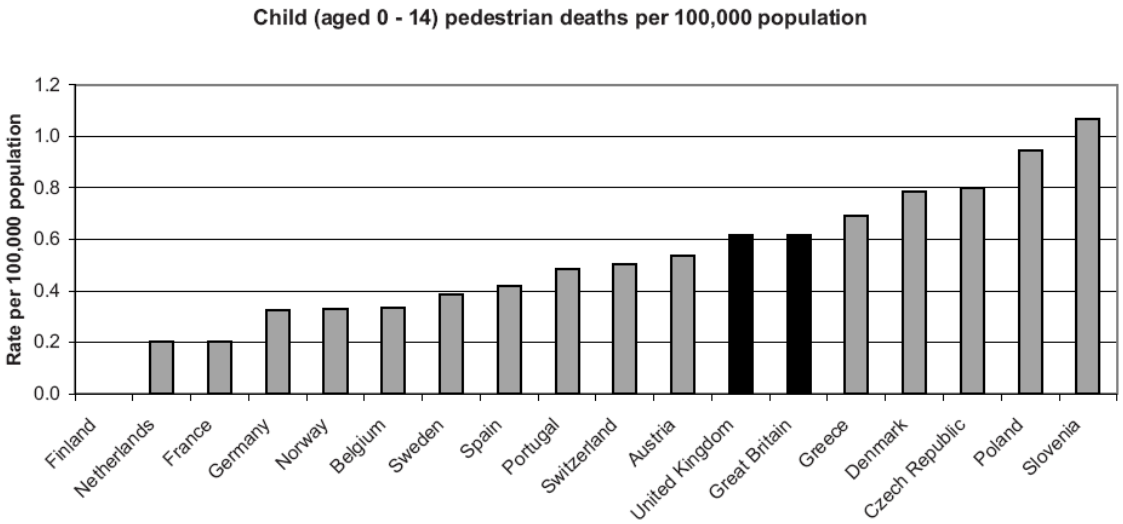


Source: (Bar chart created by the reviewer from the Table 51, page 170) Road Casualties Great Britain: 2007 Annual Report. Transport Statistics Publications (as at September 2008). http://www.dft.gov.uk/pgr/statistics

Original source: International Road Traffic and Accident Database (OECD), ITF, EUROSTAT and CARE (EU road accidents database).

***** 2005 population data for Portugal.

Figure 14. International comparisons: rates for child pedestrian deaths per 100,000 population - European countries: 2006

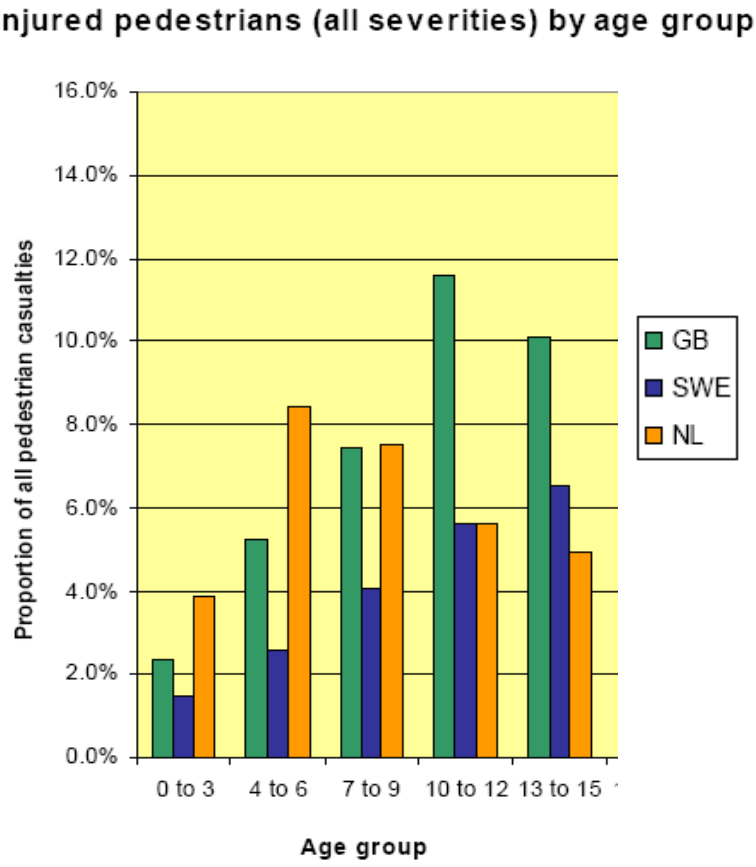


Source: (Table 51, page 171) Road Casualties Great Britain: 2007 Annual Report. Transport Statistics Publications (as at September 2008). http://www.dft.gov.uk/pgr/statistics

The following figures (Figure 15 to Figure 17) show the percentage of pedestrian casualties by age in three countries, using data from the SUNflower project, a collaborative study into transport injuries in UK, Sweden and the Netherlands (http://sunflower.swov.nl/reports/SUN%20Group.pdf). They reveal interesting differences between the three countries in terms of the distribution of injury rates across age, with road injury rates gradually increasing in UK and Sweden up to age 15 years, but the modal age-range for injuries in the Netherlands being those aged 4 to 6 years. Overall, for children as pedestrians, the UK has the worst rates of the three countries for both fatalities and serious injuries (including fatalities).

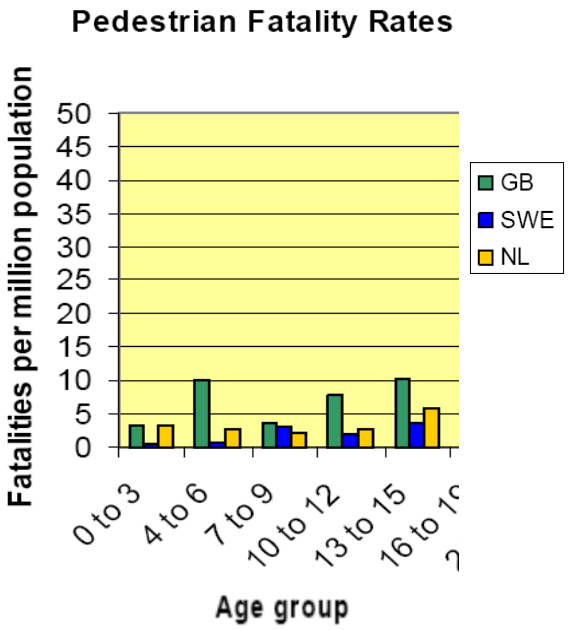
After the figures from the SUNflower project, Figure 18 to Figure 20 show the only international comparative child injury data that we found which explicitly adjusts for measures of exposure to risk of each type of road injury (from (Christie et al., 2007))

Figure 15. Percentage of all injured pedestrian casualties (all severities) by age group in the UK, Sweden and the Netherlands



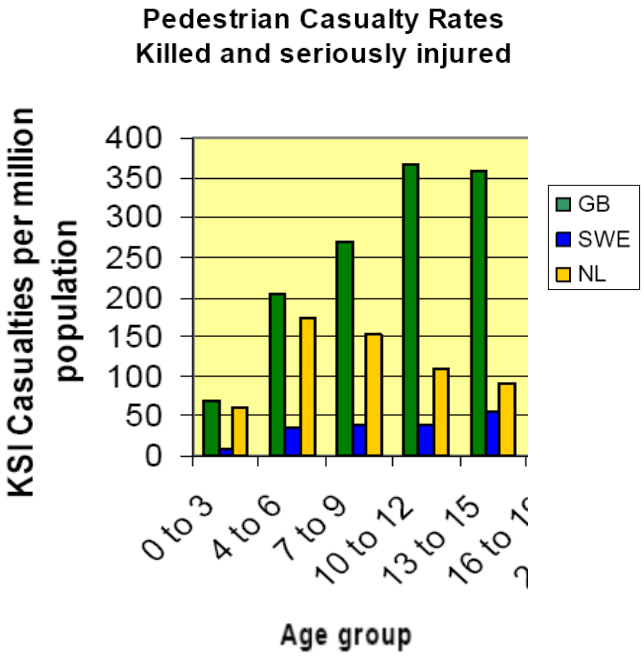
Source: (Figure 2.2, page 12-13) An extended study of the development of road safety in Sweden, the United Kingdom, and the Netherlands. http://sunflower.swov.nl/reports/SUN%20Group.pdf

Figure 16. Pedestrian fatality rates per million population by age group



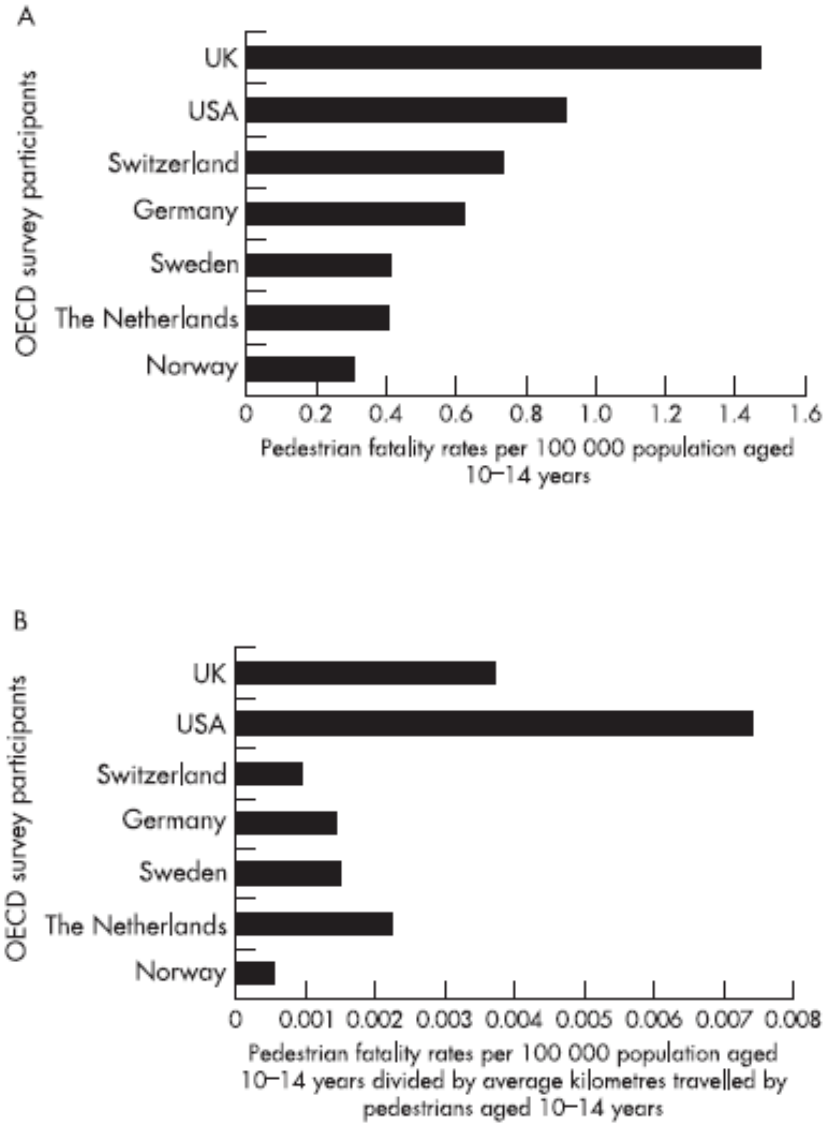
Source: (Figure 2.2, page 12-13) An extended study of the development of road safety in Sweden, the United Kingdom, and the Netherlands. http://sunflower.swov.nl/reports/SUN%20Group.pdf

Figure 17. Pedestrian casualty rates (killed and seriously injured) per million population by age group



Source: (Figure 2.2, page 12-13) An extended study of the development of road safety in Sweden, the United Kingdom, and the Netherlands. http://sunflower.swov.nl/reports/SUN%20Group.pdf

Figure 18. Pedestrians aged 10-14 years: population-based fatality rates (A) and population-based fatality rates expressed per unit of exposure (B) for a sample of Organisation for Economic Cooperation and Development (OECD) countries.

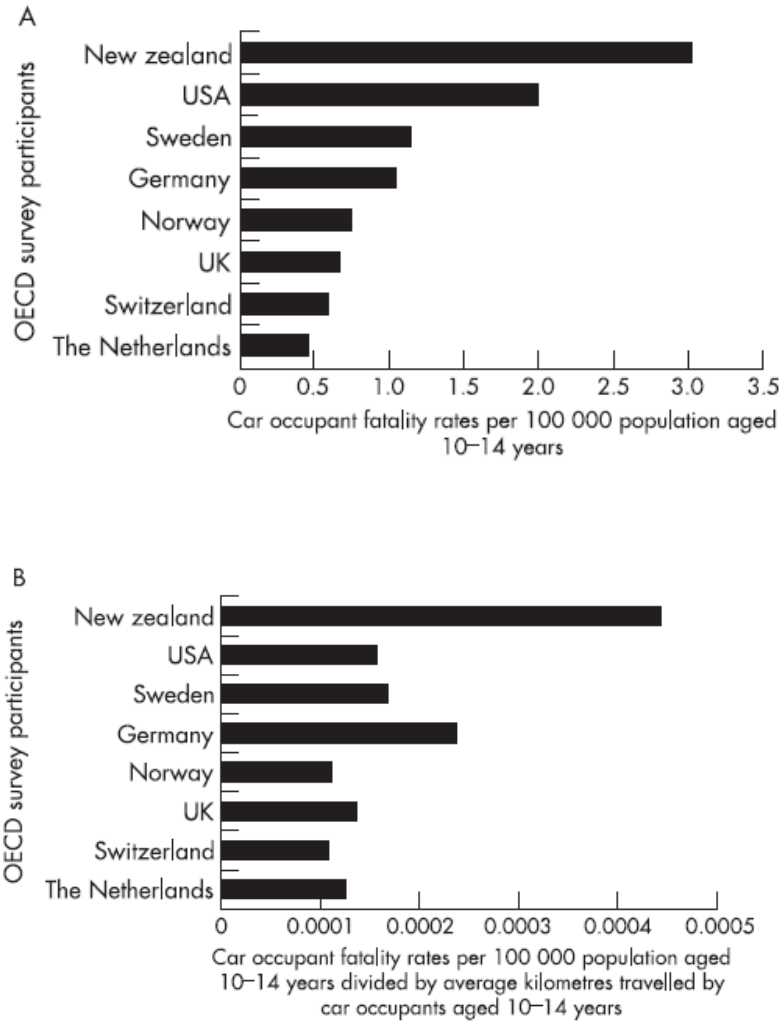


Source of the following figures: (Figure 1, page 127) Nicola Christie, Sally Cairns, Elizabeth Towner, Heather Ward. How exposure information can enhance our understanding of child traffic ''death leagues''. Injury Prevention 2007;13:125–129

The study is based on a questionnaire survey in 2002 (Christie N, Towner E, Cairns S, et al. Children's road traffic safety: an international survey of policy and practice, Department for Transport, 2004, Road Research Report No.47.)

2.2.2.3. As car passengers

Figure 19. Car occupants aged 10–14 years: population-based fatality rates (A) and population-based fatality rates expressed per unit of exposure (B) for a sample of OECD countries.

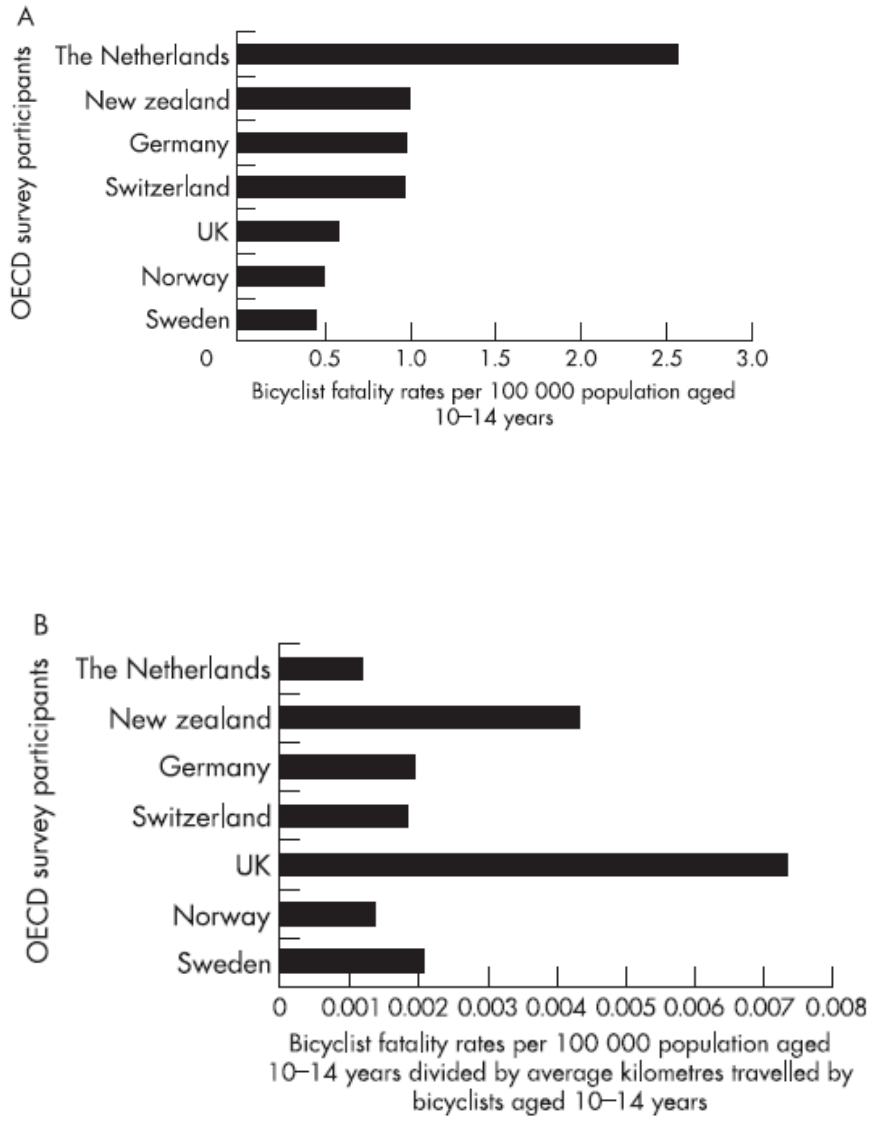


Source of the following figures: (Figure 2, page 127) Nicola Christie, Sally Cairns, Elizabeth Towner, Heather Ward. How exposure information can enhance our understanding of child traffic ‘‘death leagues’’. Injury Prevention 2007;13:125–129

The study is based on a questionnaire survey in 2002 (Christie N, Towner E, Cairns S, et al. Children’s road traffic safety: an international survey of policy and practice, Department for Transport, 2004, Road Research Report No.47.)

2.2.2.4. As cyclists

Figure 20. Bicyclists aged 10–14 years: population-based fatality rates (A) and population-based fatality rates expressed per unit of exposure (B) for a sample of OECD countries.



Source of the following figures: (Figure 3, page 128) Nicola Christie, Sally Cairns, Elizabeth Towner, Heather Ward. How exposure information can enhance our understanding of child traffic ''death leagues''. Injury Prevention 2007;13:125–129

The study is based on a questionnaire survey in 2002 (Christie N, Towner E, Cairns S, et al. Children's road traffic safety: an international survey of policy and practice, Department for Transport, 2004, Road Research Report No.47.)

2.2.3. In the home environment

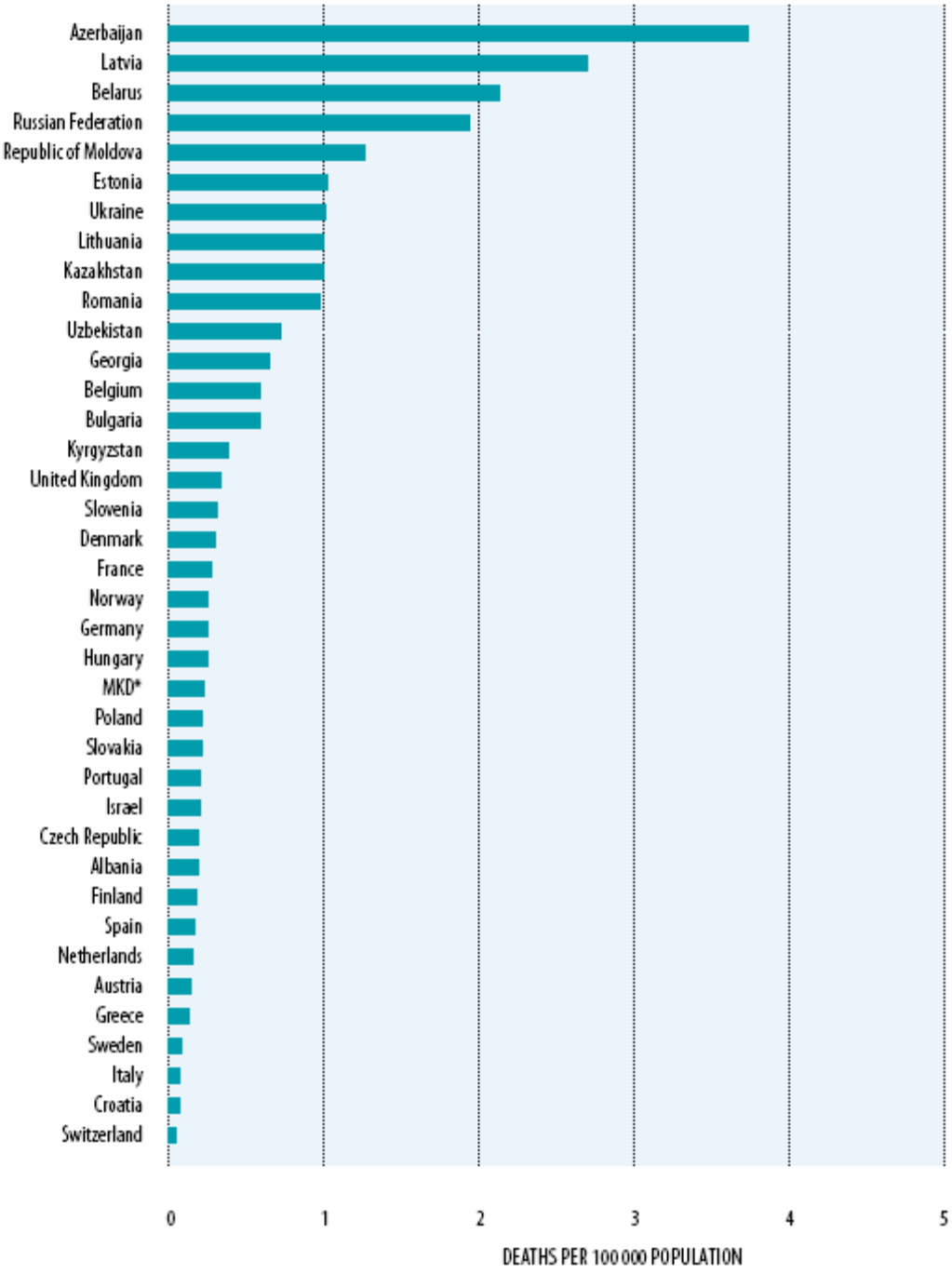
2.2.3.1. All types of accident in the home

No international comparative injury data found (except emergency department attendance rates for “home and leisure injuries”; see Figure 7, already shown on p.37).

2.2.3.2. Fire-related

See Figure 21

Figure 21. Standardised mortality rate from fires in children in the WHO European Region, 2003–2005 or most recent three years



*International Organization for Standardization code for the former Yugoslav Republic of Macedonia.

Source: (Figure 6.2, page 50, CHAPTER 6) Dinesh Sethi, Elizabeth Towner, Joanne Vincenten, Maria Segui-Gomez and Francesca Racioppi. European report on child injury prevention. © World Health Organization 2008

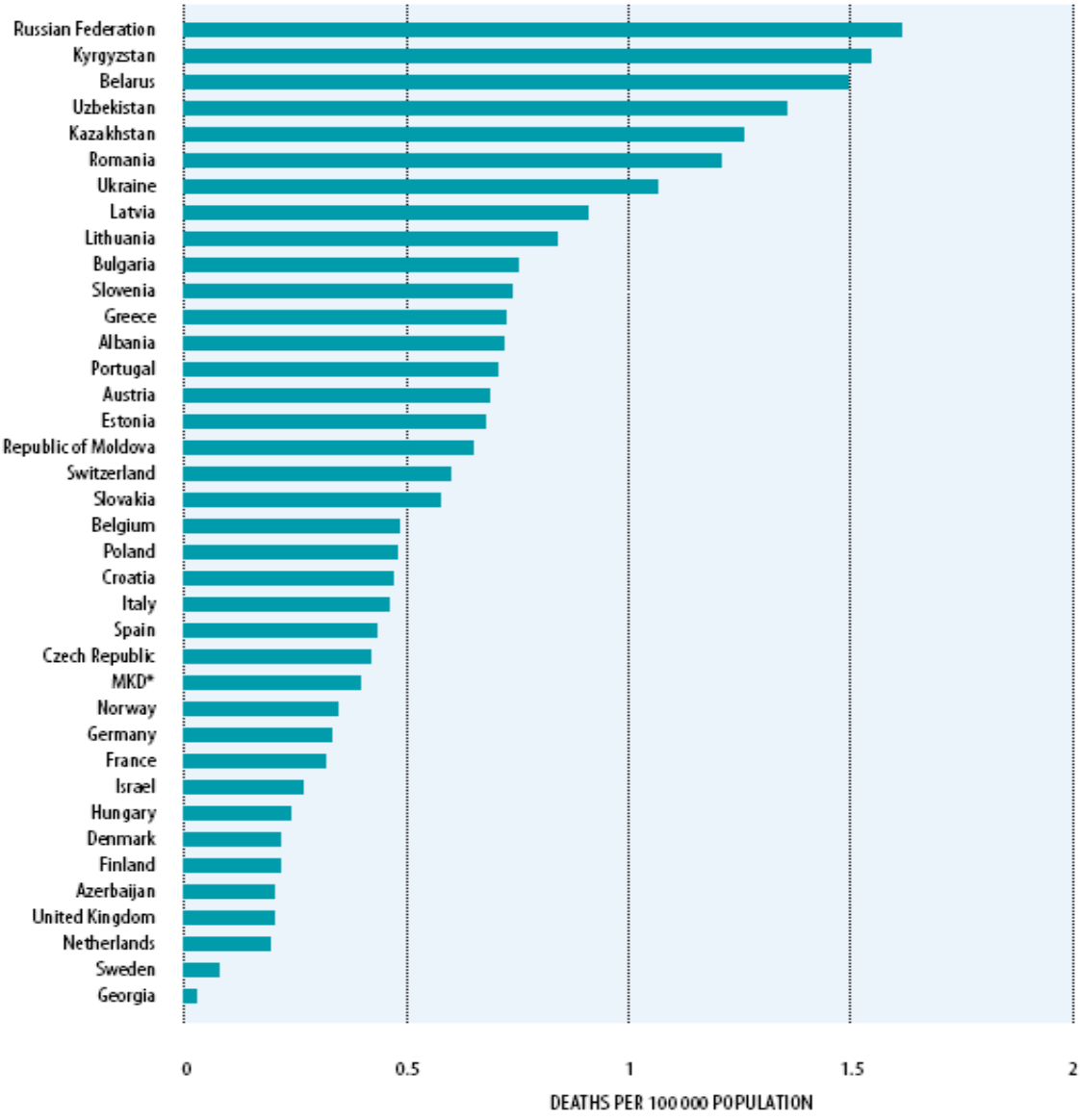
Original source: European detailed mortality database (DMDB) [online database] - European detailed mortality database (DMDB) [online database]. Copenhagen, WHO Regional Office for Europe, 2008 (http://www.euro.who.int/InformationSources/Data/20070615_2, accessed 13 November 2008).

2.2.3.3. Heat-related but not fire (burns and scalds from liquids)

No international comparative data was found for these types of child unintentional injury.

2.2.3.4. Falls-related (or falling objects)

Figure 22. Average standardised mortality rates for falls in children aged 0–19 in the WHO European Region, 2003–2005 or most recent three years



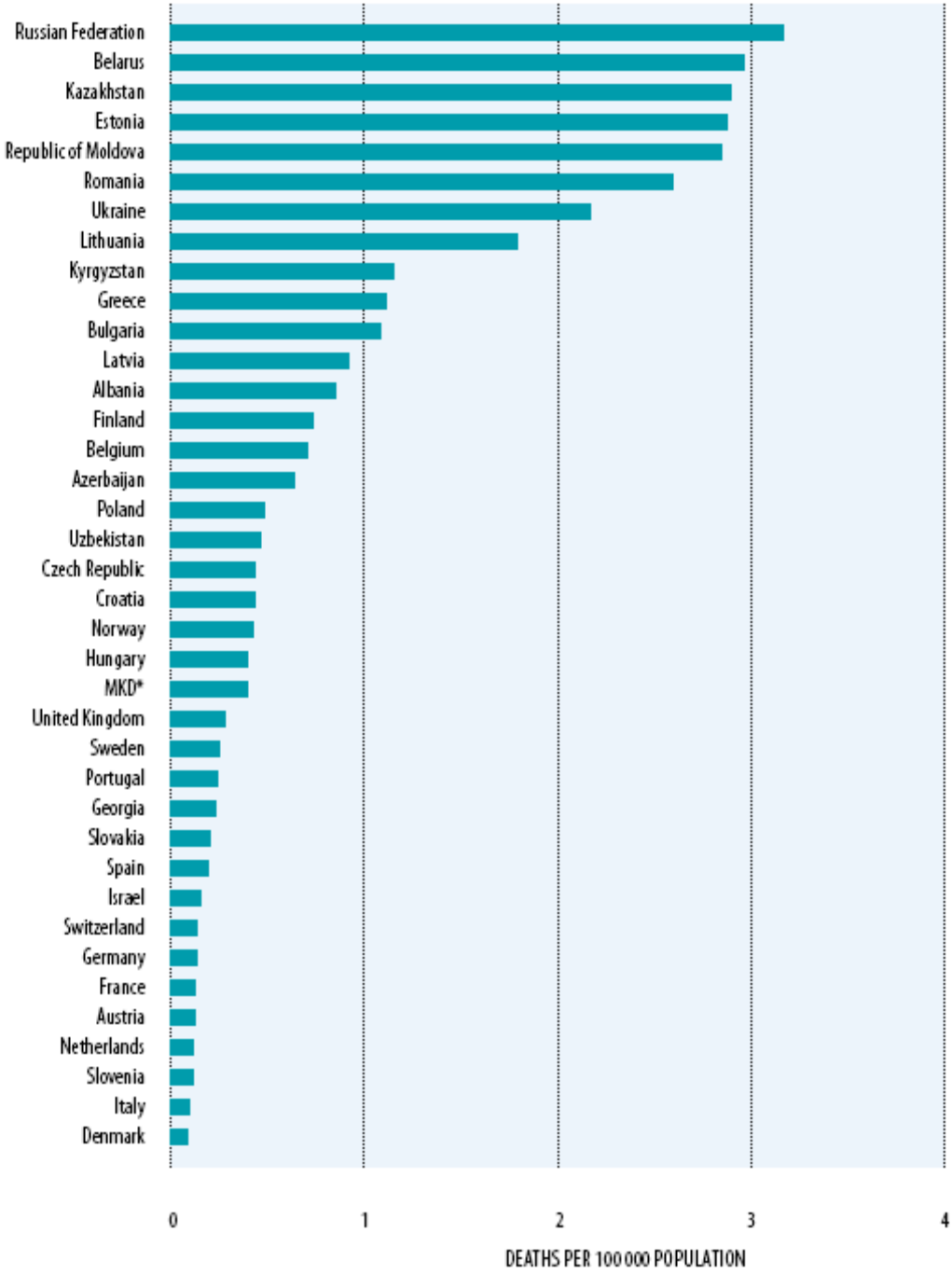
*International Organization for Standardization code for the former Yugoslav Republic of Macedonia.

Source: (Figure 7.1, page 60, Chapter 7) Dinesh Sethi, Elizabeth Towner, Joanne Vincenten, Maria Segui-Gomez and Francesca Racioppi. European report on child injury prevention. 2008

Original source: European detailed mortality database (DMDB) [online database] -- European detailed mortality database (DMDB) [online database]. Copenhagen, WHO Regional Office for Europe, 2008 (http://www.euro.who.int/InformationSources/Data/20070615_2, accessed 13 November 2008).

2.2.3.5. Poisoning–related

Figure 23. Average standardised mortality rate for poisoning in children aged 0–19 in the WHO European Region, for 2003–2005 or most recent three years



*International Organization for Standardization code for the former Yugoslav Republic of Macedonia.

Source: (Figure 5.1, page 40, Chapter 5) Dinesh Sethi, Elizabeth Towner, Joanne Vincenten, Maria Segui-Gomez and Francesca Racioppi. European report on child injury prevention.

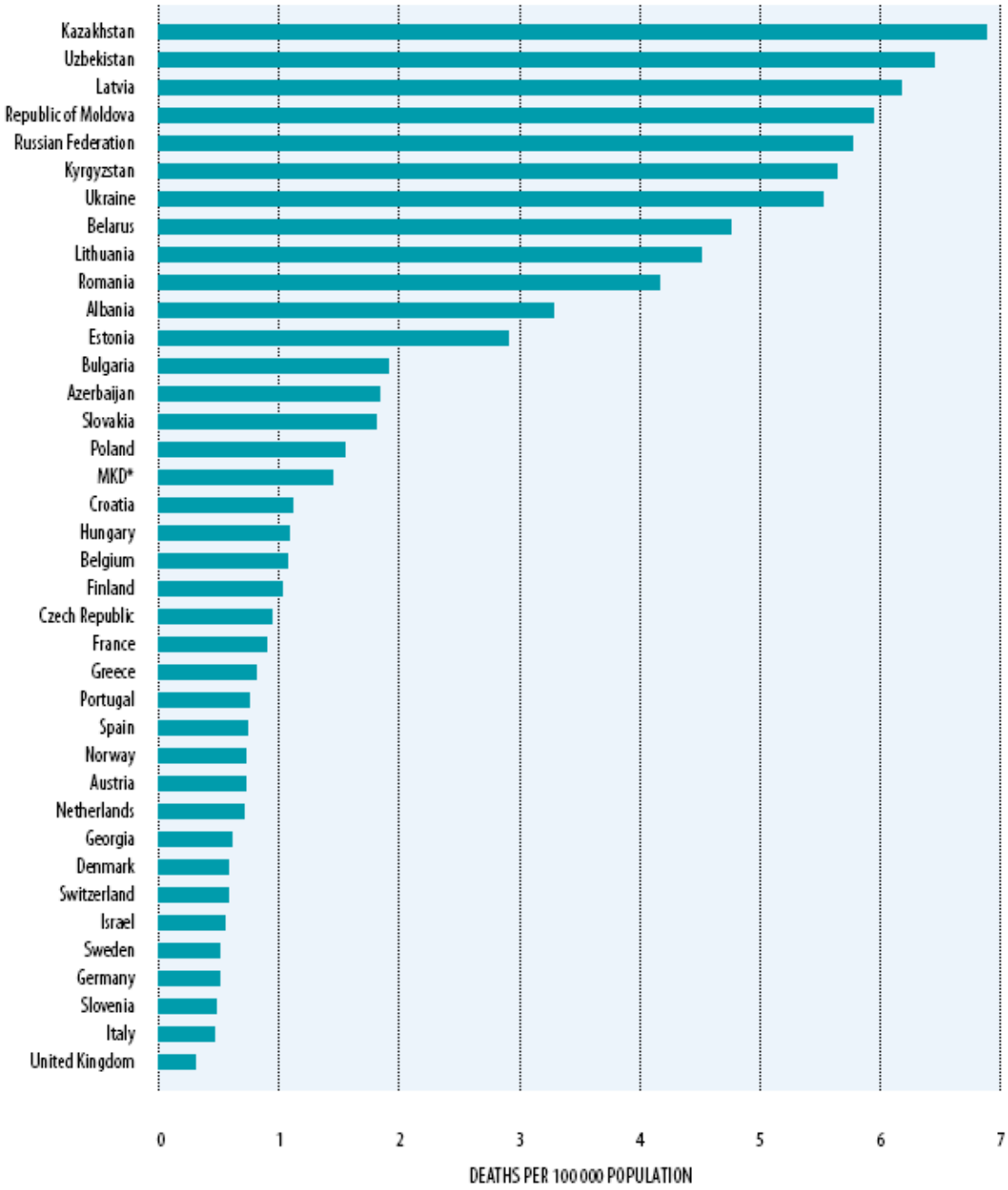
Original source: European detailed mortality database (DMDB) [online database] -- European detailed mortality database (DMDB) [online database]. Copenhagen, WHO Regional Office for Europe, 2008 (http://www.euro.who.int/InformationSources/Data/20070615_2, accessed 13 November 2008).

2.2.4. In other external environments

2.2.4.1. Play and leisure related

Under this heading, we could only find international comparative data relating to drownings.

Figure 24. Average standardised mortality rates for drowning in children aged 0–19 years in the WHO European Region, 2003–2005 or most recent three years

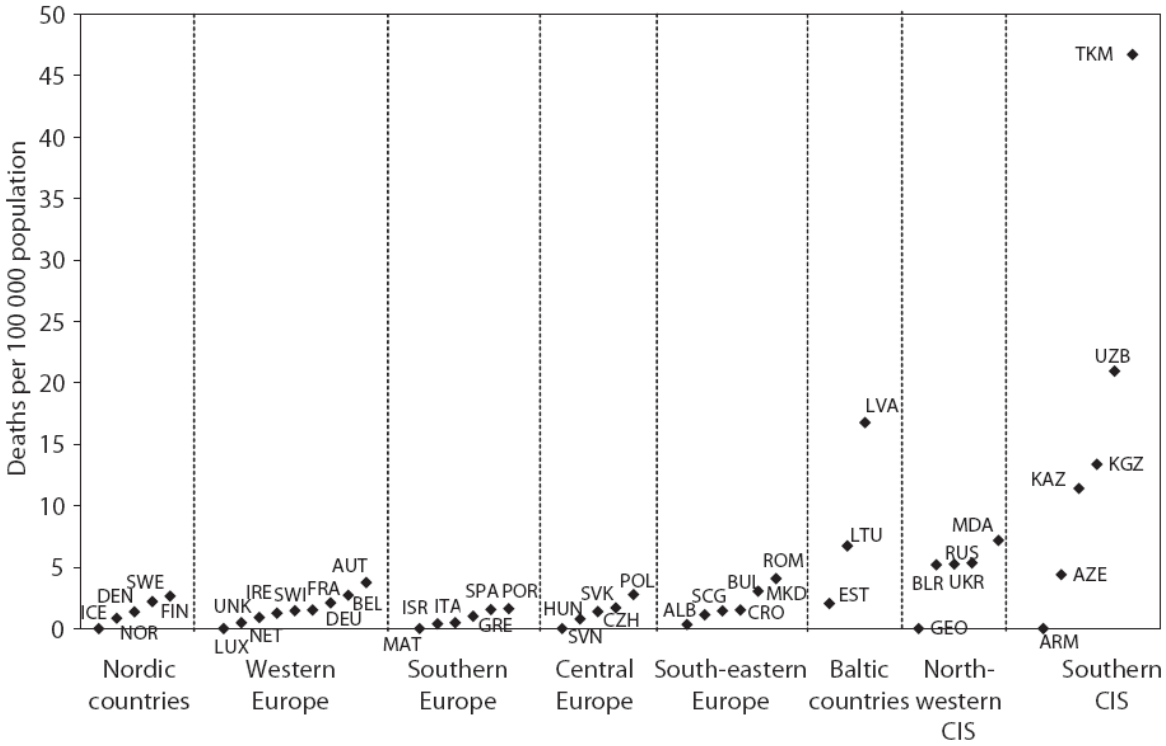


*International Organization for Standardization code for the former Yugoslav Republic of Macedonia.

Source: (Figure 4.1, page 30,Chapter 4) Dinesh Sethi, Elizabeth Towner, Joanne Vincenten, Maria Segui-Gomez and Francesca Racioppi. European report on child injury prevention. WHO Europe, 2008.

Original source: European detailed mortality database (DMDB) [online database]: European detailed mortality database (DMDB) [online database]. Copenhagen, WHO Regional Office for Europe, 2008 (http://www.euro.who.int/InformationSources/Data/20070615_2, accessed 13 November 2008).

Figure 25. Standardised mortality rates for drowning in children aged 1–4 years by country and subregion of the WHO European Region, 2002



Source: (Fig. 1. page 54, Annex 3) Injuries and Violence in Europe, by Sethi et al. 2006.

Original source: Mortality indicators by 67 causes of death, age and sex (HFA-MDB) [online database, accessed on 13 October 2005] ---- Murray CJL, Lopez AD. The global burden of disease: a comprehensive assessment of mortality and disability from diseases, injuries and risk factors in 1990 and projected to 2020. Cambridge, MA, Harvard School of Public Health, 1996 (Global Burden of Disease and Injury Series, Vol. I)

Country Abbreviations: Albania ALB Armenia ARM Austria AUT Azerbaijan AZE Belarus BLR Belgium BEL Bulgaria BUL Croatia CRO Czech Republic CZH Denmark DEN Estonia EST Finland FIN France FRA Georgia GEO Germany DEU Greece GRE Hungary HUN Iceland ICE Ireland IRE Israel ISR Italy ITA Kazakhstan KAZ Kyrgyzstan KGZ Latvia LVA Lithuania LTU Luxembourg LUX Malta MAT Netherlands NET Norway NOR Poland POL Portugal POR Republic of Moldova MDA Romania ROM Russian Federation RUS Serbia and Montenegro SCG Slovakia SVK Slovenia SVN Spain SPA Sweden SWE Switzerland SWI The former Yugoslav Republic of Macedonia MKD Turkmenistan TKM Ukraine UKR United Kingdom UNK Uzbekistan UZB

2.2.4.2. Sports-related

There was one paper which we found which might have provided useful international comparative sports injury rates for children: (Belechri M. et al. 2001). However, unfortunately the tables in this paper only showed the *age distribution* of children (5 - 14 years old) injured in sports by gender and age, by type of injury, injured body part and treatment, and injured in specific sports by gender, age, type of injury and injured body part in selected EU countries in 1998; because they reported only the actual total numbers for each country or actual numbers in their sample, overall injury rates which are comparable across countries could not be calculated.

2.3. Summary of international injury incidence/mortality data

The tables and graphs in Section 2.2 can be seen as illustrating a number of general points. These are:

- The most commonly available international injury data, which is regarded as sufficiently comparable to be reported in the same tables and graphs, is on child deaths and mortality due to injuries.
- There are a number of high-income countries which consistently have low standardised mortality rates for children (relative to other high income countries) due to unintentional injuries across a range of injury types/causes. The following countries were often at or near the top of the rankings for the lowest child mortality rates for injuries due to all unintentional injuries road traffic, poisoning, drowning, falls and due to fires (and respective rankings among countries included in European mortality database):
    - Sweden
    - Netherlands
    - Switzerland
    - UK

- On the basis of the same data from the recent European Region WHO report (mortality rates due to injury) other countries had relatively low child injury death rates for some cause of injuries, but not others (see Table 2). For example, Italy has a favourable fatal injury ranking for child deaths due to poisoning, drowning and fires but much worse for injuries on the road. The UK has some of the lowest child mortality rates in Europe for deaths due to drownings and falls, but not due to poisoning or fires.

- Compared with France and Germany, which are usually regarded as socio-economically similar countries to the UK, it appears that children in the UK have lower rates of fatal injury – both for overall rates for all injuries, and most of the main types of injury. However, with regard to injuries to children as pedestrians, deaths due to poisoning, and deaths due to “other causes” of injury, the UK has relatively worse rates. This unfavourable finding for the UK (or GB) with regard to child pedestrian fatalities is also confirmed by international comparative data we found which adjusts for exposure to risk (Christie et al., 2007, Bly et al., 1999, Bly et al., 2005).

Table 2. National rankings according to lowest standardised mortality rates for different types of unintentional injury in children (aged 0-19 years), selected countries

Country	All (0-14yrs)	All (0-19yrs)	RTIs*	Pedest-rian** (0-14yrs)	Fire	Falls	Drown-ing	Poison-ing	Other
Sweden	2nd	6th	5th	7th	4th	2nd	5th	14th	19th
Netherlands	4th	2nd	8th	2nd	7th	3rd	10th	4th	1st
Switzerland	14th	5th	9th	10th	1st	21st	7th	8th	7th
Spain	12th	18th	26th	8th	8th	15th	13th	10th	4th
Germany	6th	9th	17th	4th	18th	11th	4th	7th	3rd
France	16th	13th	19th	3rd	20th	10th	16th	6th	10th
Italy	3rd	19th	25th	-	3rd	16th	2nd	2nd	-
UK	1st	7th	7th	12th	23rd	4th	1st	15th	14th

Sources: Dinesh Sethi, Elizabeth Towner, Joanne Vincenten, Maria Segui-Gomez and Francesca Racioppi. European report on child injury prevention. WHO 2008.

Except data on All injuries in 0-14 year olds (for both unintentional and intentional injuries), which comes from:

*RTI = Road Traffic Injuries NB. Those countries ranked 1st, 2nd, 3rd, and 4th for RTIs are, somewhat unusually: Azerbaijan, Georgia, Albania, and MKD (former Yugoslav Republic of Macedonia).

** Ranking amongst 18 European countries (see Figure 14, p.44 of this report). Source: (Table 51, page 171) Road Casualties Great Britain: 2007 Annual Report. Transport Statistics Publications (as at September 2008). http://www.dft.gov.uk/pgr/statistics

3. Main review

3.1. Methods

This review sought to identify international comparative analyses of legal and regulatory interventions, as well as mechanisms of enforcement and compliance for legislation and regulation, to prevent child injuries. The analysis was restricted to road environment modification and road design, safety equipment and assessments in the home and interventions in the wider environment.

3.1.1. Inclusion and exclusion criteria

We defined international comparisons to include, not only those studies that assessed programmes and interventions across more than one country, but also in the case of federal countries, studies that compared differences in injury outcomes and legal, regulatory, enforcement and compliance mechanisms across states/provinces. We however excluded studies that made comparisons across smaller areas within a country, e.g. between cities/towns of less than one million people and comparisons across counties and municipalities.

In respect of road related injuries, we focused on legislative and regulatory interventions, as well as enforcement and compliance measures, that were intended to modify road design and or road environment. These included various traffic calming measures, speed zones, home zones, signing, walking and cycling networks and safe routes to school. We have included studies looking at the use of speed cameras, both visible and hidden as a way of changing driver behaviour, where these were explicitly intended to reduce child injuries. We have excluded studies focusing solely on maximum speed limits on major motorways but included interventions to reduce speed elsewhere. We applied this restriction to the study of speed cameras given our focus is on the modification of road environments where children not only may be passengers in vehicles but potentially are also pedestrians. Studies focusing on lighting and visibility, restraints including seat belts and child seats, safety

measures such as air bags and bicycle helmets, and laws governing blood alcohol limits were excluded. Driver education and licensing studies were also excluded.

In the home environment we focused on two areas: international comparative analysis of legislation, regulation, enforcement and compliance mechanisms to do with the use of home safety equipment, which (as defined in the final version of the home intervention Scope) includes smoke alarms, hot water temperature restrictors, stair gates and oven, window and door guards and locks, and on the use of “home safety assessments”. In the wider environment we focused on legislation, regulations and standards and guidelines set by professional bodies on sports activities and leisure, including playgrounds and other play activities. Studies focussing on restricting access to firearms as a way of reducing unintentional child injuries were excluded given their limited relevance to UK context.

We also included papers that assess the merits of interventions that monitor and evaluate child injuries across countries and regions, **where this data is intended to be used to influence the development of childhood injury prevention policy**. Finally the review searched for international comparative studies looking at the use of legislation and regulation in respect of workforce development, such as requirements for mandatory injury prevention training in professional qualification curricula.

3.1.2. Search strategies

We recognised that the nature of this particular topic would mean that potentially much relevant literature is likely to appear in reports of international agencies, governments and non-governmental organisations rather than in academic journals. Thus we complemented a rapid bibliographic database search with a handsearch of key journals and websites, augmented by contacts with experts and a narrow Google search.

Date and language restrictions

We restricted ourselves to studies published between 1997 until 2009. While we did not exclude non-English language papers, we did not have time to assess their suitability given the short time period for this review.

Bibliographic searches

We combined a range of terms for children and adolescents with terms for injury or accident prevention and legislation, regulation, enforcement and compliance for a number of databases: Pubmed/MEDLINE; the International Bibliography of the Social Sciences; Econlit; ASSIA; Geobase; Transport Research Information Service; SportsDiscus and Theses.com. (See Appendix 1 for more detail on these search strategies)

We also searched the Safety Lit database which specialises in multi-disciplinary work relevant to preventing unintentional injuries, violence, and self-harm. Based at the Centre for Injury Prevention Policy and Practice at the University of San Diego, and endorsed by the World Health Organisation it covers more than 2600 journals, as well as review conference proceedings and reports from government agencies and organizations. Overall the archive contains more than 90,000 records. We systematically searched all abstracts in this database over the period 1997 – December 2008 that had been catalogued in the following areas: burns, scalds and fire; community based prevention; drowning, suffocation; falls; home and consumer product safety; pedestrians and bicycles; poisoning; recreational and sports issues; school issues; transportation issues. In addition we searched through all reports and conference proceedings on the database.

Citation searching and hand search of key journals

We looked at citations of papers that met our inclusion criteria to identify additional papers. In addition we hand searched from 2009 (including articles accepted for publication) to the beginning of 1997 a number of key journals that were all available electronically: Accident Analysis and Prevention, Injury Prevention, Pediatrics, Journal of Safety Research, and the American Journal of Public Health. In addition, because the abstracts of these journals were available electronically we were also able to follow citation maps, not only for papers that met our inclusion criteria, but also those for ‘near miss’ papers (usually excluded because geographical areas for comparison were too small to meet our inclusion criteria). In addition we also looked at the reference lists in relevant Cochrane and other systematic reviews related to road modification, traffic calming and child injury prevention. We also hand searched the entire set of abstracts from the October 2008 European Conference on Injury

Prevention and went through the Handbook of Road Safety Measures (Elvik and Vaa, 2004).

Website searches

A range of websites were searched and are listed below. These consist of a combination of governmental websites, together with a range of child injury related resources.

Government Departments

Australia – Victoria Government Health Promotion
http://www.health.vic.gov.au/healthpromotion/

Australian Government Department of Health and Ageing
http://www.health.gov.au/

British Columbia Provincial Government (Health and Transportation Ministries)

English Department of Health

English Department of Children, Schools and Families

English Department of Transport (Road Safety Research Report Series)

Ireland – Department of Health and Children; Department of Transport

Scottish Government

New Zealand Government – Health; Kids and Youth; Transport and Roads

Northern Ireland Government

Welsh Assembly Government

University Departments

Harbourview Injury Prevention and Research Centre, University of Washington, USA http://depts.washington.edu/hiprc/index.html

Harvard School of Public Health, Boston, USA

Nottingham University

University of Swansea

Department of Preventive and Social Medicine, University of Otago, Dunedin, New Zealand

National and International Organisations

The websites of a number of international organisations have also been searched. Some of these were identified at the outset; others were identified as a result of citation searching or being highlighted in other sources of grey literature. The following websites have been searched:

Public Health Association of Australia http://www.phaa.net.au

Australian therapeutic guidelines http://www.tg.com.au/home/index.html

Austrian Road Safety Board http://www.kfv.at/

Public Health Agency of Canada http://www.phac-aspc.gc.ca/dpg_e.html

Canadian Task Force on Preventive Health Care http://www.ctfphc.org.ca

CAPIC Collaboration for Accident Prevention and Injuries Control http://www.capic.org.uk

Commission for Integrated Transport http://www.cfit.gov.uk/

Consumer Safety Products

Irish Injury Observatory

EPOC Cochrane Effective Practice and Organisation of Care Group http://www.epoc.uottawa.ca/aboutus.htm

European Child Safety Alliance

European Commission – DG Enterprise and Industry – Toys http://ec.europa.eu/enterprise/toys/index_en.htm

European Commission DG Health and Consumers

European Commission DG Transport

European Conference of Ministers of Transport

European Road Assessment Programme www.eurorap.org

European Road Observatory

EuroSafe

Global Road Safety Commission - www.grsproadsafety.org

Hamilton Public Health & Community Services Effective Public Health Practice Project (EPHPP) http://www.city.hamilton.on.ca/PHCS/EPHPP/default.asp

Health Evidence Network http://www.euro.who.int/HEN

Institute for Road Safety Research (Netherlands) SWOV www.swov.nl

International Road Transport Forum

New Zealand Guidelines Group www.nzgg.nz

New Zealand Health Technology Assessment Clearing House http://nzhta.chmeds.ac.nz

OECD Organisation for Economic Co-operation and Development http://www.oecd.org

Slower Speeds Initiative http://www.slower-speeds.org.uk/

Swedish National Institute of Public Health http://www.fhi.se/

Transport division of the United Nations Economic Commission for Europe (UNECE)

OECD/ECMT Transport Research Centre

Transport Research Laboratory Ltd

World Road Association (PIARC)

UNICEF The United Nations Children's Funds (www.unicef.org)

US Consumer Product Safety Commission

US National Institutes of Health http://www.nih.gov

US Centers for Disease Control and Prevention http://www.cdc.gov

US Agency for HealthCare Research and Quality (AHRQ) http://www.ahrq.gov including USPSTF (US Preventive Services Task Force) http://www.ahrq.gov/clinic/uspstfix.htm/

World Bank

WHO

Expert contacts

We also contacted a number of acknowledged experts in child injury prevention to identify further studies that might meet our inclusion criteria. These included David Ormandy, University of Warwick; Eleni Petridou (University of Athens and co-ordinator APOLLO project); Morag MacKay and Joanne Vincenten – European Child Safety Alliance; Hemo Lotem – JDC, Jerusalem, Israel (suggested as contact through mailing below); Linda Cook, Transport Research Laboratory (to seek access to final report of the 'DUMAS' Project)

We also posted a message to list members of the European Health Policy Group mailing list which has approximately 400 subscribers worldwide, as well as to members of the Bertelsmann Foundation's International Network Health Policy and

Reform monitor group (www.healthpolicymonitor.org). This generated a number of responses: Peter Paulus, Institute of Psychiatry, University of Lüneburg; Mark McCarthy, University College London; Chantal Cases and colleagues from the Institut de Recherche et Documentation en Economie de la Santé (IRDES), Paris, Fance; Ted Marmor, Yale University, USA; Isabelle Durand-Zaleski, Assistance Publique, Hopitaux de Paris, France.

3.1.3. Study quality assessment

Different dimensions of quality are routinely considered in the different study designs, both qualitative and quantitative, that can appear in public health assessments conducted for NICE. However we could not identify any specific set of quality assessment criteria or questions to be used in respect of the international comparative ecological studies identified in our review. In the absence of such a tool, we (DM, AP, RA) developed our own set of questions to use in quality assessment, which were adapted largely from the different quality assessment checklists that appeared in the first edition of the NICE Methods Manual and other quality assessment documents (NICE, 2006, Weightman et al., 2005). These questions are shown in Table 3 below.

Where studies met (answer 'Yes' to question) more than half of these criteria, it achieved a score of '++' (strong), where it was judged to meet 3 or more criteria it scored '+' (moderate), and meeting 2 or less criteria scored '-' (weak). (Judgement on studies against the criteria was assessed by one reviewer and checked by a second reviewer).

Table 3. Study quality assessment checklist questions

1. Does the study provide justification for the introduction of the policy/strategy/legislation/regulation in both/all countries/regions?
2. Has a justification for choice of comparator countries/regions been included?
3. Does the study provide baseline information on relevant childhood injury rates and/or safety behaviours prior to the introduction of the policy/programmes that are being compared?
4. Does the study provide sufficient background information on the context and previous situation regarding legislation, regulation, enforcement and compliance prior to the introduction of the new policy/strategy/legislation/regulation in both/all

countries/regions?

5. Does the assessment state clearly defined time periods when the strategy/legislation (etc.) was implemented in the countries/regions?

6. Have injury rates been adjusted to take account of differences in relative exposure to risk in the comparator countries/regions?

7. Has sufficient information on sources of data for injury rates and/or safety behaviours been documented and reported?

8. Are methods of data collection stated as being consistent across the different countries/regions?

9. Where consistent data collection and reporting is claimed, is this justified by evidence within the paper (and/or) have the authors made any adjustments to make comparison more meaningful, or provided a justification for not doing so?

10. Have the policies/programmes/strategies/legislation etc been described in sufficient detail to permit replication elsewhere?

Note that, because of the inherently multi-national and therefore multi-context nature of the evidence in such studies, we have decided that it does not make sense to apply a scoring for study 'applicability to the UK'. This is further justified by the fact that there are so few included studies, so that readers will be in a position to judge the applicability themselves on the basis of the detailed findings presented.

3.2. Findings

Our review of electronic databases and grey literature initially identified 1340 references. After examination of abstracts we reduced this to 306 potentially includable papers or reports then examined in full text version.

Ultimately ten papers met our review's inclusion criteria. They are summarised in Table 4 on the following page. Much of what we excluded focused on the use of seat belts and other in car child restraints, including the use of special seats, as well as the use of special driver licence schemes for young drivers. We also came across a number of US studies related to firearm restrictions for children, an issue which does not have much relevance within a UK context. We did however find a number of

studies (so-called ‘near misses’) which may have met our inclusion criteria save for the fact that they did not make a comparison between significant enough geographical areas. (The total list of excluded articles, as well as Table 8 which provides more information on ‘near misses’ identified, is provided in Appendix 2).

Most of the included studies - and especially those including the UK or GB as a compared country - concerned legislation which should or could impact upon road-related injuries to children. Three US-based studies focused on safety legislation to do with childrens’ use of off-road leisure vehicles (two studies on all-terrain vehicles or ‘quad bikes’, and one on snowmobiles). Only the studies by Towner and Towner (2002), and more recent publications by Vincenten & Mackay (2007) and ENHIS (2007), covered a more comprehensive range of policy and legislation to examine the potential associations with a broader range of child injury types.

We found no international comparative studies which met our inclusion criteria and which focussed on: mass media campaigns (e.g. to support/promote compliance with legislation, regulation or standards); legislation and regulation on the training and education of professionals; or on the use of national monitoring and surveillance systems as a specific stimulus for child unintentional injury prevention policy making.

Fuller details of the subjects, methods and findings of these ten included papers are presented in the Evidence Tables in Appendix 3. They are also discussed in turn in the following sections.

Table 4. Summary of ten included studies by injury setting and type of national policy/strategy

Publication Details	Source of Data for Analysis	Countries / Regions	Setting / Injury Type			Data year or period	Policy/strategy focus					Injury/Outcome data
			Road	Home	Other		Legislation, regulation	Enforcement, compliance	Mass media	Monitoring & surveillance	Workforce support	
Towner et al 2002	Detailed analysis of data collected but not reported in depth within UNICEF Innocenti 2001 study	26 OECD countries	●	●	●	2000 for survey; 1971-75 and 1991-95 for fatal injury data	●	●				UNICEF injury league table position
Christie et al 2004	New survey across OECD countries plus analysis of IRTAD	21 OECD countries	●			2003 for survey data 1996-2000 for fatal injury data	●					Survey data on availability of exposure to risk Exposure adjusted injury rates Travel behaviour
Christie et al 2007	Further discussion of Christie et al 2004 report w	9 countries (incl. UK) where exposure data were available	●			2003 for survey data 1996-2000 for fatal injury data	●					Survey data on availability of exposure to risk Exposure adjusted injury rates Travel behaviour

Publication Details	Source of Data for Analysis	Countries / Regions	Setting / Injury Type			Data year or period	Policy/strategy focus					Injury/Outcome data
			Road	Home	Other		Legislation, regulation	Enforcement, compliance	Mass media	Monitoring & surveillance	Workforce support	
Bly et al 1999	Original survey data plus use of official death and serious injury data	Great Britain, France, the Netherlands	●			Survey: May 1998-April 1999 Injury data:12 to 24 months in 1996-1997	●					Exposure to risk Survey (e.g. crossing activity)
Bly et al 2005	Further analysis of data collected in Bly et al 1999	Great Britain, France, the Netherlands	●			Survey: May 1998-April 1999 Injury data:12 to 24 months in 1996-1997	●					Exposure to risk Survey (e.g. crossing activity)

Publication Details	Source of Data for Analysis	Countries / Regions	Setting / Injury Type			Data year or period	Policy/strategy focus					Injury/Outcome data
			Road	Home	Other		Legislation, regulation	Enforcement, compliance	Mass media	Monitoring & surveillance	Workforce support	
Mackay & Vincenten, 2007	New collation of data on practice and policy. WHO Mortality Database	18 European countries	●	●	●	Practice and policy: 2006 2001 – 2003 Mortality data (or latest available if earlier)	●	●				Child injury fatalities
WHO Centre for Environment and Health, 2007	National expert survey	23 countries in the WHO European Region (excl UK)		●	●	2006	●					*Not collected*
Helmkamp, 2001	ATV fatality rates from CPSC. State specific safety requirements from Speciality Vehicle of America's Annual List	All US States			●	1990 – 1999	●					ATV-related child fatality rates
Keenan & Bratton, 2001	State Trauma Registries. Fatality data from CPSC	2 US States			●	January 1997 – July 2000	●					Helmet-wearing rates and head injury rates

Publication Details	Source of Data for Analysis	Countries / Regions	Setting / Injury Type			Data year or period	Policy/strategy focus					Injury/Outcome data
			Road	Home	Other		Legislation, regulation	Enforcement, compliance	Mass media	Monitoring & surveillance	Workforce support	
Rice, 2001	Injury and fatality data from CPSC	18 US States			●	January 1990 – April 1998	●					Helmet-wearing rates and head injury rates

Can differences in legislation, regulation, enforcement and compliance help explain differences in child injury rates between countries?

Good quality data on the occurrence of injuries by different environment/product user groups, locations, specific risk factors, combined with information on the level of exposure to risk can help in the development of policies and programmes to reduce child related injuries. As part of the review we also sought to identify studies that looked at international comparisons of the monitoring and evaluation of injuries in children as a way of influencing policy and practice. This included not only routine monitoring and surveillance of injuries used to influence policy and practice, but also any explicit attempts to analyse the impact of legislation, regulation, enforcement and compliance on childhood injury rates and safety behaviours.

The **UNICEF Innocenti Report** which provided a 'league table' of child injury related deaths in OECD countries, reported that more than 40% of all deaths were attributable to accidents (UNICEF, 2001). Substantial variation between these countries was reported on this league table, with death rates in New Zealand, the USA and Portugal being between two and three times greater than those observed in Sweden, the UK, Italy and the Netherlands.

One aspect of this work was further discussed and expanded on in a paper prepared by those contributors to the UNICEF report responsible for the collection of information on the use of legislation used in the report (**Towner and Towner, 2002**). Only a very basic table (Figure 9 of the UNICEF report) showing whether legislation had been implemented was shown – no data were provided on strength of enforcement of legislation. This follow up paper therefore provided much more detail than previously shown in the UNICEF report on the use of legislative measures up to the year 2000 and also considered whether those OECD countries with the widest range of child safety legislation and strongest levels of enforcement had made the most progress in reducing child injury related deaths since the 1970s. Furthermore it looked at whether these countries fared well on the UNICEF league table of injury related child deaths. The presence of legislation in respect of specific injury prevention interventions previously identified in systematic reviews as being effective was documented: bicycle helmets, child safety seats/restraints, seat belt wearing by children, speed limit in urban areas, child resistant packaging/pharmaceuticals,

smoke detectors in homes, barrier fencing in domestic swimming pools, child banned from riding/driving tractors, and the adoption of playground design and construction standards. A national expert in child injury prevention from each country gave a subjective opinion on the strength of enforcement of legislation in each country. Data were obtained in 26 of 29 OECD data countries; data were not obtained from Denmark, Mexico or Poland. Of the 26 countries which provided information, Australia, New Zealand, Canada, USA, Iceland, and Norway had legislation in place for seven areas, while Sweden covered eight areas. Three countries Greece, Hungary and Turkey only had legislation in place covering three of the ten areas.

This study concluded that there is substantial use of legislation in terms of key measures of road safety: all 26 countries had national or sub-national legislation on seatbelt wearing by children and also for speed limits on roads in urban areas. Although twelve countries had playground standards legislation, in other areas legislation or regulation was much more limited: only six countries had rules governing smoke alarms in the home, while seven had legislation on poolside fencing. No clear pattern emerged when looking at the extent to which countries with the most legislation did well in the UNICEF injury-related death league table. The country with the most extensive use of legislation, Sweden, also had the lowest rate of deaths, while Norway was also in the top 5. However, other countries with much safety legislation lay near the bottom of the table Australia (16th), Canada (18th), New Zealand (22nd), and the USA (23rd). Moreover, Germany, the country with the greatest rate of decrease in child injury related deaths when comparing deaths in 1991-1995 with the period 1971-1975, only had laws in place covering five of the ten areas identified as amenable to legislative intervention. Of the high legislators, only Canada, Norway and Sweden were in the top ten child injury reducing countries. In conclusion Towner and Towner argued for further research into injury related legislation and emphasised the importance of obtaining contextual information to help better understand the links between legislation and injury prevention.

The **European Child Safety Alliance (ECSA)**, in partnership with the EU, WHO Regional Office for Europe, the UNICEF Innocenti Research Centre and non-governmental organisations have produced a series of Child Safety Report Cards

which map the existence of evidence based policies to support child and adolescent safety (ages 0-19) in the European Union (MacKay and Vincenten, 2007)[3]. The 2007 report covered nine injury prevention policy areas relevant to the scope: pedestrian safety, cycling, car occupancy, water safety/drowning prevention; fall prevention; burn prevention; accidental poisoning prevention; accidental choking/strangulation prevention. Countries received a score ranging from 5 to 0 depending on the extent to which they had implemented evidence-based safety policies. Experts provided a judgement on the extent to which laws have been enforced. Country scores were then been compared with age-standardised rates of child and adolescent (0-19) fatal injuries observed across Europe. These fatality rates are however not adjusted to take account of differences in exposure to risk.

There was thus little relationship to be observed between countries scoring well in terms of the implementation of safety measures and those that had low child fatality rates. Looking at child pedestrian safety in 15 countries (including Northern Ireland and Scotland), Germany had a score of more than 4 yet was fourth highest in the death rate table. In contrast the only other country to score as highly was Denmark, which came tenth in terms of death rates. Poland which had an above average safety score had the second worst death rate. Again, when looking at policies to promote safe cycling, no relationship could be observed between fatality rates and national “safety policy scores”. (Table 5)

[3] At the time of writing the Child Safety Report Card work is currently being updated. 27 country partners (- including all four UK constituent countries) have completed updated assessments to July 2008. Updated ‘Report Cards’ and profiles and a European summary were due to be released in April 2009.

Table 5. Traffic-related Safety Scores and child fatality rankings

Topic/Average Safety Score	Top five performing countries on cause-specific child fatality league	Topic Safety Score
Motor Vehicle Passengers and Drivers (3/5)	Austria (best)	2.5
	Czech Republic	3.5
	Netherlands	3
	Poland	3.5
	Germany (5th best)	3
Child Pedestrian Safety (3/5)	France (best)	3
	Sweden	3.5
	Austria	3
	Germany	4
	Netherlands (5th best)	3.5
Child Cyclists (3/5)	France (best)	3
	Portugal	1.5
	Austria	1.5
	Spain	2
	Sweden (5th best)	5

For areas other than traffic related accidents, when comparing safety card scores to the best ranking of countries in terms of age-standardised fatality rates, again there was no obvious correspondence to the implementation of measures for water safety, burns or choking/strangulation prevention (Table 6). For poisoning, the study notes, Sweden and the Netherlands with 4 or 4.5 scores out of 5 were also good performing countries. However while Northern Ireland achieved 5 stars, it had one of the highest fatality rates (4th from the bottom). Fall prevention scores more closely correspond to rates of deaths due to falls than other injury issues. The authors suggest the general lack of correspondence between safety measures and injury rates may be an artefact of differing degrees of exposure to risk and variations in levels of implementation and enforcement. Average safety scores for non-traffic related areas were low, being no more than 2.5 out of 5, reflecting the low level of measures introduced with comparatively few countries introducing regulations and laws.

Table 6. Non-traffic-related 'Safety Scores' and child fatality rankings

Topic/Average Safety Score	Top five performing countries on cause-specific child fatality league	Topic Safety Score
Water safety (2/5)	Portugal (best)	0.5
	Scotland	1
	Northern Ireland	1.5
	Netherlands	2
	France (5th best)	2.5
Choking (2/5)	Sweden (best)	3
	Spain	0.5
	Denmark	2.5
	Austria	2
	Northern Ireland (5th best)	2.5
Burns (2/5)	Portugal (best)	0.5
	Italy	1
	Greece	0.5
	Netherlands	3
	Czech Republic (5th best)	1.5
Poisoning (2.5/5)	Netherlands (best)	4
	France	3.5
	Germany	2.5
	Portugal	1.5
	Italy (5th best)	1.5
Fall prevention (1.5/5)	Northern Ireland (best)	3
	Sweden	2
	Denmark	2
	Netherlands	2.5
	Scotland (5th best)	1

Another comparative assessment of national policies on unintentional injuries (excluding road traffic injuries) in children and adolescents (age 0 – 19) was undertaken as part of the **European Environment and Health Information System Project (ENHIS)**. It used survey data from 23 countries in the WHO European Region (WHO European Centre for Environment and Health, 2007). Scores out of 24 were given, covering 12 key policies for the prevention of injuries across the same five areas of non-traffic related injury prevention (burns, choking, poisoning, drowning and falls) used in the ECSA Child Safety Score Card system. Using this scoring

system national policy efforts across Europe are moderate. Some specific preventive policies have been implemented in all reporting countries, but no country has adopted or is fully implementing and enforcing all 12 policies considered in this indicator: overall scores ranged from 18 in Belgium to just 3 in Albania – the UK did not provide data. Again no consistent trend was observed between countries with poor levels of policy implementation and mortality rates from poisoning and drowning.

The findings from these broad studies looking at the role of legislation and regulation in helping to explain differences in child injury rates all suggest that simply replicating policies and programmes already implemented in countries with low child injury fatality rates (such as those with the lowest rates in the UNICEF league table) may have variable results. Countries may have low rates of serious injury and fatalities not because their injury prevention strategies are effective, but rather because of fewer children who are exposed to the risk of injury. In some countries, for example, the poor quality of the road infrastructure may mean it might be considered too dangerous for children to walk and/or cycle on urban roads.

In addition to the above studies we note one excluded commentary paper (Ellsasser and Berfenstam, 2000). This compared trends in death rates in Germany with those in four European countries, for those aged 0 to 4 and 5 to 14 years: Austria, Switzerland, the Netherlands and Sweden. It looked at institutional structures and surveillance systems that were in place in these countries in order to improve injury prevention programmes in Germany. It recommended the establishment of a well-funded central organisation to both coordinate child injury prevention measures at a national level and be responsible for surveillance and research. Other recommendations included better collaboration between national and local organisations (both statutory and non-governmental) and the strengthening of child safety legislation including consumer product safety controls. Studies can also be identified at a local level. Work in Sweden, for instance, has compared the development across municipalities of safety policies for children in adolescents in four settings: general, road, pre-school and school leisure (Guldbrandsson and Bremberg, 2004). Municipalities with more active and multi-measures safety promotion policies were associated with lower rates of childhood injury differences in childhood injuries than municipalities with few safety measures (Sellstrom et al., 2003).

Use of exposure data in road traffic safety studies

Studies have been commissioned by national governments and international agencies to collect data at an international level to determine how adjustments for exposure might help to explain differences in injury rates between countries and thus influence policy. The English Department of Transport commissioned an international survey of policy and practice on child road safety across OECD countries with the aim of examining factors that may have a role in explaining differences in child road traffic fatality rates between countries such as differences in exposure, a country's demographic and socio-economic indicators, road safety policy and practice and legislation and research (**Christie et al., 2004**). It was intended to complement an expert review on road safety being prepared by the OECD (Organisation for Economic Cooperation and Development, 2004).

The Christie et al study mapped the availability of different injury prevention interventions and observed the extent to which those countries that had most measures had lower rates of traffic related child fatalities. In relation to children as pedestrians, most top performing countries (the top five in the survey) had introduced traffic calming measures such as 30 kph speed limits, road modifications and signalised crossings in most local authority areas, many also had traffic calming measures outside schools, had parks or playgrounds in most residential areas, and legislation placing responsibility on drivers for pedestrian accidents. This distinguished them from more than half of the remaining 15 countries. Top performing countries in respect of bicycling could not be determined because of the small number of cyclists and very different uptake of cycling across countries; however it was noted that the Netherlands, which has one of the lowest rates of exposure-adjusted fatality from cycling, has one of the most extensive networks of cycling infrastructure. Although not the focus of this evaluation, well performing countries also had high rates of seat belt wearing compliance, could identify high-risk sub-population groups and had mandatory use of seatbelts in school buses. Only one of the overall top performers, the UK, had set casualty reduction targets for child injuries. Four of the top five (Sweden, UK, Norway and Germany) had a national plan in place for child traffic safety for more than ten years. The Netherlands did not have a plan.

The importance of taking account of risk of exposure data to traffic injury data was also discussed in a further commentary on the **Christie et al 2004 study** (Christie et al., 2007). Of 21 OECD countries that participated in the Department of Transport survey discussed above (Christie et al., 2004), this paper further highlighted that only eight had sufficiently comparable information that could be used to adjust International Road Traffic Accident Database (IRTAD) fatality rate data, to take account of exposure. Even here the lack of data meant that the analysis had to be restricted to children aged between 10 and 14. Adjustments to take account of exposure were shown to alter the ranking of countries on the 'death league' when looking at pedestrian, car occupant and bicycle related fatalities. For instance, the US overtakes the UK in terms of pedestrian fatalities; and Germany becomes markedly less safe in terms of car occupancy. However the adjustment using exposure to risk of death while cycling "entirely alters the classification of countries as good and less good": of the eight countries, the Netherlands which had the highest unadjusted fatality rate has the lowest fatality rate when adjusted by average number of kilometres travelled per annum by cyclists aged 10-14 years.

Christie et al thus concluded that there is a need for an international standard to be developed to allow more consistent comparisons of travel data to be made. Exposure data may help further if, as demonstrated in a comparative analysis of child pedestrian safety in Great Britain, the Netherlands and France, it takes into account contextual differences in exposure. For instance, looking at the road environment (e.g. on which roads children walk) or behavioural factors (e.g. likelihood to use a marked crossing) (Christie et al., 2007).

Bly and colleagues (1999) sought to identify reasons why child pedestrian injury rates in Great Britain were substantially higher than those in France and the Netherlands, despite GB's overall good safety record (Bly et al., 1999). To quantify differences in the level of exposure a survey was undertaken in 25 different geographical areas in all three countries to identify all travel-based activity on the previous day, including routes, modes of travel and amount of time spent travelling using a travel diary. Approximately 1,000 children in each country were interviewed between May 1998 and April 1999 to provide a representative range of socio-economic and demographic characteristics. Days for which children's travel patterns

were recorded were chosen to be representative of the actual number of days that either fell on the weekend, in term time or on holiday weekdays.

Interviewers then walked random parts of walking (or in-line skating) activity routes to categorise them in terms of road environment, number of roads to be crossed and time taken for journeys. They also examined a representative sample of accident sites, including all those where a child was killed in the previous year, plus others where serious injuries were sustained in each of the three countries. The aim was to allow both exposure and accidents factors to be compared in a consistent way, and related to a wide range of relevant aspects of the roads and traffic. Deaths and serious injury data in the three countries were obtained for a twelve month period in 1996 between 1997 from the STATS 19 database in Great Britain and the Centre d'Etudes Techniques de l'Equipement in France. Official ministry of transport data for the two years 1996 and 1997 were obtained in the Netherlands. Rates of injury were adjusted by exposure in order to produce an "expected" accident rate if each road environment carried the same risk in all three countries. Comparison of this "expected" rate with the actual rate then would indicate what proportion of the overall differences between countries would be due to differences in the distribution of exposure, as distinct from differences in risk between the countries for a given environment.

Overall levels of exposure, measured in time or in road crossings were found to offer no explanation for higher injury rates in GB. The study reported that the amount of time children (gender not significant) spent near roads was similar in all three countries, with the number of road crossings in GB at all ages being slightly lower than in the other two countries. The estimated risk per unit of exposure (either in time or by road crossing) for both males and females, and in different age groups, was though statistically significantly higher ($p \sim 0.05$) in GB compared to the Netherlands, with the exception of risks per exposure time for males aged 10-11. It was also significantly higher than that in France for males aged 5-9 (by both time and road crossings) and for boys aged 12-15 (by time only) ($P \sim 0.05$).

The distribution of exposure across **different types of road** was very different in the three countries. Much more time was spent by children near main through roads in GB, while French children spent around half their time near local distributor roads,

and little on local “residential” roads. Children in the Netherlands spend little time or crossing activity on main through-roads and more time on local residential roads, where long-established traffic calming measures are in place.

The study estimated that the differences in exposure to different types of road, most notably with GB children spending 69% of their time near major roads compared to just 19% in the Netherlands and 41% of time France, can explain about 34% of the difference between the overall accident rates in GB and the Netherlands (54% of 157%), and 19% (13% of 70%) of the difference relative to France. (see Table 7)

Table 7. Expected accident rate due to different distributions of exposure by road type at overall average risk for each type

Road Type	Great Britain		France		Netherlands	
	Time	Crossing Activity	Time	Crossing Activity	Time	Crossing Activity
	%	%	%	%	%	%
Main through road	0.69	0.73	0.41	0.48	0.19	0.16
Local distributor road	0.14	0.11	0.45	0.47	0.12	0.11
Local residential road	0.24	0.24	0.09	0.08	0.29	0.29
Local non residential road	0.01	0.03	0.01	0.00	0.09	0.06
Cul-de-sac	0.02	0.03	0.02	0.01	0.01	0.02
Other	0.02	0.01	0.01	0.00	0.02	0.05
Sum of "expected" CPA fatality rates on all road types	1.13	1.19	1.00	1.08	0.73	0.71
(% of NL rate)	(154%)	(169%)	(138%)	(153%)	(100%)	(100%)
Average CPA fatality rate per head (1997) (% of NL rate)	1.39		0.82		0.54	
	(257%)		(152%)		(100%)	

Source: (Bly et al., 1999)
Estimated fatal accidents per year per 100,000 children
CPA = Child Pedestrian Accident ; NL = Netherlands

Even though less time is spent on **local distributor and residential roads** in GB, the relative risk in terms of exposure time is significantly greater (P~0.05) than in the Netherlands, but not significantly different from France. Looking at relative risk for different **road type crossing exposure**, this is significantly greater (P~0.05) in GB compared to the Netherlands (for local distributor and residential roads) and France for local distributor roads.

Differences in crossing activity were found to account for 44% of the difference in overall accident rates between GB and the Netherlands, but only 15% of the difference with France. Children in the latter two countries were more likely to be near roads where traffic is travelling "slower than most traffic in towns". The greater exposure of children in France and the Netherlands to **lower speed limits accounts** for about 40% of the difference in Britain's overall accident rate relative to France for both time and crossing activity exposure, and for 30% (time) and 20% (crossing activity) of the difference relative to the Netherlands.

The study also looked at where children are likely to cross roads. Children in France were more likely to use a marked crossing, and much less likely to cross away from a junction (no significance provided). Hypotheses put forward for this were a higher density of marked crossings on French streets or perhaps the higher penalties imposed on jaywalkers. In GB and the Netherlands the risks associated with an unmarked crossing were significantly lower than for marked crossings. In France, conversely, unmarked crossing activity is associated with a significantly higher risk than marked crossing activity. Moreover, the risk on marked crossings in Britain increases from main roads to local roads, suggesting that the design and performance of local crossings should be examined more closely.

While the survey reported a greater (and statistically significant) prevalence of calming measures in the Netherlands compared with Britain or France: traffic calming measures were available in about half of all time and crossing exposures, while in Britain and France these were available in only 15% of time exposures and 10% of crossing exposures.

In conclusion, the analysis also recommended further investigation into the impact of traffic calming measures to inform future traffic safety policy. This was not feasible in the study because nearly half of all traffic calming measures at accident sites had been installed after accidents, whilst data on timing of installations in Netherlands and France was not available. The authors did though speculate that “special measures may play a substantial role in reducing the Netherlands overall accident rate, perhaps accounting for a third of the gap between the countries.”

Further analysis of this dataset was subsequently undertaken to further help inform child pedestrian safety policy in GB (**Bly et al., 2005**). This additional analysis focused on safety behaviours in the patterns of exposure to risk by socio-demographic characteristics and type of activities: e.g. journeys to school, journeys to and from visiting friends, and playing/hanging around in the street.

In terms of exposure data, few distinct trends across the socio-economic groups in the percentages of children walking were observed, although in GB fewer children in the highest social class group (AB) walked compared to the lowest (DE) group. In the

Netherlands the trend goes in the opposite direction. It was not possible to look for statistically significant differences by ethnicity because of small sample numbers.

The results of this study show that children in Great Britain are significantly more likely (statistical significance not reported) than children in the other two countries to walk to school along more major through roads, with higher traffic volumes and faster traffic, and they are less likely to be subject to speed limits lower than the standard urban limit. There was a trend toward lower social classes being more likely to walk to school in GB and France but not in the Netherlands. The exposure of British children to major roads and busy roads when visiting friends is much less than it is for overall pedestrian activity, and is much more similar to that in the other countries. However, the greater likelihood of being in environments with low speed limits in other countries persists. Traffic calming measures were in place for 54% of journeys to school in the Netherlands, compared with just 19% in GB and 11% in France. Evidence from other GB studies is also consistent with findings of this report.

Evidence statement 1: There remains a lack of comparable and in depth exposure to risk information to help in analysis of the relative impact of different legislative, regulatory, enforcement and compliance interventions (Towner and Towner 2002 +; Christie 2007 +; Christie et al 2004 +).

Evidence Statement 2: Two ecological studies (Mackay and Vincenten 2007 +; ENHIS 2007-) in high income countries were unable to associate variations in child morbidity and/or mortality rates across countries to differences in legislation, regulation, enforcement and compliance for road environment modification, road design, home and leisure environment interventions. However for road safety, evidence from two ecological studies, one of moderate quality and the other strong, (Christie et al 2004+; Bly et al 1999 ++) suggest a weak trends towards better performing countries (in terms of child fatality rates) having more road environment modification and road design measures in place.

Evidence Statement 3: Evidence from one well-conducted ecological study (Bly 1999 ++) indicates that differences in the distribution of exposure in the road environment for child pedestrians (in particular relating to time spent near busy main roads) can explain some of the difference in severe child injury and fatality rates between Great Britain and two other northern European countries, France and the Netherlands

The prevention of road-related child injuries

International comparisons of specific road modification measures

There are three inter linked components of a dynamic road safety system: road user, the vehicle and the road infrastructure (Runyan, 1998). A wealth of literature is available on effective interventions targeted at the first two areas: in terms of regulatory and legislative interventions there are a number of international/region comparative studies conducted looking at the effects of mandatory seat belt, bicycle helmet and child seat restraint use (Peden et al., 2004).

However, this review focuses on the latter component, what in the Haddon matrix would be classified as pre-crash environmental interventions, such as using good road design and traffic calming/management measures as a way of reducing population road related injuries. Road environmental modifications can include the use of various markings and signing, specific speed control zones, the installation of pedestrian crossings and traffic calming measures. The latter can include speed humps, the use of roundabouts, traffic lights, curved roads, road narrowing and pedestrian refuge islands (Retting et al., 2003). Compliance with speed limits may be enhanced by both hidden and visible use of speed cameras/radar devices.

While we did not find additional comparative studies focusing on one of these specific measures alone, it should be noted that we did however find evaluations of the effectiveness of interventions at a smaller area level e.g. for towns and municipalities. For traffic calming interventions at a local level, we identified several studies, including one looking at cities in Wales (Jones et al., 2005), and another on municipalities across Sweden (Leden et al., 2006). Other studies have compared the impact of 20mph speed zones in different parts of England (Webster and Layfield, 2007, Webster and Mackie, 1996)

A number of studies that have undertaken comparative analysis of policy and practice in road safety were excluded from our main review. The **SUNflower study** assessed the background to road safety strategies in Sweden, Great Britain and the Netherlands and looked at trends in traffic related fatalities between 1980 and 2000 (Koornstra et al., 2002). However there was no discussion of the direct impact on child fatalities, other than in respect of the use of seat belts and child seat restraints. A follow up 'SUNflower +6' study that covered an additional nine countries, while providing more age-specific background information, also did not provide data on the impacts of differences in road safety policy on child-injury rates, other than in respect of seat belts, child seat restraints and bicycle helmets (Wegman, 2005, Eksler et al., 2005, Hayes et al., 2005, Lynam et al., 2005).

In 2004 the **OECD Expert Group on Child Injury Prevention** also produced a report reviewing current practice and putting forward recommendations for policy and practice; it does not though undertake any original analysis to look at factors influencing differences in injury outcomes across countries (Organisation for Economic Cooperation and Development, 2004).

The **first three year evaluation of the Road Safety Strategy in Great Britain** (Department of Transport, 2004) did not assess whether the introduction of targets in themselves acted as a catalyst for change. It simply reported changes in fatalities, serious injuries and minor injuries for both adults and children across GB, reflecting on various policy documents that had been developed and different national and local schemes initiated. Compared with a 1994-1998 baseline child fatalities and serious injuries had decreased continually for two road user sub-groups: pedestrians and cyclists, whereas for car passengers there had been a levelling off in injury rates by 2001 and also little change in deaths and serious injuries for other road user groups (e.g. coach, bus passengers). Overall there had been a 33% reduction in deaths in serious injuries compared with the baseline, however there was no breakdown or comparative analysis provided of progress in the three countries: England, Scotland and Wales. An earlier report, focusing solely on child injuries, again only provided statistics at a GB level, although it did provide detailed information on policy development and actions in each of the three countries (Department of Transport, 2003).

Evidence statement 4: No international comparative studies of specific road design and road modification interventions that focused on child injury prevention were identified; area wide comparative studies at a local level were identified, but excluded from this review.

Home safety equipment and home safety assessments

In addition to the **Mackay and Vincenten** and **WHO ENHIS** studies we sought to identify international comparisons of legislation and regulations in respect of specific types of home safety equipment, including smoke alarms, hot water temperature restrictors, stair gates and oven, window and door guards and locks. Again we found it difficult to find studies that focused specifically on the role of legislation or regulation in increasing the use of such appliances. We consulted with one expert on the use of legislation in respect of housing and health (David Ormandy) who suggested that little information existed in this area. In terms of legislation governing general standards of housing health and safety England appears to be unique in having local authorities independently rate the health of housing stock provided by landlords (Burridge and Ormandy, 2007, Department for Communities and Local Government, 2006) including on criteria such as risk of burns and scalds to vulnerable population groups.

Turning to specific interventions, and taking the case of smoke alarms: it is clear that several countries and US States have had legislation in place for some time regarding the use of smoke alarms, particularly in respect of new build properties (ISCAIP Smoke Detector Legislation Collaborators, 1999). However we were unable to find any studies that looked at the impact of legislation across countries. The only study we identified through citation searching of one paper (Warda et al., 1999) was a 1985 study which compared one US county with legislation for retrospective fitting of smoke alarms in existing homes, with another US county where legislation applied only to new houses or apartments (McLoughlin et al., 1985). We did though identify comparisons between US States of interventions to influence the uptake and installation of smoke alarms including the use of long life alarms, financial incentives such as subsidies, voucher schemes or giveaways, or education and counselling campaigns not linked with legislation (Ballesteros et al., 2005, Harvey et al., 2004). Similarly, we could not identify comparative analysis of regulations and legislation

regarding hot water temperature regulators, although before and after studies in a single jurisdiction are available (Erdmann et al., 1991, Leahy et al., 2007)

One excluded study identified looked at the impact of legislation to lock windows on rates of child and adolescent falls (Pressley and Barlow, 2005). This was excluded from our analysis because it did not meet our inclusion criteria for geographical areas. This study compared differences in patterns of injury for children up to age eighteen resulting from falls from buildings and structures in the five boroughs of New York City where enforced window guard legislation was in place with upstate New York where no legislation existed. It concluded that legislation on the use of window guards is associated with a reduction in injury rates and should be made mandatory.

Turning to the role of home safety assessments, again studies exist on the association between home safety assessment and childhood injuries (Kendrick et al., 2007, King et al., 2001, King et al., 2005), but again we could not find any international comparisons of legislation or regulations on the provision or availability of home safety assessments. One near miss, because the intervention fell beyond the scope of this review, relates to differences in the enforcement of housing legislation intended to reduce the risk of lead poisoning. Differences in child lead poisoning in two US states were associated with differences in the degree of enforcement of legislation (Brown et al., 2001).

Evidence statement 5: No international comparative studies of specific home safety equipment were identified; area wide comparative studies at a local level were identified in some areas but excluded from this review. No international comparative studies looking at the role of regulation and legislation for home safety assessments could be identified.

Leisure-related injuries

Rules and regulations governing sports have long been argued to help reduce child injuries (Watson, 1984). However, few studies in the area of sports and leisure met the terms of our inclusion criteria, although in some respects this may reflect the fact that rules and regulations set by governing bodies may not be subject to the same degree of evaluation as in other regulatory environments. Moreover, rules may be set internationally in the case of some sports, which may reduce the scope for

comparisons of differences in regulations with regard to protective equipment. For example, regulations of the International Rugby Board, the governing body for world rugby, have set criteria governing the type of head gear and shoulder pads that might be worn and making it mandatory for all players to use mouthguards (International Rugby Board, 2008). In the US the American Dental Association produces guidelines on the sports for which mouthguards are recommended for children and adults (American Dental Association, 2009), while the American Academy of Pediatricians (AAP) has issued guidelines recommending limits on body checking in ice hockey players aged 15 and under as a way of reducing injuries (2000). We have not, however, found any studies looking at how differences in compliance with such guidance and governing regulations for sports have impacted on the risk of injuries across countries, although there has been some general discussion of differences in the use of mouthguards by ice hockey players in schools in the USA and Canada (Castaldi, 1993).

Studies have identified playground design and construction as risk factors for child injury (Mitchell et al., 2007, Gunatilaka et al., 2004, Sherker and Ozanne-Smith, 2004, Norton et al., 2004, Mott et al., 1997). We noted at EU level regulations EN 1176 and EN 1177 provide guidelines on playground equipment, freefall height and surfaces. Both regulations are however only advisory and not a legal requirement, for instance recommending against the installation of playground equipment more than three metres high and to use soft surfacing on the ground (ROSPA, 2004). We could not identify any studies to date that look at differences in rates of playground-related child injuries alongside differences in the degree of compliance or enforcement of this EU-wide regulation. However, within one jurisdiction, studies can be identified which suggest a link between stricter standards of playground safety and a reduction in injuries, as for instance noted in Ontario (Howard et al., 2005). Monitoring and surveillance mechanisms may be needed to help enforce compliance with regulation – one study in New South Wales, Australia found that less than 2% of playgrounds examined fully complied with safety guidelines (Witheaneachi and Meehan, 1997).

While no international comparisons could be identified, the effectiveness of **legislation on swimming pool fencing** to prevent child drowning has been examined by a number of studies, predominantly relating to the situation in specific Australian States (Thompson and Rivara, 2000). We identified two studies that were

close to meeting our inclusion criteria. One looked at differences in enforcement measures and rates of compliance with legislation on fencing for swimming pools in three municipalities in the Australian State of New South Wales. It concluded that compliance with the law was weakest in areas with little routine monitoring and inspection (van Weerdenburg et al., 2006). A similar approach was used in an assessment of differences in enforcement procedures re pool fencing legislation across 64 of the 74 local authorities in New Zealand (Morrison et al., 1999). This study also suggested that differences in the strength of enforcement and monitoring procedures, along with difficulties in interpreting the law have contributed to variations in compliance nationwide.

There has also been some analysis of the impact of legislation and regulation on access to fireworks by children, but we were unable to identify any international comparative analysis. Single jurisdiction studies that we identified do not provide a consistent finding in respect of firework controls. One small scale study which look at the impact of the easing of very restrictive controls in Northern Ireland did not report any substantial increase in firework related accidents (Fogarty and Gordon, 1999) while another reported an increase in serious eye injuries (Chan et al., 2004). A statistically significant increase in firework related injuries was however reported following the introduction of more restrictive legislation in 2002 in Northern Ireland (Campbell, 2005). In England the authors of another small scale study in Newcastle concluded that legislation restricting the sale of fireworks to the weeks around November 5th did have some impact in reducing risk of injury (Edwin et al., 2008). But as experience in the Republic of Ireland indicates, legislation alone can be ineffective in preventing all firework related injuries, as there may be relatively easy access to illicit (often inferior quality) fireworks (Jones et al., 2004).

Preventing injuries in off-road leisure vehicles

One area of attention for children's sports and leisure injuries concerns **all-terrain vehicles** (ATVs), commonly called 'quad-bikes' in the UK. The use of quad bikes has come under some scrutiny following a number of child related accidents, involving the deaths of children as young as seven in Northern Ireland (BBC News, 2007). Legally in England children aged 13 can ride quad bikes on private land after they have received formal training; they can only be used on public roads by those aged

16 or over but little is known about how well legislation is enforced (Anonymous, 2008). In Ireland, increased recognition of the risks to children from ATVs has led to calls for the introduction of legislation to ban their use by the under 16s (Curran and Leary, 2008).

Several studies from the United States provide an indication of the role of legislation in helping to reduce injuries to children arising from the use of off-the-road leisure vehicles. According to the US Consumer Product Safety Commission in 2002, more than one third of total ATV related mortality occurred in children aged 16 and under. Two studies looked at the relationship between variations in child injury rates and differences in legislation across US States. **Helmkamp** provided a comprehensive overview of the current status of safety legislation in place across all US states (Helmkamp, 2001). The whole population (age 0-84) was divided into four age groups, including children aged 1-16. States were placed in one of three groups: helmet and other safety equipment required; machine related requirements but no helmet requirements; no legislation. The correspondence between individual state ATV-related fatality rates for those aged 16 and under and the use of legislation was mixed; but this may be due to the small number of deaths.

When looking at overall mortality rates in the entire population, in states without safety legislation the fatality rate was approximately double that of the other two groups of states with safety legislation (0.17 deaths versus 0.08 and 0.09 deaths respectively per 100,000). The death rates for boys aged 16 and under in the first group with helmet law and other safety equipment required ranged from 0.06 to 0.61, for the group with machine related requirements these ranged from 0.11 to 0.81, while for no legislation group they ranged from 0.14 to 1.04. Overall, for the population as a whole there was a clear association between an improvement in death rates and some use of safety legislation, although the authors acknowledged the limitations in the quality of the injury fatality data used.

Another ecological study focused on the use of helmets by children aged 15 and younger riding ATVs in two US States, one with and one without a helmet law **(Keenan and Bratton, 2004)**. In the study head injury data were taken from trauma registries and fatality data linked to ATVs were obtained from the US CSPC but no information on exposure to risk was used.

The study suggests that legislation appears to be effective in influencing safety behaviour. Pennsylvania has had a helmet law for ATVs in place since 1985, while North Carolina has no such laws; living in North Carolina was an independent predictor for not wearing a helmet. A statistically significant higher rate of helmet use by children was reported in Pennsylvania (35.8%) compared to North Carolina (16.7%), ($p<0.001$); previous studies support helmets as a way of reducing serious head injuries.

Another example of analysis of the impact of legislation and regulation on the use of off-the-road vehicles is a study on snowmobiles. Clearly opportunities for using snowmobiles in the UK are limited to a small number of areas which regularly have significant snowfall (e.g. there is a snow mobile dealership serving Aberdeenshire and Pershire) (see http://www.yamaha-motor.co.uk/products/snowmobiles/authorised_snowmobile_dealer.jsp) Children accompanying their parents on winter holidays may also have the opportunity to use the vehicles.

In the US where winters can be harsh, **snowmobiling** is a popular sport for children. However given the heavy weight, size and speed of snowmobiles, they can increase the risk of serious injury and death. Snowmobile legislation, including legal age restrictions on operation alone on public and/or private property and the use of helmets has a potential role to play in reducing the risk of injury. One review identified eighteen states where there had been at least one child death between 1990 and 1998 **(Rice et al., 2000)**. It looked at whether long standing guidelines issued in 1988 from the AAP), and which recommend that no-one under the age of 16 should use a snowmobile, had been implemented. Using data from the US CPSC National Electronic Injury Surveillance System, legislative arrangements in the five states with the highest child death rates (Minnesota, Wisconsin, Michigan, Alaska and New York) were identified. None of these complied with the AAP guidelines despite the high number of deaths. Alaska had no restrictions at all; while those over the age of 12 (over 10 in New York) could ride a snowmobile on public property; only three required the use of helmets (Rice et al., 2000). The authors did however note that injury data need to be treated with caution as there may be under reporting of death rates from such injuries on death certificates across states, and there was no information is available to adjust fatality rates to take account of exposure to risk.

In conclusion, there is a great need for regular and consistent injury surveillance systems to make study results more representative and applicable to other settings. For example, none of the three studies took exposure information into account, which makes their results less conclusive. Moreover, the three studies did not provide much information on the time period for the actual implementation of the safety laws/legislation. Analyses were retrospective, first looking at data on death rates or fatalities and then investigating what had been done for the data collection periods. There is much room for more studies exploring the effectiveness of particular safety measures. Making use of proper baseline information, and data on exposure to risk of injury would need to be taken in account in effective policy planning, implementation and monitoring, which will help in turn to feed into the cycle of the future policy making process.

Evidence statement 6: Few international comparative studies looking at the role of legislation, regulation, enforcement and compliance in preventing specific leisure related injuries could be identified. One area where studies were identified referred to all terrain vehicles (ATVs). Weak evidence in one ecological study (Helmkamp 2000 -) suggests that US states with legislation to reduce the risk of injury when using all- terrain-vehicles have lower rates of fatal accidents than US states without such legislation. Evidence from another ecological study (Keenan & Bratton 2004 +) suggests that helmet wearing when using ATVs is significantly greater in one US state with a long standing law than in another state without any legislation. ATV related studies are of some relevance to the UK where quad bikes are used and child injuries have been reported. Weak evidence from one ecological study (Rice 2001 -) indicates that legislation in US states with high childhood fatality rates from snowmobiling does not comply with longstanding guidelines which recommend a ban on the use of snowmobiles by the under 17s. Snowmobiles are of very limited direct relevance to the UK, although they are used in the winter in parts of Scotland, while children from the UK may use them elsewhere if on winter holidays.

Monitoring and surveillance systems

Several international databases have been used to provide data on injuries in comparative studies. We have not identified any studies that evaluate the impacts of these databases per se in influencing the development of legislation, regulation,

enforcement and compliance actions across countries. Databases are used to help set and monitor progress towards targets to help reduce child injuries, making use of surveillance data that identifies systematic differences in injury rates across countries (Petridou, 2000, Rogmans, 2000). One analysis, for example, looking at the use of quantified road safety targets in 14 high-income countries and road traffic fatalities over an eighteen year period 1981-1999, albeit not focused on any one population sub group such as children, reported a significant reduction in fatalities after such targets were set (Wong et al., 2006). At an EU level, a Common Road Safety Action Plan has now been adopted. It includes a target to achieve a 50% reduction in road traffic fatalities by 2010. It is being accompanied by a shared information infrastructure (see below) to enable comparison of the road safety performance across the EU and stimulate healthy competition among Member States to outperform each other in a European road safety 'league' (International Transport Forum, 2008).

A number of European directives on safety measures for children do also refer to data from international databases including the European Home and Leisure Accident Surveillance Database. This database has now been subsumed into the publicly available EU Injury Database (IDB) (https://webgate.ec.europa.eu/idb). In addition to home and leisure accidents (HLA), IDB has since 2006 covered injuries from traffic, work place, violence and self harm. The aim is to complement the existing surveillance systems in these areas on a national as well as EU level, e.g. the CARE - Community database on Accidents on the Roads in Europe – (see below). IDB claims that it is 'the only data source in the European Union that contains standardised cross-national data on external causes and circumstances of home and leisure accidents. The data contains unique details on accident mechanisms, accident and injury-related activities, and occurrence and related products, details which can be analysed in relation to type and severity of the actual injury for each record.' In the US a similar function is fulfilled by the Consumer Product Safety Commission's National Electronic Injury Surveillance System (NEISS) (http://www.cpsc.gov/LIBRARY/neiss.html). This provides state level data for use in analysis.

One initiative managed by the OECD/ECMT Transport Research Centre is the International Road Traffic and Accident Database (IRTAD),

(http://internationaltransportforum.org/irtad/index.html) which collates and harmonises national road traffic injury and other road transport data to identify knowledge gaps and to facilitate effective international comparisons. An ongoing development is work to incorporate measures of exposure into the database.

Another cross country database is CARE – (Community database on Accidents on the Roads in Europe). Hosted by Directorate General Transport, European Commission, it claims that it has a higher level of disaggregation than most other databases, i.e. CARE comprises detailed data on individual accidents as collected by the Member States. Work is also underway by the newly established European Road Safety Observatory to set up a European common framework for a set of risk exposure data. (see http://www.erso.eu/safetynet/content/safetynet.htm)

Evidence statement 7: No international comparative studies looking at the role of surveillance and monitoring systems in influencing the use of legislation, regulation, enforcement and compliance interventions could be identified. International databases have though been used as a source of injury data in studies identified (Christie 2004 +; Bly 1999 ++; Mackay and Vincenten 2007 ++). Other reports indicate the use of international surveillance systems to assist in determining and monitoring progress on targets for injury prevention (International Transport Forum, 2008, Petridou, 2000).

Workforce Development

We were not able to identify any international comparative studies looking at the relationship between differences in regulations and legislation on professional qualifications and ongoing training for professionals who come into contact with children and rates of injury. One US study does merit attention. Making use of data from all 50 US States it models the association between differences in regulations across US states on requirements for the education of day care centre directors on fatal and non-fatal accident rates for children in these facilities. Ultimately data are only presented in pooled, aggregated form for the whole of the US rather than at individual US State level, but the study does indicates that tighter regulations are associated with lower accident and fatality rates (Currie and Hotz, 2004).

The European Safety Scorecard also provides some contextual information on workforce capacity across 18 countries (MacKay and Vincenten, 2007). It reported that 16 of 18 countries had capacity building initiatives for child injury prevention, although only two 'reported attempts to comprehensively address basic levels of knowledge in key groups of child and adolescent injury stakeholders'. Only five countries had national networks for the exchange of information on prevention of child injuries.

Evidence statement 8: No international comparative studies looking at the association between the use of legislation and regulation in respect of professional qualifications and ongoing training for professionals who come into contact with children and rates of childhood injury were identified in this review.

4. Discussion and Conclusions

While much evidence has been collected to strengthen the evidence base on child injury prevention (Bunn et al., 2003, Kendrick et al., 2007, Turner et al., 2004, Wilson et al., 2006), there appears to be little cross-national analysis of legislative, regulatory, enforcement and compliance-related policies. Moreover, what is available is dominated by road safety related policies, and much of this focuses on the use of safety belts, other child safety restraints and the use of cycle helmets, all of which are beyond the scope of this review.

In part this is unsurprising, as many legislative and regulatory decisions are made not at a national (or state level in the case of federal countries), but rather at local level; implementation may also be the responsibility of a number of different sub-national stakeholders (Towner et al., 1998). In the case of England, while policies are issued through the different Ministries, more than 300 local authorities are charged with their implementation, while in France the Ministries have enforcement powers (even at the local level) the 36,000 + municipalities can also adopt powers to enforce legislation (Ormandy, personal communication).

One comparative study on road safety interventions in Europe noted that any comparison of enforcement activities is challenging as ‘effective enforcement is a multi-agency activity, and its effectiveness depends on the consistency of the attitudes and approach used by each agency, and the co-ordination between them. For example, accident data will often be held by the transport ministry but data on police numbers, police activity, and court actions and sentences will usually be held by a separate Ministry’ (Lynam et al., 2005).

The EU ESCAPE (Enhanced Safety Coming from Appropriate Police Enforcement) project, for instance, reported that it was very difficult to obtain such information in order to compare different countries enforcement activity. The problem was compounded because different police regions within the same country did not all necessarily follow the same enforcement strategies, so that describing typical enforcement levels in a particular country was not appropriate. Moreover, when it comes to specific enforcement measures for speed limits for instance, this study

suggested that “results of local experiments in speed control do not always have national level application. Often it is not possible to extrapolate the tactics used in experiments or demonstrations because they have involved temporary shifting or concentration of policing resources to a specific location or target behaviour at the expense of other targets and locations” (Makinen et al., 2003).

One previous systematic review also highlighted the lack of evaluation of regulatory interventions for the prevention of fall related injuries in playgrounds and other settings, stating that ‘ the potential for regulatory approaches in settings where enforcement strategies are feasible has not been systematically assessed; there needs to be further research in the prevention of injuries caused by falls (Waters et al., 2001). Another challenge is to measure the impact of legislation, regulations and standards: some may be quantitative (involving specific measuring or counting) whereas others are qualitative, requiring informed judgements.

In some areas covered by this review legislation plays a minor role, as in the case of many sports where governing bodies set safety standards. There appears to have been little cross-country evaluation, or indeed incentives for evaluation, of such regulations and guidelines (there is lots of evidence on the impact of guidelines generally – but basically these are unlikely to have an impact on their own).

Where comparative analyses have been identified, there are limitations in data used. The age ranges covered by studies vary and in general the adjustment of injury data to take account of risk of exposure is rare; this appears in part to be due to a lack of monitoring systems and data on individual patterns of behaviour. Most studies in our review have also made use solely of data on injury related child fatalities because of the difficulties in obtaining accurate information on serious and less serious non-fatal injuries.

While there are numbers of comparative studies which have documented international differences in legislation, regulations and other national level strategies aimed at preventing unintentional injuries in children, and likewise there are several of major reports (e.g. from the OECD, UNICEF and WHO) which have presented international comparative data on child injury rates, there are few studies which have combined these types of information in the same international comparative analysis.

We found only ten papers, covering eight international comparative analyses which met our review's inclusion criteria. Two papers represented additional analysis or further discussion of a data previously collected for an earlier publication. Of the six papers which included the UK or Great Britain as a comparator country, four were focused exclusively on road-related injuries (Christie et al. 2004 & 2007; Bly et al. 1999 & 2005). The other two, by Towner and Towner (2002) and more recently in 2007 by Mackay & Vincenten, cover a wider range of types of child injury and injury settings spanning the road, the home and other environments together with documenting relevant national legislation or policies for preventing those types of child injury.

Only two of the includable studies focused exclusively on injuries in non-road and non-home environments, and these were both on safety legislation applying to off-road motorised vehicles (ATVs or 'quad bikes', and snowmobiles), and compared levels of legislation and child injury rates between US states.

A lack of international comparative evidence should not be taken as a lack of research evidence on the possible associations between legislation, regulations, and/or policies to promote enforcement and compliance with such legislation or standards. There is, more specifically, a lack of international comparative studies which have collated and presented comparable data on BOTH child injury rates or child injury fatality rates (or relevant safety behaviours), AND reliable data on corresponding national-level policy activity or legislation. Despite having broader inclusion criteria, which would include comparative studies of large sub-national jurisdictions (e.g. US States or German *Lander*), this led to only three additional studies being included (on the use of off-road motorised leisure vehicles). In addition to consistently collected cross-sectional data on child injuries and national policies or legislation, there is a clear need for proper baseline information to strengthen inferences based on geographical variations with temporal (e.g. time-series or before-and-after) information.

We did identify additional small-scale comparative studies looking at the impacts of legislation across different municipalities, counties, towns etc, as well as before and after analyses of the impact of LREC interventions in one jurisdiction. Although not meeting our inclusion criteria, they may nonetheless be of relevance to policymakers,

particularly given that in many jurisdictions legislation and regulation, particularly in respect of safety standards may be developed at a very local level.

Another, possibly more obvious, weakness of the current evidence base is the low 'sample size' of countries included in each comparative study. With so many potential factors affecting the documented level of child injuries in a given country, and many factors also mediating the effectiveness of any prevailing legislation, regulations or other national policies (e.g. levels of enforcement activity, prior levels of compliance, publicity to promote compliance/awareness), it is reasonable to expect that any meaningful patterns of association would only become apparent when consistent data from a large number of countries is compared. There is clearly a methodological trade-off here though, because widening the net of included countries in a given survey will almost inevitably create more problems for assuring (a) data collection and reporting consistency and (b) the increased impact of socio-economic, cultural, geographical (urban/rural mix, climate), and other factors on the risk of child injury.

Having said that, because of the specific problem of assessing, and potentially adjusting for, exposure to different levels of injury risk in different countries, there also seems to be value in conducting detailed studies in small groups of countries which have been selected for the comparability in some respects, or the resources that they can apply to consistent data collection. The insights from the two studies by Bly *et al* (1999, 2005), which only focused on data from GB, France and the Netherlands is a good example of this.

It is also important to note that much might be learnt about the potential impact of legislative, regulation, enforcement and compliance interventions by looking at experience in other areas. This may include studies eliminated from our analysis which looked at the role of LREC interventions in impacting on the use of bicycle helmets, seat belts and car seat restraints (Dowswell et al., 1996, Brown et al., 1997), e.g. recent work supporting the effectiveness of mandatory seat belt laws in reducing youth fatalities across different US States (Carpenter and Stehr, 2008). For instance one systematic review prepared by the US Taskforce on Community Preventive Services that looked at the comparative effectiveness of interventions to increase the use of child safety seat restraints reported that child safety seat laws,

distribution plus education programmes, community-wide information plus enhanced enforcement campaigns, and incentive plus education programmes were effective. In contrast education only programmes aimed at parents, young children, health care personnel or law enforcement personnel did not have enough evidence to prove efficacy (Zaza et al., 2001) .

Another issue may be to examine factors which are likely to make LREC prevention and public health related measures successful. Laws may be more effective, if similar statutes have been on the books for some time (Lacey et al., 2000) while a critical level of public acceptance of the importance of an issue may be needed in order for a law to be effective in changing individual behaviours. The role of the media in influencing compliance might also be considered (Cowan Jr et al., 2009, Potts and Swisher, 1998, Ramsey et al., 2005). Other factors that needs consideration include the extent to which different approaches are required to reach different communities and help reduce inequalities in the rate of injuries across communities (Kendrick et al., 2009, Graham et al., 2005), and the extent to which subsidies and financial incentives might be used alongside legislation and regulation to increase uptake of safety devices (Hendrie et al., 2004).

The forthcoming reviews of evidence for the PDG will have an opportunity to gather and assess some of the studies which were excluded by this review, for example because they compared jurisdictions which were judged too small (e.g. comparisons between cities, or comparisons between municipalities or districts within cities). Also, with the ongoing APOLLO project (see Appendix 3) and major current initiatives like the European Child Safety Report Card, more evidence involving a larger group of countries with more consistent data collection is going to be available soon. In the Child Safety Report Card project, 27 country partners (including all four UK constituent countries) have completed updated assessments to July 2008 and updated ‘Report Cards’ and profiles and a European summary are due to be released in April 2009. This may be in time to feed into the PDG’s deliberations and NICE guidance development.

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Appendix 1: Search Strategies

We combined a range of terms for children and adolescents with injury or accident prevention and legislation, regulation, enforcement and compliance for a number of databases: Pubmed/MEDLINE; the International Bibliography of the Social Sciences; Econlit; ASSIA; Geobase; Transport Research Information Service; SportsDiscus and Theses.com

Pubmed search strategy

1. Social Control /
2. Wounds and Injuries /
3. 1 OR 2
4. Child /
5. Adolescent /
6. 4 OR 5
7. Accident Prevention /
8. 3 AND 6 AND 7

Limits: Abstracts only; Humans, 1997 -

894 references identified meeting criteria identified in Pub Med

110 papers examined

ASSIA, Econlit, Geobase, IBSS, TRIS,search strategy

1. Child* .tx

2. Adolescent* .tx
3. Youth* .tx
4. Infant* .tx
5. Teenager* .tx
6. 1 OR 2 OR 3 OR 4 OR 5
7. “social control” .tx
8. legislation.tx
9. regulation* .tx
10. enforcement.tx
11. compliance.tx
12. 7 OR 8 OR 9 OR 10 OR 11
13. accident*
14. injur*
15. wound*
16. burn*
17. scald*
18. drown*
19. fall*
20. poison*
21. suffocat*

22 13 – 21

23 6 AND 12 AND 22

Limits 1997 –

IBSS: 87 initially papers found; 3 papers examined

Econlit – 5 papers found; 5 papers examined

ASSIA :55 papers initially found; 7 papers examined

GEOBASE: 27 papers initially found; 5 papers examined

TRIS online; 150 papers initially found; 20 papers examined

A search of Sports Discuss was also conducted identifying 25 potentially relevant references.

Appendix 2: Excluded papers

Of 306 references, 296 were excluded and are listed below:

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Near Misses

Within these excluded studies a number of 'near-misses' merit further attention. These papers have largely been excluded because they do not have an international comparison or sub-national comparison across areas of at least one million population, use a before and after analysis in one jurisdiction only, or because they focused on an area of child injury prevention which we have excluded from the scope of this review.

Table 8 Near Miss Studies Identified

Citation	Country / Region / City	Setting / Injury Type	Legislation, Regulation, Enforcement or Compliance	Principal Findings	Reason for exclusion
Brown, Gardner, Sargent et al, 2001 **The effectiveness of housing policies in reducing children's lead exposure**	Two adjacent north-eastern US States	Home / Lead poisoning	Differences in enforcement of legislation to prevent lead poisoning in housing. Both states had established lead poisoning prevention programs, with nearly universal screening and widespread public education.	Difference in lead poisoning rates likely due to differences in enforcement of housing legislation	Not focused on use of safety equipment in home or home safety assessments
Cummings, Grossman et al 1997 **State gun safe storage laws and child mortality due to**	All 50 US States and District of Columbia	Home & Environment/ Access to Firearms	Use of legislation that make gun owners responsible for storing firearms to make inaccessible to children	State safe storage laws intended to make firearms less accessible to children appear to prevent unintentional shooting deaths among children	Focus on firearms not relevant to UK context

firearms				younger than 15 years.	
Currie & Hotz, 2004 **Accidents will happen? Unintentional childhood injuries and the effects of child care regulations**	All 50 US States and District of Columbia	Environment/Workforce / Training for child day care center directors	Regulations requiring minimum levels of education for day care center directors	Model built using published data on regulations and accident rates across US. Finds consistent evidence that requiring day care center managers to have more education reduces both accident rates and accidental death rates.	Although data from across US used; data shown at aggregate pooled level only; no state level data provided
Erdmann et al 1991 **Tap water burn prevention: the effect of legislation**	Washington State	Home/ Scald prevention	Introduction of legislation to set maximum temperature for water heaters at 49 Celsius	Before and after study – change appears to be associated with reduction in injuries to children due to tap water scalds	No comparator geographical region Also pre lit review cut off 1997
Fogarty & Gordon, 1999 **Firework related injury and legislation: the epidemiology of firework injuries and the effect of legislation in Northern Ireland**	Northern Ireland	Environment & Leisure/ Burn prevention	Repeal of legislation banning sale of all fireworks (other than sparklers) to the public	Before and after study – small scale study which suggests repeal of legislation has had no impact on firework accidents	No comparator geographical region. Limited information on children
Hepburn et al 2006 **The effect of child access prevention laws on unintentional child firearm fatalities, 1979-2000**	All 50 US States	Home & Environment/ Access to Firearms	Use of legislation that make gun owners responsible for storing firearms to make inaccessible to children	When data on firearm deaths adjusted for firearm prevalence and state and national effects – significant reduction in unintentional child deaths only in California and Florida. May be some effect of legislation alongside other legal	Focus on firearms not relevant to UK context

				measures	
Jones et al, 2005 **Traffic calming policy can reduce inequalities in child pedestrian injuries: database study**	Swansea and Cardiff	Roads/ traffic calming schemes	Introduction of road modification measures to reduce speed of traffic	Ecological study indicated that traffic calming measures are associated with significant reductions in child injury rates; targeting at areas of deprivation can help reduce inequalities in health	Size of geographical comparators too small
Leahy et al 2007 **The impact of a legislative intervention to reduce tap water scald burns in an urban community**	New York City	Home/ Scald prevention	Introduction of legislation to prevent tap water scalds	Before and after study in same jurisdiction. Rate of tap water scalds to children increased after legislation, but 100% of scalds occurred in building exempt from legislation	No comparator geographical region
Leden et al, 2006 **Safe pedestrian crossings for children and elderly**	Road sites near schools in Boras, Trollhatten and Malmo, Sweden	Roads/ traffic calming schemes	Road modification including placing of speed cushions near pedestrian traffic crossings and increased visibility markings	Before and after study. Behaviour of car drivers improved through modification; car drivers more likely to give way to pedestrians	Small geographic area
McLoughlin et al 1985 **Smoke detector legislation: its effect on owner-occupied homes**	Two counties in Maryland	Home/ Fire /Suffocation prevention	Legislation requiring installation of smoke detectors in all homes	Compared to neighbouring county with no legislation, statistically significantly fewer homes had no working smoke detector	Small geographic area; no specific mention of children; pre lit review cut off 1997
Morrison et al 1999 **Achieving compliance**	64 territorial authorities in New	Leisure/ Safety measures for swimming pools	Compliance and enforcement of New Zealand Fencing of	Postal and telephone surveys. Reports differences in compliance	Size of geographical comparators too

with pool fencing legislation in New Zealand: a survey of regulatory authorities	Zealand		Swimming Pools Act ten year after introduction	procedures and status between authorities, but not specific authority information provided and no link to outcomes	small. No specific data reported on actual compliance measures in specific authorities
Pressley & Barlow, 2005 **Child and adolescent injury as a result of falls from buildings and structures**	Five boroughs of New York City	Home & Environment/ Fall prevention	Legislation based window fall prevention programme with enforcement	Incidence of injury resulting from falls from buildings is nearly half that observed in rest of New York (despite having more multi-family dwelling buildings) State where no legislation and also in US (but no data on legislation elsewhere in US). Window guards are associated with reduced injury resulting from falls from buildings and should be mandated in multi-family dwellings where small children reside	Only one state; although there is some New York city versus rest of New York state comparison
Sellstrom et al, 2003 **Association between childhood community safety interventions and hospital injury records: a multilevel study**	25 municipalities in Stockholm County, Sweden	Road, Home & Environment/ Injury Prevention	Implementation on municipal safety policies and programmes	Ecological study – municipalities that implemented fewer safety measures risks of injury for preschool children 33% greater than in areas where many measures implemented	Size of geographical comparators too small
Van Weerdenburg et al 2006 **Backyard swimming**	Three local councils in New South Wales,	Leisure/ Safety measures for swimming pools	Enforcement and compliance with legislation on swimming pool fencing	Safety behaviours only: pool safety compliance appears poor in areas where little enforcement	Size of geographical comparators too

pool safety inspections: a comparison of management approaches and compliance levels in three local government areas in NSW	Australia			measures in place	small
Wang, 2000 **The effects of state regulations on boating accidents and fatalities**	50 US States	Environment & Leisure/ Boat safety	Legislation and regulation to recreating boating accidents, including laws on minimum age for piloting boats, mandatory boating education in school; mandatory use of flotation devices	Modelling study – minimum boat operating age and boating education programmes in school found to be significantly effective in reducing boating accidents. Mandatory use of flotation devices in states associated with higher accident rates	No state level data presented; no specific data on impacts on child injuries presented
Webster & Mackie, 1996 **Review of traffic calming schemes in 20mph zones**	72 road locations (predominantly residential) in England	Roads/ traffic calming schemes	Introduction of road modification measures to reduce speed of traffic	Before and after analysis: average annual child pedestrian and child cyclist accidents significantly reduced (p=0.05) by 70% and 48% respectively	Size of geographical comparators too small
Webster & Starnes, 2000 **Reexamining the association between child access prevention gun laws and unintentional shooting deaths of**	All 50 US States and District of Columbia	Home & Environment/ Access to Firearms	Use of legislation that make gun owners responsible for storing firearms to make inaccessible to children	Of 15 States with laws in place before 1998 reduction in unintentional firearm death rates only significant in Florida. Suggested that this may be because of use of other enforcement measures	Focus on firearms not relevant to UK context

children					

Appendix 3: Evidence tables

The following pages contain the data extraction tables containing standard details of those studies included in the systematic review. There are separate tables to show:

Study subject and methods (including assessed quality score) (9)

Study findings (10)

Table 9. Study subject and methods

Study Details	Countries / Regions	Setting / Injury Type	Duration	Sample size	Age Range	Legislation. Regulation, Compliance, Enforcement or Other	Source of injury data	Source of safety behaviour
Towner & Towner Year: 2002 Citation: UNICEF's child injury league table. An analysis of legislation: more mixed messages.	26 of 29 OECD countries (Denmark, Mexico and Poland did not provide data)	Childhood injury deaths in any setting, including road, home and leisure	Survey on legislation in place by 2000; Previously published child injury death data from 1971-75 and 1991-1995 also used	Country child populations	0-14	Legislation and enforcement interventions including , speed limit in urban areas, child resistant packaging, smoke detectors, pool fencing , bans on riding/driving tractors, playground standards.	UNICEF's child injury league table Published sources of legislation and childhood injury date; Questionnaires on legislation sent to country experts	N/A

Study Design: Ecological Quality Score: +								

Study Details	Countries / Regions	Setting / Injury Type	Duration	Sample size	Age Range	Legislation. Regulation, Compliance, Enforcement or Other	Source of injury data	Source of safety behaviour
Christie et al Year: 2007 Citation: How exposure information can enhance our understanding of child traffic "death leagues" Study Design: Ecological Quality Score +	UK, USA, Germany, Netherlands, Norway, Sweden, Switzerland, New Zealand	Child pedestrians, cyclists, car occupants	Germany: 1998-9; New Zealand:1997; Netherlands: 1999; Norway: 2001; Sweden: 1999; Switzerland: 2000; UK: 1999-2001; USA:1995	Germany: 3200; New Zealand: 3638; Netherlands: 1681, Norway: 582, Sweden: 1000; Switzerland: 3071, UK: 1527 USA: 42,033	10-14	Monitoring / Surveillance (Impact of exposure rates on death league table rankings)	Fatality: the International Road Traffic and Accident Database.	Travelling behaviour: survey of experts in government transport administrations.

Study Details	Countries / Regions	Setting / Injury Type	Duration	Sample size	Age Range	Legislation. Regulation, Compliance, Enforcement or Other	Source of injury data	Source of safety behaviour
Christie et al Year: 2004 Citation: Road Safety Research Report No.47. Children's Road Traffic Safety: An international Survey of Policy and Practice Study Design: Ecological Quality Score: +	20 OECD countries	Child pedestrians, cyclists, car occupants	1996 - 2000	500-1500 children per age band (i.e. 0-5, 6-9 and/or 10-14). Making total samples for 0-14 year olds btw 1500-4500.	0 – 14	Safety measures for pedestrians, including speed reduction measures, 30kph/40kph limits, signal crossing, non-signal crossing. Safety measures near schools including speed reduction measures, 30-40 kph limits, signal cross, non-sign cross, barriers, parking restrictions, warning signs (table 23). Legislation aimed at child pedestrian behaviours.	Fatality: the International Road Traffic and Accident Database.	Survey data

Study Details	Countries / Regions	Setting / Injury Type	Duration	Sample size	Age Range	Legislation. Regulation, Compliance, Enforcement or Other	Source of injury data	Source of safety behaviour
Bly et al Year: 1999 Citation: Comparative study of European child pedestrian exposure and accidents Study Design: Ecological Quality Score: ++	Great Britain, France, the Netherlands	Child pedestrians	May 1998 – April 1999: Exposure survey Accident site surveys: 1996 and 1997 data	Exposure survey (25 interview areas) Total interviewees GB: 1002 France: 993 Netherlands: 1024 Accident sites: GB 500 (93 fatal); France 499 (57 fatal); Netherlands 493 (19 fatal)	5-15	Monitoring and surveillance	GB: STAS 19 Database; France: Centre d'Etudes Techniques de L'Equipement database; Netherlands: Ministerie van Verkeer en Waterstaat database	Exposure Survey

Study Details	Countries / Regions	Setting / Injury Type	Duration	Sample size	Age Range	Legislation. Regulation, Compliance, Enforcement or Other	Source of injury data	Source of safety behaviour
Bly et al Year: 2005 Child Pedestrian Exposure and Accidents – Further Analyses of Data from a European Comparative Study Study Design: Ecological Quality Score: ++	Great Britain, France, the Netherlands	Child pedestrians	May 1998 – April 1999: Exposure survey Accident site surveys: 1996 and 1997 data	Exposure survey (25 interview areas) Total interviewees GB: 1002 France: 993 Netherlands: 1024 Accident sites: GB 500 (93 fatal); France 499 (57 fatal); Netherlands 493 (19 fatal)	5-15	Monitoring and surveillance	GB: STAS 19 Database; France: Centre d'Etudes Techniques de L'Equipement database; Netherlands: Ministerie van Verkeer en Waterstaat database	Exposure Survey

Study Details	Countries / Regions	Setting / Injury Type	Duration	Sample size	Age Range	Legislation. Regulation, Compliance, Enforcement or Other	Source of injury data	Source of safety behaviour
Mackay & Vincenten, Year: 2007 Citation: Child safety summary report card for 18 countries Study Design: Ecological Quality Score:+	18 countries: Austria, Belgium, Czech Republic, Denmark, Estonia, France, Germany, Greece, Hungary, Italy, Netherlands, Northern Ireland, Norway, Poland, Portugal, Scotland, Spain Sweden.	Road, Home and Leisure	October 2004 – July 2007	55,000	0-19	National level law/ policies in nine areas (passenger safety, motor scooter and moped safety, pedestrian safety, cycling safety, water safety/drowning prevention, fall prevention, burn prevention, poisoning prevention, choking/strangulation). Includes: national plans / targets on injury prevention; child home visits with education programmes; Pedestrians: includes reduced speed in residential areas; driver responsibility in crash involving child pedestrian. Drowning includes: pool fencing; recertification for lifeguards; use of floatation device; requiring water safety education, Poisoning: includes child resistant packaging; Burn prevention: includes pre-set temperature (50°C) for water heaters or building standards; maximum temperature 50°C for tap water; working smoke detectors in all dwellings; child resistant cigarette lighters; flame retardant fabrics in children's nightwear; Controlling sale of fireworks. Choking and strangulation: includes• restrictions on unsafe products; warning labels on products (e.g., toys) to prevent choking, suffocation or strangulation; banning production & sale of latex balloons, use of inedible materials in food products and drawstrings in children's clothing; regulating design and sale of blind cords and cot design		

Study Details	Countries / Regions	Setting / Injury Type	Duration	Sample size	Age Range	Legislation. Regulation, Compliance, Enforcement or Other	Source of injury data	Source of safety behaviour
WHO Centre for Environment and Health Year: 2007 Citation: Policies to reduce and prevent selected unintentional injuries(falls, drowning, poisoning, fires and choking) in children and adolescents Study Design: Expert Survey Quality Score: -	23 countries in WHO European Region (excluding UK)	Road, home and leisure	2006	N/A	0-19	Drowning: barrier fencing required for public/private pools, water safety education (e.g. swimming lessons) compulsory in the school curriculum Falls: playground equipment and landing surfaces to meet safety standards. Fires (burns, scalds): Safe pre-set temperature (54°C) mandatory for all water heaters, Building codes requiring working smoke detectors in all dwellings, Sale of fireworks to children under 18 years of age prohibited. Poisoning: Child-resistant packaging mandatory for (non) pharmaceuticals. Choking and suffocation: Informative warning labels mandatory on products to prevent choking, Use of inedible materials prohibited in food products, Use of drawstrings in children's clothing prohibited	Age Standardised Data from WHO European Region Mortality Database. Survey of expert in government departments in ENHIS-2 countries	Not applicable

Study Details	Countries / Regions	Setting / Injury Type	Duration	Sample size	Age Range	Legislation. Regulation, Compliance, Enforcement or Other	Source of injury data	Source of safety behaviour
Helmkamp Year: 2001 Citation: A comparison state-specific all terrain vehicle –related death rates, 1990-1999 Study Design: Ecological Quality Score: -	50 US States and District of Columbia	Fatalities on the road and in recreational areas	1990-1999	Not stated	All divided into 4 age groups including 1-16 year olds	Helmet and other safety equipment requirements (21 states) Machine-related safety but no helmet requirement (23 states), No safety legislation (6 states and the District of Columbia).	Death data, obtained from the Consumer Product Safety Commission, US Census Bureau state-, age-, and sex-specific population estimates	

Study Details	Countries / Regions	Setting / Injury Type	Duration	Sample size	Age Range	Legislation. Regulation, Compliance, Enforcement or Other	Source of injury data	Source of safety behaviour
Keenan et al Year: 2001 Citation: All- terrain vehicle legislation for children: a comparison of a state with and a state without a helmet law Study Design: Ecological Quality Score: +	Two US States: Pennsylvania and North Carolina	Road & Leisure (woods, forest, mountains, in public parks, farms) Fatalities and trauma admissions	Jan 1997-July 2000	1080 children. Pennsylvania: 858, North Carolina :222	0-15	The law in Pennsylvania prohibits the use of ATVs by children <10 years old on public land and requires that children <16 years old riding on public land be helmeted and pass an ATV safety course. No legislation in North Carolina	Trauma Database and fatality reports from the CPSC Death certificate data, and emergency medical service (EMS) data. Trauma Registry and the Office of the Chief Medical Examiner (OCME)	CPSC, Medical examiner data

Study Details	Countries / Regions	Setting / Injury Type	Duration	Sample size	Age Range	Legislation. Regulation, Compliance, Enforcement or Other	Source of injury data	Source of safety behaviour
Rice et al Year: 2000 Citation: Snowmobile injuries and deaths in children: a review of national injury data and state legislation. Study Design: Ecological Quality Score: -	18 US States (with a focus on Michigan; Alaska; Wisconsin; Minnesota and New York)	Fatalities/injuries on public and private property and recreational areas	Jan 1990-April 1998	291 paediatric snowmobile related injuries and 75 deaths	0-16	Compliance with AAP guidelines which recommend that no-one under 17 should operate a snowmobile. Snowmobile legislation including legal age restriction to operate alone public/private property	Non-fatal injury data from CPSC National Electronic Injury Surveillance System (NEISS). Fatality data from the National Injury Information Clearinghouse Death Certificate Data Files.	Analysis of state statutes

Table 10. Study findings

Author/ Year/ Rating	Differences in injury rates	Differences in safety behaviours	Author conclusions	Barriers/ Facilitators	Notes
Towner & Towner Year: 2002 Citation: UNICEF's child injury league table. An analysis of legislation: more mixed messages. Study Design: Ecological Quality Score: +	Sweden (1st) and Norway (5th) with the widest range of legislation were high in rank on the league table. But other high legislating countries such as Australia (16th), Canada (18th), New Zealand (22nd), and the USA (23rd) were categorised as less good performers. No clear pattern between adoption of safety measures and changes in injury rates between 1971-75 and 1991-1995. E.g. Germany had greatest reduction in mortality but only modest legislation without child injury group at a national level.		Wide range of legislation and variations in strength of enforcement blurred relationship with variations in child injury death rates. Political structures did not appear to have much influence on degree of enforcement.	Culture - legislation may be more effective in different societies. Political will and support may be Indicated by whether country had established child injury groups. Lack of recognition of injury one barrier to implementation e.g. Greece.	Data on enforcement obtained from the subjective view of expert opinion

Author/ Year/ Rating	Differences in injury rates	Differences in safety behaviours	Author conclusions	Barriers/ Facilitators	Notes
Christie et al Year: 2007 Citation: How exposure information can enhance our understanding of child traffic “death leagues” Study Design: Ecological Quality Score +	Pedestrians: fatality rates per 100,000 children show Norway having 0.3 (the lowest) and the UK 1.48 (the highest). When exposure was taken into account, USA had 0.007(the highest), Norway 0.0005 (the lowest). Child car occupants, fatality rates per 100,000: New Zealand 3.1 (h), The Netherlands 0.4 (l). But when exposure was considered, New Zealand 0.00044(h), Switzerland 0.00011(l). Child cyclists, fatality rates per 100,000: The Netherlands 2.6 (h), Sweden 0.4 (l). But, when exposure was included, UK 0.0074 (h), The Netherlands 0.0012 (l).		Adjusting for exposure helps provide more meaningful fatality rates. Especially for child cyclists, good and less good performing countries were reversed. Systematic approaches to international data comparison hampered by lack of exposure date. Exposure data also should consider the different features of the road environment in each county.		Even in countries here with exposure data; this was not available for younger children.

Author/ Year/ Rating	Differences in injury rates	Differences in safety behaviours	Author conclusions	Barriers/ Facilitators	Notes
Christie et al Year: 2004 Citation: Road Safety Research Report No.47. Children's Road Traffic Safety: An international Survey of Policy and Practice Study Design: Ecological Quality Score: +	Top five performers (fatality rates per 100,000 pop) Overall: Sweden 1.58; UK 1.86; Norway 2.08; Netherlands 2.2; Germany 2.34 Child pedestrians: Sweden 0.35; Netherlands 0.44; Finland 0.67; Germany 0.69; Denmark 0.72 Car occupants: Switzerland 0.47; UK 0.48; Netherlands 0.51; Sweden 0.76; Norway 0.78	Child pedestrians: Four of the top performers: Sweden, Netherlands, Finland and Denmark, had speed reduction measures in most areas. All top performers except Netherlands had signal crossings in most local authority areas. Pedestrian near schools: top performers had speed reduction schemes near many schools 4 top performers Sweden, Finland, Denmark, Germany provided outside play areas in most residential areas. 3 top performers Sweden, Netherlands, Germany, had legislation on driver responsibility.		Facilitators: Child-centred approach: advisory environmental planning guidance for the safety, security and freedom of movement of children. Provision of play space: environmental standards, legislation at local authority level with senior staff in charge of plans. Holistic approach: low speed limits, speed reduction measures, promotion of secondary safety and publicity aimed at both children and their parents and drivers. Lack of resources and capacity for costly environmental modifications can be barrier	Qualitative description of safety measures only

Author/ Year/ Rating	Differences in injury rates	Differences in safety behaviours	Author conclusions	Notes
Bly et al Year: 1999 Citation: Comparative study of European child pedestrian exposure and accidents Study Design: Ecological Quality Score: ++	Difference in expected Accident Rates per 100,000 children due in part to differences in exposure to road type % Time exposure /% crossing activity for main through roads: GB 0.69 /0.73; France 0.41/0.48; Netherlands 0.19/0.16 Greater amount of time GB children spend on major roads explains 34% of difference in overall accident rates in GB and Netherlands, and 19% difference to France. Differences in crossing activity account for 44% of the difference in overall accident rate between Britain and the Netherlands, but only for 15% of the difference with France.	Estimated risk per unit of exposure (either in time or road crossing) is statistically significantly higher for nearly all age groups and both genders in GB compared with Netherlands. Estimated Accident Risk per Unit of Exposure (significant difference between GB and other countries at 5% level) Time Exposure: 5-9 Males: GB 2.09; France 1.02; Netherlands 0.70 5-9 Females: GB 0.80; Netherlands 0.37; 10-11 Females: GB 0.91; Netherlands 0.27 12-15 Males: GB 1.68; France 0.87; Netherlands 0.63; 12-15 Females: GB 1.12; Netherlands 0.43 Crossing Exposure: 5-9 Males: GB 2.00; France 1.12; Netherlands 0.77; 5-9 Females: GB 0.83; Netherlands 0.34; 10-11 Males: GB 1.85; Netherlands 0.77;10-11 Females: GB 0.91; Netherlands 0.34; 12-15 Males: GB 1.61; Netherlands 0.80; 12-15 Females: GB 1.17; Netherlands 0.35	Total exposure, measured in time or in road crossings offers no explanation of higher injury rates in GB. Greater exposure of children in France and the Netherlands to lower speed limits accounts for about 40% of the difference in Britain's overall accident rate relative to France for both time and crossing activity exposure, and for 30% (time) and 20% (crossing activity) of the difference relative to the Netherlands. Greater exposure to traffic judged to be relatively faster in Britain explains about 15% (time) and 25% (crossing activity) of the difference in overall accident rate relative to France, and 17% (time) and 25% (crossing activity) relative to the Netherlands. The risk on marked crossings in Britain increases from main roads to local roads, suggesting that the design and performance of local crossings should be examined more closely.	Further investigation of impact of traffic calming measures needed – nearly half in GB installed after accidents; data on timing of installations in Netherlands and France not available.

Author/ Year/ Rating	Differences in safety behaviours	Author conclusions
Bly et al Year: 2005 Child Pedestrian Exposure & Accidents – Further Analyses of Data from a European Comparative Study Study Design: Ecological Quality Score: ++	**School journeys:** % of journeys on foot: Overall GB 56; FR 54.1; NL 34.3; 5-9s: GB 63.1; FR 60.8; NL 40.6; 12-15s: GB 47.8; FR 44.4; NL 15.3; % of journeys with exposure to main roads: GB 25%; FR 14%; NL 6% % of exposure on journeys where traffic speed faster than most towns: GB 12%; FR 7%; NL 5% % exposure time in journeys where measures to slow down traffic GB 19%; FR 11%; NL 54% % of journeys where special crossing used: GB 17%; FR 72%; NL 26% **When visiting friends:** % of journeys with exposure to main roads: GB 12%; FR 30%; NL 2% % of exposure where traffic speed faster than most traffic in towns: GB 9%; FR 11%; NL 1% % exposure time where measures to slow down traffic GB 4%; FR 15%; NL 65% % of journeys where special crossing used: GB 10%; FR 63%; NL 85% **When playing:** % of journeys with exposure to main through roads: GB 9%; France 7%; NL 5% % exposure where traffic speed faster than most traffic in towns: GB 3%; France 6%; NL 3% % exposure time on play journeys where measures to slow down traffic GB 11%; FR 15%; NL 45% % of play journeys where special crossing used: GB 86%; FR 62%; NL 86%	Over half of children walk to school in Britain and France, compared with a third in the Netherlands. Younger children are more likely to walk to school than older children. In both Britain and France, children from lower SEGs are more likely to walk to school than children from higher SEGs. Children in Britain are significantly more likely to walk to school along more major through-roads, with higher traffic volumes and faster traffic. They are less likely to be subject to speed limits lower than the standard urban limit. Children walking to school in Britain or the Netherlands were much more likely to cross the road at an unmarked place than were children in France, but no data on the overall provision of marked crossings are available. The exposure of British children to major roads and busy roads when visiting friends is much less than it is for overall pedestrian activity, and is much more similar to that in the other countries. However, the greater likelihood of being in the presence of low speed limits in the other countries persists, while 65% of the activity is in the presence of special measures to slow speeds in the Netherlands. British children are even more likely to cross the road at an unmarked place when visiting friends than they do overall, at 90% of crossings, compared with 37% in France and 15% in the Netherlands.

Author/ Year/ Rating	Differences in injury rates	Differences in safety behaviours	Author conclusions	Barriers/ Facilitators	Notes
Mackay & Vincenten Year: 2007 Citation: Child safety summary report card for 18 countries Study Design: Ecological Quality Score:+	There is great variability between the best and worst performing countries. Injury rates are 5 times higher in the countries with the poorer performance. Child safety scores did not generally correspond well to the best performing countries in terms of child injury fatalities. This reflects differences in exposure (which were not included) as well as differences in enforcement and implementation.	Scores for pedestrian safety: Germany=5, average=3 out of 5 stars. Water safety/drowning: no country>4 scores, average= 2 stars. Fall prevention: no country with 4 or above scores, average= 1.5 stars. Poisoning: Northern Ireland=4, Sweden, the Netherlands=4or 4.5 stars, average= 2.5 stars. Burns: no country >4, average=2.5 Choking/strangulation: no country >4, average=2.5.		Leadership, capacity, infrastructure to support the child safety: no country >4 stars, average=2 stars out of 5.	

Author/ Year/ Rating	Differences in injury rates	Differences in safety behaviours	Author conclusions	Barriers/ Facilitators	Notes
WHO Centre for Environment and Health Year: 2007 Citation: Policies to reduce and prevent selected unintentional injuries(falls, drowning, poisoning, fires and choking) in children and adolescents Study Design: Expert Survey Quality Score: -	No consistent trend could be identified between country policy implementation scores and performance in reducing child injuries. The inconsistency in trend was particularly marked for prevention of drowning and poisoning.	Belgium with a score of 18/24 was the best performer, followed by Austria, Czech Republic and Greece with 17. Albania scored just 3.	National policy efforts to reduce unintentional injuries in children and adolescents are moderate as measured by these scores. Countries with the same indicator score do not necessarily have the same policies and the same progress in implementation. In addition, since the definitions are semi-quantitative, it is difficult to get a precise assessment of actual implementation and coverage of programmes.	Long standing existence of legislation does not mean it has been enforced; e.g. Albania has legislation on pool fencing since 1989 but not implemented	No adjustment of injury data for exposure. Reliance on subjective expert assessment of extent of enforcement and implementation

Author/ Year/ Rating	Differences in injury rates	Differences in safety behaviours	Author conclusions	Barriers/ Facilitators	Notes
Author: **Helmkamp** Year: 2001 Citation: A comparison state-specific all terrain vehicle – related death rates, 1990-1999 Study Design: Ecological Quality Score: -	States without safety legislation had a collective death rate twice that of the other 2 groups (helmet & machine requirements & machine only)—0.17 deaths per 100 000 vs. 0.08 and 0.09, respectively. (No significance testing reported) Arkansas had the highest death rate (2.11) among female adolescents aged 1 to 16. West Virginia had the highest rates in each of the 4 age groups: 1–16 (1.04), 17–49 (1.51), 50–64 (0.67), and 65–84 (0.98).		States with some level of safety legislation, be it mandated helmet use or machine-related requirements, have substantially fewer deaths and lower fatality rates than do states that have no ATV safety laws.	Not mentioned	Rates based on few events are often subject to large fluctuations. This phenomenon is likely at play with the crude rates presented in the study.

Author/ Year/ Rating	Differences in injury rates	Differences in safety behaviours	Author conclusions	Barriers/ Facilitators	Notes
Author: **Keenan et al** Year: 2001 Citation: All- terrain vehicle legislation for children: a comparison of a state with and a state without a helmet law Study Design: Ecological Quality Score: +	Head (36.9%:Pennsylvania vs.28.8%: North Carolina), Face(9.1%,12.6%), Spinal cord(3.7%, 5.4%), t Thoracic(7.1%, 5.0 %), Extremity/vascular/peripheral nerve (29.3, 32.4%), Burn(0.1%, 0.9%), Unspecified (3.0%, 2.7%).	A statistically significant higher rate of helmet use was reported in Pennsylvania (35.8%) compared with North Carolina (16.7%), ($p<0.001$)	Legislation appears to be effective in influencing safety behaviour. Living in North Carolina (where no helmet law in place) was an independent predictor of non-helmet use	Individual's willingness to comply, regardless of regulations. Societal attitudes toward regulation and access to designated state park areas.	Death rates were not separately reported in 2 states, only the sum of the total deaths in both was reported with/without helmet use. The total number of child-hours riding ATVs in Pennsylvania and North Carolina is unknown. Injury data were taken from trauma registries and there was no information on exposure to risk.

Author/ Year/ Rating	Differences in injury rates	Differences in safety behaviours	Author conclusions	Barriers/ Facilitators	Notes
Author: **Rice et al** Year: 2000 Citation: Snowmobile injuries and deaths in children: a review of national injury data and state legislation. Study Design: Ecological Quality Score: -	18 states had at least one reported snowmobile related death in study time period. Highest number of deaths in Minnesota (16), followed by Wisconsin (11), Michigan (9), Alaska (6), New York (5**)**	None of five worst performing states complied with the AAP guidelines. Alaska had no restrictions at all; while those over the age of 12 (over 10 in New York State) could ride a snowmobile on public property, while three required the use of helmets	State legislation often lacks age restrictions on private property, and laws requiring helmet use are rare. Legislators have not addressed the dangers of paediatric snowmobile-related injuries.		The authors note that injury data need to be treated with caution as there may be under reporting of death rates from such injuries on death certificates across states, while no information is available to adjust fatality rates to take account of exposure to risk

Appendix 4: Summary of APOLLO project

Initiated by CEREPRI and run under the auspices of DG SANCO, the “Strategies And Best Practices For The Reduction Of Injuries” (APOLLO) Project began on December 2005 and will run for 3 years. This project is the first concerted effort of this magnitude with over 25 experts within the European Union.

The project aims to provide: (a) the evidence on the health and financial burden of injuries and easily measurable indicators and (b) recommendations on how to overcome the barriers in applying existing best practices and efficient policies to decrease the most common injuries in the EU member states with specification of success and failure factors for implementation of injury prevention programs in all age groups and all types of injuries. In addition, implementation activities will focus on two high injury burden areas: (a) falls among elderly and (b) injuries among vulnerable road users. Dissemination activities include the creation of a scientific platform with input from practitioners in the field, injury victims and policy makers as well as the dissemination of results of all the work packages.

Activities under the projects heading are divided amongst six Work Packages. This project aims to actively manage injuries at each level of this complex public health problem. Similar to the structure followed in other successful endeavours, the project will approach the prevention of injuries at the overall policy level, apply the priorities and strategies at the operational level and devote substantial resources to communicate the results. ’

The home page of the **Apollo Project**: http://www.euroipn.org/apollo/index.htm