Heads Up

Concussion and head injuries in children and young people in Wales

GIG CYMRU NHS WALES | Iechyd Cyhoeddus Cymru Public Health Wales

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Heads up: Head and concussion injuries in children and young people in Wales
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Key messages

Head injuries are common among Welsh children with some 33,000 attending emergency departments each year.

The numbers appear to be increasing but the causes behind this are not well understood.

Head injuries are more common in boys and rates are highest in 1-4 year olds where falls are the leading cause.

Head injuries are around twice as common in children from the most deprived communities.

Improvements in the coding of emergency department data, with the introduction of the Joint Action on Monitoring Injuries in Europe (JAMIE) Minimum Data Set, will further our understanding of the scale and underlying causes.

There is considerable evidence for many short and long term adverse consequences of head injury, including psychological and behavioural problems and poorer school performance for those worst injured.

There are a number of evidence based guidelines on the prevention of childhood injuries that, if implemented in full, would reduce the incidence and consequence of injuries, including those in the home (parenting and safety equipment) and on the road (slower speeds, safe routes to school, etc).

Potential risks and benefits from sports participation are not very well characterised and there are opportunities to carry out further research in this area to clarify these issues.

1. Introduction

Welsh Government has recognised the significant impact that unintentional injuries can have on children, young people, their families, poverty and society as a whole. In *Our Healthy Future,* Welsh Government made the reduction of accidents and injuries one of their ten priorities for action. This is further supported through their early years and childcare plan, *Building a Brighter Future* (2013).

Head injuries are the commonest cause of death and disability in people aged 1-40 years in the UK. In England and Wales each year, around 1.4 million people attend emergency departments (ED) as the result of a head injury. NICE (National Institute for Care and Health Excellence) has recognised that between 33-50% of head injuries affect children under the age of 15 years[1].

A head injury is defined by NICE as any trauma to the head other than superficial injuries to the face. Concussion is described as a disturbance in brain function caused by a direct or indirect force to the head or neck[2]. In the majority of cases, the causes of head and concussion injuries are the same. Many head injuries result in concussion, but due to delays in presentation many cases are not formally assessed at the time of injury. The term 'head injury' is often used to code both concussive and non-concussive injuries in clinical practice. Therefore this report will include concussion within the broader term of head injuries.

Head injuries in children and young people account for 4.05% of all ED (emergency department) attendances and 5.90% of all unintentional injury attendances. These injuries can lead to fatal, serious or disabling outcomes for children and whilst the majority of head injury patients do not require specialist intervention, others do experience long-term disability[1]. This can result in physical, cognitive, emotional and behavioural problems as well as poorer educational attainment[3, 4].

There are significant differences in both gender and age groups attending ED due to a head injury. The highest risk categories for attendance at ED are males aged between 1-4 years. The highest risk category for fatal head injuries are males aged between 15-18 years.

The focus of this report is unintentional head injuries in children and young people aged 0-18 years. It considers available information on the causes, impact, potential costs of head injuries to children and young people and the contribution they make to the overall unintentional injury picture in Wales. A range of information is provided in this report, including an overview of the issues, who is most at risk and what preventative measures are effective.

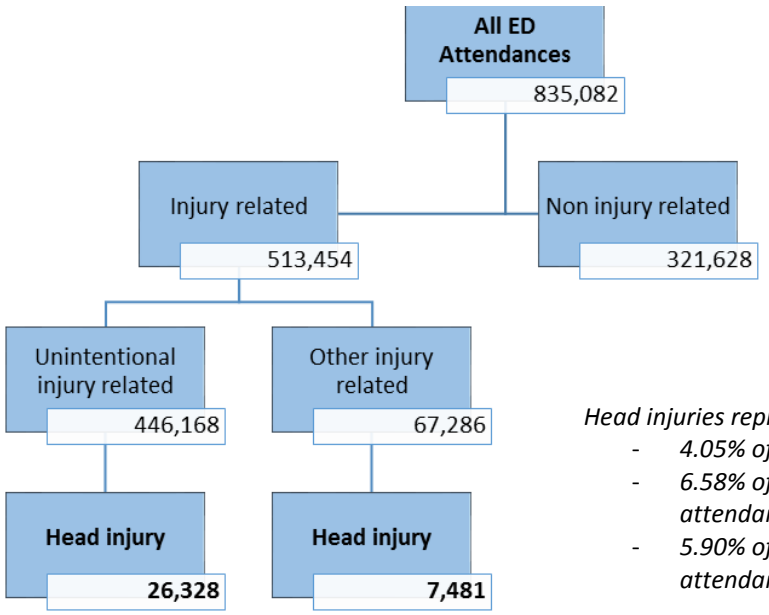
The majority of unintentional head injuries are both predictable and potentially preventable.

2. Prevalence of head injuries

2.1 ED attendance and hospital admittance

Over a period of four years (2010-2013 inclusive), a total of 33,809 children (0-18 years) in Wales attended an ED due to a head injury (figure 1). Of these, 26,328 were coded as being caused by unintentional events.

Figure 1. Number of ED attendances in children aged 0-18 years. Wales (2010-2013)

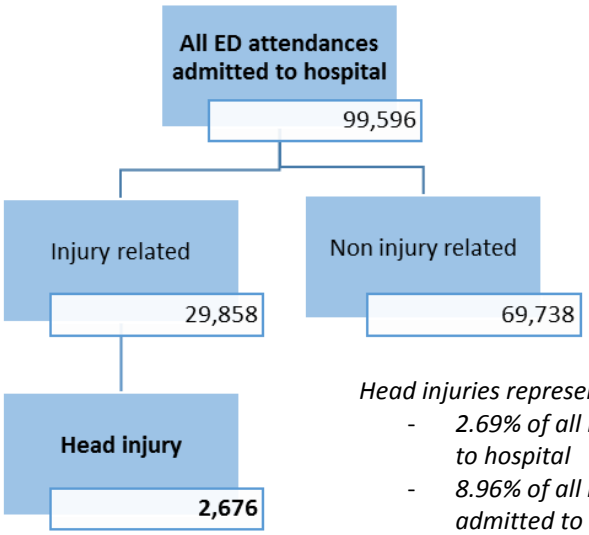


Head injuries represent:

- *4.05% of all ED attendances*
- *6.58% of all injury related attendances*
- *5.90% of all unintentional injury attendances*

Source: (EDDS) Emergency Department Data Set

Figure 2. Number of ED attendances admitted to hospital in children aged 0-18 years. Wales (2010-2013)



Head injuries represent:

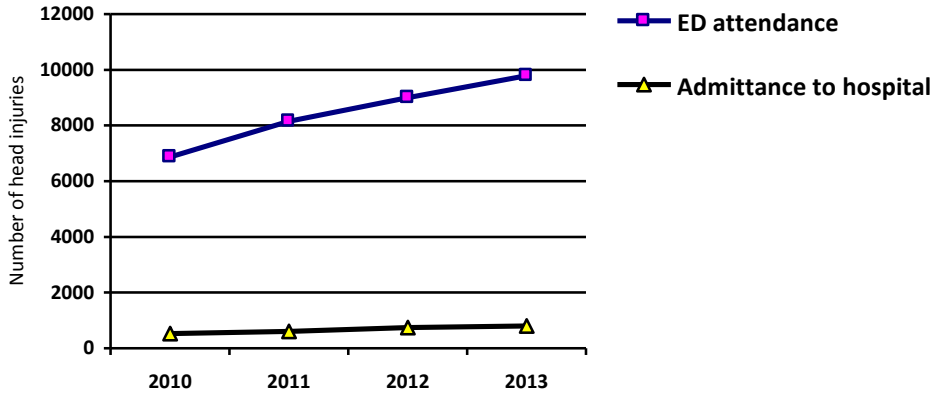
- *2.69% of all ED attendances admitted to hospital*
- *8.96% of all injury related attendances admitted to hospital*

Source: Hospital attendance field in EDDS

Whilst the number of ED attendances and hospital admissions for head injuries has risen steadily over the last 4 years (2010 – 2013, Figure 3) this is most likely due to an increase in the number of ED departments submitting data over this period, as it is only since April 2012 that all hospitals providing emergency care facilities in Wales have submitted data. Although an increase in attendances and admissions are observed between 2012 – 2013, these may be the result of improved data coding, or an increase in the tendency to attend ED (attendance rates are increasing) rather than a real increase in head injuries. Therefore, until ED data quality is improved, the following results should be interpreted with caution.

During the same period, the average length of stay for hospital admissions as a result of head injuries in children (0-18) was 3.98 days. The maximum length of stay was 80 days. The percentage of children who attended emergency departments and were subsequently admitted were, on average; 7.69% (2010), 7.40% (2011), 8.33% (2012) and 8.13% (2013).

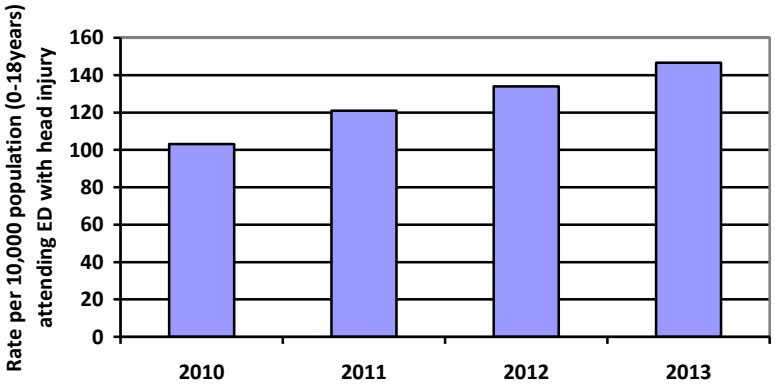
Figure 3. Number of ED attendances and related admittances for head injury per year for children aged 0-18 years in Wales (2010-2013)



Source: (EDDS) Emergency Department Data Set and PEDW (Patient Episode Database Wales) 2010-2013

As mentioned above more specific reasons for these increases are not completely understood and further investigations may be necessary to understand this fully. Figure 4 illustrates the rate per 10,000 population attending ED with head injuries over this period.

Figure 4. Average rate of ED attendances for children (0-18 years) for head injury, rate per 10,000 population (2010-2013)



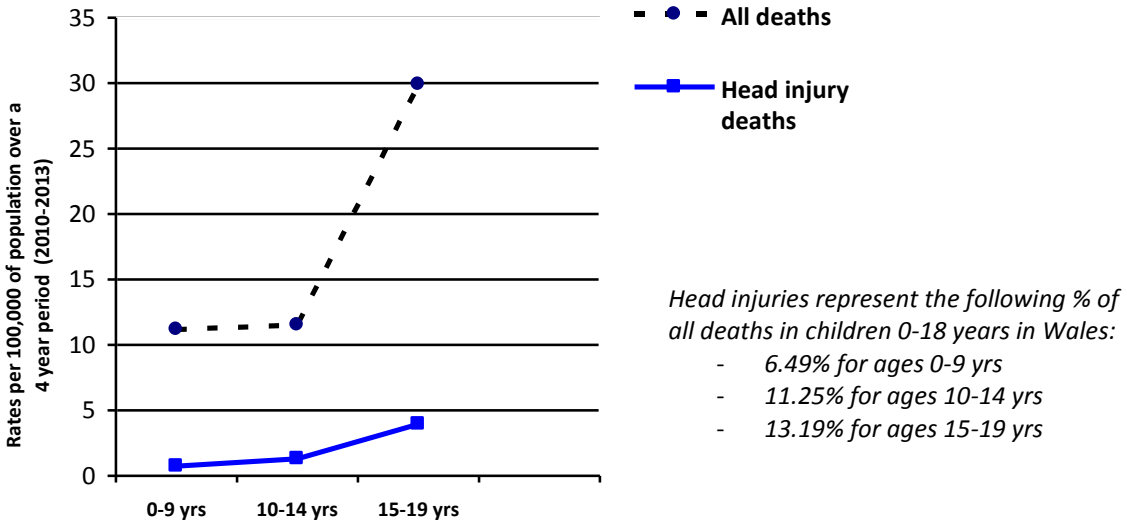
Source: CAPIC, using EDDS 2010-2013

2.2 Mortality

Head injury deaths are relatively few in number although still one of the leading causes of death in these age groups. However, the numbers increase sharply in young people aged between 15-19 years as shown in figure 5, rising from 6.69% of all deaths for 0-9 years to 13.19% for 15-19 years. This represents a marked difference when compared to ED attendances where the 15-19 year age group are among the least likely to suffer a head injury, but when one occurs, are the most likely to die.

In this age group, road traffic collisions represent a significant number of deaths, many as a result of head injury. Head injuries caused by road traffic collisions are often more severe due to the increased velocity of impact.

Figure 5. Comparison of rates per 100,000 of population of deaths from all causes and deaths from head injury (0-19 years) over a four year period in Wales (2010-2013)



Head injuries represent the following % of all deaths in children 0-18 years in Wales:

- *6.49% for ages 0-9 yrs*
- *11.25% for ages 10-14 yrs*
- *13.19% for ages 15-19 yrs*

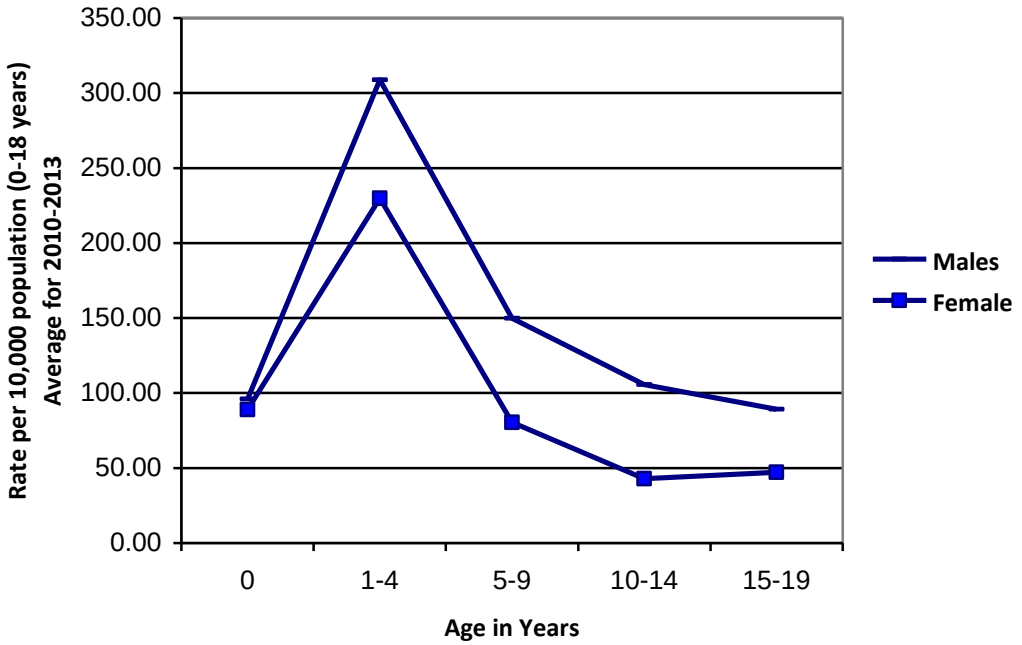
Source: *ONS Mortality Files*
Note i): *ICD10 codes S000 – S099 were searched in all cause of death fields. A broader search was used as it was noted that head injuries were not recorded uniformly and are often given the generic code S090 (unspecified injury of head).*
Note ii): *It was noted that head injuries were not recorded uniformly within the ICD10 code fields.*

2.3 Gender

More males with head injuries attend ED than females. Figure 6 shows that from the age of 1 year, males are more likely than females to experience a head injury. This finding is consistent with gender trends across the majority of unintentional injuries.

Figure 6 illustrates that the difference between genders is more pronounced in the teenage years,

Figure 6. Head injury attendance in Emergency Departments in Wales, aged 0-18 years, average rate per 10,000 population by gender and age group (average for 2010-2013).

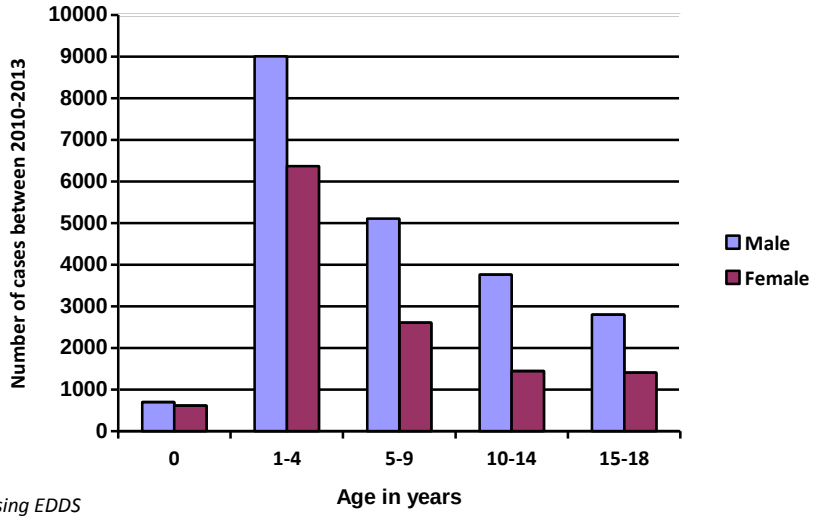


Source: CAPIC, using EDDS

2.4 Age

As with other categories of unintentional injuries, the 1-4 year age group is amongst the most vulnerable. Within this category, there are numerous mechanisms of head injury, with falling from a height accounting for the largest number. This is primarily due to an imbalance between the desire to explore new environments and the stages of their physical and cognitive developmental.

Figure 7. Head injury attendances in Emergency Departments in Wales, aged 0-18 years, total number between 2010-2013



Source: CAPIC, using EDDS

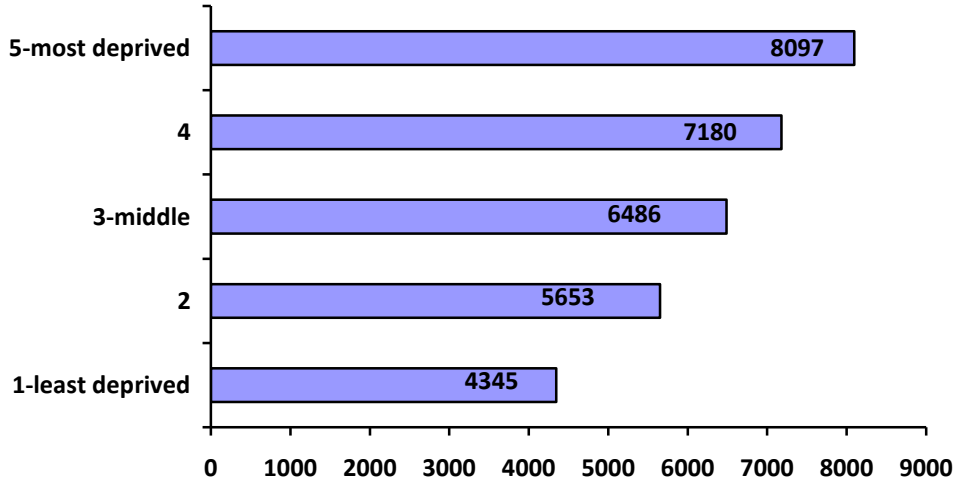
2.5 Deprivation

There have been numerous studies and reports showing the links between deprivation and an increased risk of unintentional injuries; injury produces the greatest of all inequalities in health. For certain types of injuries, children from least affluent households are up to 37 times more likely to die from an unintentional injury[5].

In one such report, the World Health Organization (WHO) commented on the strong relationship between social class and injuries[6]. Risks factors identified include greater exposure to overcrowding, hazardous environments, sole parenthood, unemployment, young maternal age and low maternal education.

Figure 8 illustrates the difference in ED attendances for head injuries across the quintiles of deprivation. These are based on dividing the lower super output areas in Wales (nearly 2000 small areas) into five equal groups based on ranking of the Wales Index of Multiple Deprivation.

Figure 8. Total number of head injury emergency department attendances by quintile of deprivation in children aged 0-18 years in Wales between 2010-2013.



Source: EDDS, CAPIC

3. Causes of head injuries

Whilst this report endeavours to use Welsh data whenever possible, detailed data on the causes of head injury are not currently collected in Wales. This is due to inadequacies in the current emergency department computer systems. Therefore the following section draws on information and trends from other countries in order to provide a more detailed understanding of the causes of head injuries in children and young people.

The following information has been gathered from analyses of the JAMIE (Joint Action on Monitoring Injuries in Europe) dataset, provided by Swansea University. JAMIE was a European joint action programme based on the Injury Data Base (IDB) emergency department based surveillance system for injury prevention with 14 contributing countries (Austria, Cyprus, Czech Republic, Germany, Denmark, Greece, Italy, Latvia, Malta, Netherlands, Romania, Sweden, Slovenia, Turkey).

Further information on JAMIE can be found at:
http://www.eurosafe.eu.com/csi/eurosafe2006.nsf/wwwAssets/D5FC1077E7DC33FCC1257C120038002B/$file/Flyer%20JAMIE_October%202013.pdf

All JAMIE data is taken from the EU Injury Database (IDB), using the Full Data Set (FDS) dictionary; *European Association for Injury Prevention (Eurosafe) (2013). IDN-JAMIE Full Data Set (IDB-FDS) Data Dictionary, Version 1.3. November 2013, Amsterdam: Eurosafe.* Further information is available at: http://ec.europa.eu/health/data_collection/databases/idb/

The following figures show that falls account for the majority of head injuries in all age groups, with the exception of the 15-18 years age group. In this age group, contact with a person or object are the main mechanisms for head injury.

Figure 9: Top 10 mechanisms of head injury for children aged 0-1 years in 14 European countries (2010-2012)

Mechanism causing head injury (0-1)	% of all head injuries	% of all injuries
Falling from height (less than 1 metre)	33.27%	18.43%
Falling from unspecified height	26.21%	14.52%
Falling from height (more than 1 metre)	8.38%	4.64%
Other falling on same level	4.97%	2.75%
Falling/stumbling by tripping on same level	4.62%	2.56%
Falling on stairs/steps	3.90%	2.16%
Unspecified falling	3.50%	1.94%
Contact with moving object	3.42%	1.89%
Contact with static object	3.42%	1.89%
Other specified blunt force	1.12%	0.62%

Source: JAMIE (IDB-FDS) 2010-2012

As with the 0-1 year age group (figure 9), the leading mechanism for head injury in the 1-4 year age group is falling from a height, as shown in figure 10. The World Health Organization Europe has identified that falls are the leading cause of traumatic brain injury in young children. In Sweden, half of all mild brain injuries in young children (0-4 years) are associated with falls from child-care and nursery products. In particular, high chairs, changing tables and bunk-beds have been cited as amongst the most common causes[7].

Appendix 1 of this report gives additional information regarding high chair head injuries.

Figure 10: Top 10 mechanisms of head injury for children aged 1-4 years in 14 European countries (2010-2012)

Mechanism causing head injury (1-4)	% of all head injuries	% of all injuries
Falling from height (less than 1 metre)	15.84%	4.79%
Falling from unspecified height	14.18%	4.29%
Falling/stumbling by tripping on same level	12.55%	3.80%
Other falling on same level	10.99%	3.32%
Contact with moving object	8.48%	2.57%
Contact with static object	7.27%	2.20%
Falling from height (more than 1 metre)	6.80%	2.06%
Unspecified falling	5.07%	1.53%
Falling on stairs/steps	4.75%	1.44%
Falling/stumbling by slipping on same level	1.74%	0.53%

Source: JAMIE (IDB-FDS) 2010-2012

As children age, their physical and cognitive abilities increase. As a result of this, their activities become more varied and consequently, influence injury mechanisms, as shown in figure 11.

Figure 11: Top 10 mechanisms of head injury for children aged 5-9 years in 14 European countries 2010-2012

Mechanism causing head injury (5-9)	% of all head injuries	% of all injuries
Contact with moving object	12.58%	2.01%
Falling/stumbling by tripping on same level	11.24%	1.79%
Other falling on same level	10.95%	1.75%
Contact with static object	9.79%	1.56%
Falling from unspecified height	8.72%	1.39%
Falling from height (less than 1 metre)	7.99%	1.27%
Falling from height (more than 1 metre)	7.27%	1.16%
Unspecified falling	4.93%	0.79%
Struck or kicked by a person	3.27%	0.52%
Falling/stumbling by slipping on same level	3.13%	0.50%

Source: JAMIE (IDB-FDS) 2010-2012

However, there is a gap in the depth of understanding on how head injuries in the 10-14 year age group are caused. One issue is that children within this age group are more likely to play sports and there is an increased risk of head injury during particular sports. The scale of the risk is not particularly well studied, nor is a competing argument that sport helps in development and may reduce risk from other causes of head injury.

The School Sports Survey (Sports Wales) 2013, shows that participation in sport increases in years 3-6 (age 7-11 years), and generally decreases in years 7-11 (age 11-16 years) [8].

More research is needed on the relationship between exposure to different sports and a broad range of measures of health and wellbeing to determine the net contribution of sports. Wales is fortunate in having the world leading Secure Anonymised Information Linkage (SAIL) system that allows data to be linked whilst protecting privacy[9, 10]. It would be tremendous if it proved possible to use this system to link sports participation and survey with a broad range of health and social outcomes data to help clarify the risks and benefits of participation in different sports.

Current Welsh data from EDDS was not used due to the high number of unspecified fields for sports related head injuries (approximately 85%). To provide a more detailed insight into the types of sports that commonly result in head injuries, appendix 2 of this report gives European trends by age groups. It should be noted that these figures are absolute numbers and do not take into account variations in exposure e.g. numbers participating.

The following figure provides frequency distributions of the mechanisms causing head injuries in the European IDB in younger and older teenagers.

Figure 12: Top 10 mechanisms of head injury for children aged 10-14 years in 14 European countries (2010-2012)

Mechanism causing head injury (10-14)	% of all head injuries	% of all injuries
Contact with moving object	13.79%	1.11%
Other fall on same level	10.77%	0.87%
Falling/stumbling by tripping on same level	10.29%	0.83%
Contact with static object	9.54%	0.77%
Struck or kicked by a person	9.51%	0.77%
Falling from height (more than 1 metre)	8.94%	0.72%
Falling from height (less than 1 metre)	5.05%	0.41%
Unspecified falling	4.20%	0.34%
Falling from unspecified height	3.83%	0.31%
Falling/stumbling by slipping on same level	3.74%	0.30%

Source: JAMIE (IDB-FDS) 2010-2012

Figure 13: Top 10 mechanisms of head injury for children aged 15-18 years in 14 European countries (2010-2012)

Mechanism causing head injury (15-18)	% of all head injuries	% of all injuries
Struck or kicked by a person	16.88%	1.70%
Contact with moving object	15.15%	1.53%
Contact with static object	9.15%	0.92%
Falling from height (more than 1 metre)	7.61%	0.77%
Other falling on same level	6.97%	0.70%
Falling/stumbling by tripping on same level	6.75%	0.68%
Other specified contact with a person	3.55%	0.36%
Falling from height (less than 1 metre)	3.07%	0.31%
Unspecified falling	2.77%	0.28%
Falling/stumbling by slipping on same level	2.31%	0.23%

Source: JAMIE (IDB-FDS) 2010-2012

Welsh Government has mandated the collection of the JAMIE Minimum Data Set. This is included in the specification of the new emergency department computer system being introduced in 2015. Whilst it does not include the level of detail in the Full Data Set, it will be a tremendous asset in helping understand the causes (and locations) of injuries and in evaluating preventive efforts.

4. Impact of head injuries

The impact of head injuries varies greatly, depending on factors such as the severity, extent and location of injuries. Many cases appear to suffer no harm but this depends on how hard one looks. Effects can be obvious or very subtle and are categorized by Headway (the brain injury association) into Physical, Cognitive and Emotional & behavioural problem domains[3]. Physical consequences include effects such as; excessive tiredness, reduced mobility and difficulties with speech. Cognitive consequences include reduction in concentration, motivation and speed of information processing, impaired reasoning and judgement. Emotional and behavioural consequences include loss of confidence, depression, anxiety and anger.

NICE state that the incidence of problems after head injury is higher than had been previously appreciated. In a Glasgow study of head injury admission in 1995/1996, 47% of patients (all ages) followed up for one year after discharge had some form of restriction to their lifestyle[1].

Headway also cites studies that look at the prevalence of post-concussion symptoms after minor brain injuries. These studies vary in their criteria and therefore their results, but show; i) 20-50% of people having symptoms beyond three months[11, 12]; ii) up to 40% had symptoms twelve months after injury[13].

A recent study (Gabbe et al, 2013) of 90,661 children with linked anonymised records from the Wales Electronic Cohort for Children demonstrated association between severe childhood head injuries and poorer educational attainment at Key Stage 1 (KS1) of the National Curriculum assessment. This study found that children who sustained intracranial injury demonstrated significantly lower chances of achieving a satisfactory KS1 result than children who had not been admitted to hospital for head injury. Gabbe et al showed that of the 90,371 children without head injury, 81% had achieved a satisfactory KS1 assessment result. For those children who had received a head injury, 77% of concussion, 74% of skull fracture and 66% of intracranial injuries achieved a satisfactory KS1 result[4].

This study also acknowledges a number of studies where poorer academic achievement following head injuries has been attributed to behavioural problems, deficits in memory and attention, information processing speeds and motor skills[4]. These large scale studies are very helpful in quantifying longer term health and social outcomes. As mentioned earlier such a system could be used to study the magnitude of the potential benefits and harms of participating in a variety of sporting activities.

5. Financial burden of head injuries

As well as the emotional and physical impact of head injuries to children, their families and society as a whole, head injuries place an enormous financial burden on health and social care services and again, on families.

Direct medical costs are cited by the Department of Health (England, 2012/13) as an average of £114 per patient attending ED and £1,161 per in-patient admission[14]. Based on the average number of head injuries (age 0-18 years) attending or admitted to hospital in Wales each year (2010-2013), this has a direct medical cost of over £3.8m for ED attendances and around £3.1m for hospital admissions. These costs do not account for specialised treatment or long-term medical and social care.

The Meningitis Research Foundation has detailed the lifelong medical, educational and social costs involved in caring for and supporting a three year old child experiencing severe neurological damage. The Child Accident Prevention Trust, on their website *Making the link*, show these costs in detail and state that although the brain injury detailed is caused by meningitis rather than trauma, the treatment, rehabilitation and long-term needs are comparable to those required by a severe traumatic brain injury[15].

Figure 14. An indication of the lifelong medical, educational and social costs for one child who suffers a severe traumatic brain injury at age three

Category of costs	Description	Approx. lifelong cost
Medical	Acute care (including PICU and rehabilitation), outpatient appointments, community health services, general health problems, special equipment to aid mobility, communication and day-to-day activities	£268,000
Educational	Additional cost of attending special education needs (SEN) schools, transport to and from schools, SEN statements	£238,000
Direct social costs	Social care assessments, direct payments for home care workers, grants for adaptations, residential respite breaks, residential care from the age of 40	£1.19m
Missed employment	Missed employment opportunities for the child and the parent who gives up work to be a full-time carer	£1.73m
Cost to government in lost tax revenue	Lost income tax revenue for parent and child	£346,000
Cost to government in benefits	Transfer payments including Disability Living Allowance, Carers' Allowance and child tax credits	£1.12m
Total cost of lifelong care and support		**£4.89m**

Source: Making the link website, Child Accident Prevention Trust and Counting the cost: a severe case of bacterial meningitis, The Meningitis Research Foundation 2011

6. Prevention of head injuries

The prevention of head injuries cannot necessarily be addressed in isolation from exposures that may result in many different injuries. They are only one piece of the wider unintentional injury picture. In order to effectively address head injuries a variety of national and local measures need to be in place. The first section of this report identifies national measures that have been identified by expert bodies as being needed to support general head injury prevention, with subsequent sections of this report providing effective interventions to reduce age or mechanism specific head injuries.

6.1 National injury prevention

The World Health Organization Europe (WHO Europe 2008) has identified the need for countries to implement a sustained and systematic approach to unintentional injury prevention. They have identified that the following national policies, infrastructures and actions should be in place in order to effectively reduce the number of injuries in children and young people[6].

Table 1: Recommended injury prevention actions, World Health Organization Europe 2008

Action	Rationale
Provide leadership in integrating the prevention of injury into a comprehensive approach to their health and development	A comprehensive strategy for the health and development of children and adolescents needs to include injury because it is the leading cause of death and disability among children
Develop and implement a policy and plan for preventing injury among children that involves other sectors	Intersectoral activities are essential for successfully preventing injury. Efforts should include sectors of government, nongovernmental organizations, private sector, mass media and the public. A comprehensive policy framework would overcome the fragmented approach to preventing injuries
Implement evidence-based action to prevent and control injuries among children	Key approaches need to include legislation, regulation and enforcement, modifying products and the environment, education and developing skills and emergency health care
Strengthen health systems to address injuries among children	Health system responses need to incorporate both primary prevention and the provision of high-quality trauma care
Build capacity and exchange best practice	Curricula that focus on preventing injury need to be integrated into health professional curricula. Exchanging knowledge by developing partnerships and networks strengthens country capacity
Enhance the quality and quantity of data for preventing injury among children	Good data on mortality, morbidity, exposure, outcomes and costs are needed to provide a foundation on which to develop and monitor policies that promote child safety
Define priorities for and support research and evaluation on the causes, effects, costs and prevention of injury	A research agenda for injuries among children needs to be developed at European and national levels
Raise awareness and target investment for preventing injury among children	Raising awareness about the ability to prevent injury among children is of paramount importance. Health systems need to advocate for safer broad government policy on ensuring safer physical environments
Address inequity in injury among children	The health sector has a key role to play in advocating for just action and can do this by promoting equity in health in all policies and by highlighting injuries as a consequence of social policies. The health sector needs to incorporate the prevention of injury in its provision of universal primary health care and support of community based action

The actions recommended by WHO (table 1) are also reiterated by the European Child Safety Alliance (ECSA) in their *Child Safety Report Card for Wales 2012*[16]. Whilst some of these recommended actions are specifically aimed at addressing head injuries, others address policy, practice and legislation that would be effective in supporting unintentional injury prevention as a whole (table 2).

Table 2: Recommended injury prevention actions for Wales, European Child Safety Alliance 2012

Action	Commentary
Further legislative powers	Welsh Government could enhance child safety by seeking further legislative powers to allow amendment/changes of legislation [UK]
Identification of a ministerial lead for child safety	Identification of a ministerial lead for child safety in Wales would provide a focal point for ministerial departments to enable a coordinated approach across government
Enhancing pedestrian safety	Implementing a policy of placing 20mph zones around every primary school and an evidence-based roadside education programme for all primary aged children
Enhancing passenger/driver safety	Introducing national laws that require children to remain seated rear facing in cars until the age of 4 years and seated in the back seat until the age of 13 years and introducing graduated licences for newly qualified drivers
Enhancing cycling safety	The implementation and enforcement of cycle helmet law for all ages
Increasing fall prevention	Enhancing current laws and building regulations related to preventing children from falling out of windows or from balconies or stairs in buildings with more than one storey and by enhancing enforcement of national standards on playground equipment and landing surfaces
Increasing practitioner and public awareness	Increase awareness of child injury risks in the home and effective prevention solutions
Continuing to improve home injury prevention programmes	Improve home injury prevention programmes through practitioner education and effective home safety equipment schemes

Source: European Child Safety Report Card for Wales 2012, European Child Safety Alliance and Eurosafe[16]

In 2012, Public Health Wales NHS Trust , Swansea University and CAPIC produced the *Burden of Injury in Wales* report[17]. This document comprehensively measured the burden of injuries on the Welsh population. Three major recommendations emerged from this report, all of which reiterate those made by WHO and ECSA (tables 1 and 2).

These recommendations and corresponding commentary are shown in table 3.

Table 3: Recommendations from the Burden of Injury in Wales 2012 report, Public Health Wales NHS Trust (PHW), Swansea University and CAPIC

Action	Commentary [edited for the purposes of this report]
ED injury data collection needs to be improved. This will require action from policy makers, health board executives and managers, ED staff and the general public	EDs are uniquely placed to support injury prevention and reduce future demand on their own services. Data quality and coding remains poor. Wales has been a key participant in the development of a new European Minimum Data Set and part of the JAMIE project. It is important to see this continue with the implementation of the JAMIE dataset in Wales. To collect this data will require support and action at all levels.
Injury prevention in Wales needs to be more collaborative and cross-sectoral so that there are greater benefits and the burden of injuries on health is reduced more quickly and more effectively	The collection of information on injuries acts as a stimulus for prevention. There are many Welsh Government strategies and programmes which relate to injury prevention, however practitioners in local authorities, health boards and a variety of other agencies and charities struggle to find accurate information on where best to target interventions and to evaluate their effectiveness. Improving the effectiveness of injury prevention is key to reducing the enormous impact of injuries. A central, ideally Ministerial, point of contact and therefore accountability is needed. In the absence of a Ministerial or Welsh Government role, a suitable appointment is needed to facilitate collaboration and coordination of effort to reduce the burden of injury.
Injury prevention should be recognised as a key public health priority, with greater commitment and capacity to support the implementation of evidence-based injury prevention and control initiatives	The scale of the burden of injuries supports the need for urgent action. Injury prevention needs to be prioritised in a public health context by Welsh Government, Public Health Wales and Health Boards. More indirectly, local authorities and others with an interest in this area need to take action. Focussed discussion about these data, their meaning, the evidence base and planning to implement this is now needed. Action is the key to reducing this burden and further strategy development at local levels is not recommended. To support this, greater effort is now needed, particularly by Welsh Government, to implement the evidence based interventions highlighted by the Child Safety Report Card Wales

Source: The Burden of Injury in Wales 2012 report. Public Health Wales NHS Trust, Swansea University and CAPIC

NICE (2010) has also issued overarching public health guidelines on the prevention of unintentional injuries among children under the age of 15 (PH29)[18]. Table 4 gives an overview of these recommendations in relation to national and local level interventions. As illustrated in tables 1, 2 and 3, these recommendations echo those of WHO, ECSA and Eurosafe, PHW, Swansea University and CAPIC.

The NICE public health guidelines and the recommendations can be viewed in full via the following links:

- **Strategies to prevent injuries among the under 15s**

https://www.nice.org.uk/guidance/ph29/resources/guidance-strategies-to-prevent-unintentional-injuries-among-the-under15s-pdf

- **Preventing unintentional injuries among the under 15s in the home (PH30)**

https://www.nice.org.uk/guidance/ph30/resources/guidance-preventing-unintentional-injuries-among-the-under15s-in-the-home-pdf

- **Preventing unintentional road injuries among the under 15s (PH31)**

https://www.nice.org.uk/guidance/ph31/resources/guidance-preventing-unintentional-road-injuries-among-under15s-pdf

Table 4: Recommendations from NICE guidelines (PH29) 2010. An overview

Recommendation	What action should be taken (overview)
Incorporate unintentional injury prevention within local and national plans and strategies (PH29)	Local and national plans should include a commitment to preventing unintentional injury and should include the following: - support for cross departmental, agency and partnership working - support for data collection and monitoring - support for the development of the workforce, including ongoing training and development
Coordinating unintentional injury prevention activities (PH29)	Ensure there is a child injury prevention coordinator in each local authority area
Developing professional standards for injury prevention (PH29)	Development of professional standards for unintentional injury prevention, taking into account the different roles and responsibilities of professionals and ensure all relevant organisations incorporate these standards
Funding the development of injury prevention standards and curricula (PH29)	Funding for educational establishment and organisations to help them develop standards for competencies in the prevention of unintentional injuries
Providing the wider childcare workforce with access to injury prevention training (PH29)	Provide access to appropriate training. Ensure the training helps to develop an understanding of the importance of preventing unintentional injuries and the preventative measures available
Establish a national injuries surveillance resource (PH29)	This should cover all populations and injuries and help to monitor injury risks and the effects of preventive measures. The coordinating agency should disseminate this information
Installation and maintenance of permanent safety equipment in social and rented dwellings (PH29)	Permanent safety equipment should include hard-wired smoke alarms, carbon monoxide alarms, thermostatic mixer valves for baths and window restrictors
Incorporating guidance on home safety assessments within relevant national initiatives	Ensure initiatives include guidance on delivering home safety assessments and providing safety education to families. These assessments should also be incorporated into local plans and strategies
Developing policies for public outdoor play and leisure	These policies should take into account the principles of British and European standards covering equipment and the environment
Promoting and enforcing speed reduction	Education and media campaigns to promote the benefits of safety initiatives, including 20mph speed limits and zones

Source: NICE: Strategies to prevent unintentional injuries among the under 15s. (PH29)2010

6.2 Preventing head injuries - falls

The World Health Organization has identified that falls prevention is reliant on the combination of a number of strategies and evidence based interventions[6].

The following interventions are evidence based and are recommended and supported by the following organisations and bodies; WHO, ECSA, Eurosafe, NICE, Children in Wales (CiW), Child Accident Prevention Trust (CAPT) and the Royal Society for the Prevention of Accidents (RoSPA).

Table 5: Evidence based effective interventions to reduce head injuries as the result of a fall

Evidence based effective interventions
Home based social support programmes for new mothers to educate them of the dangers and the need to use safety equipment
Provision of safety equipment such as safety gates, window restrictors and high chair harnesses/straps
Legislation to amend building codes for new dwellings to require all steps and staircases to have a rise not exceeding 170mm and a tread depth of at least 250mm, as well as barriers on balconies, stairs and galleries
A ban or government support of a European ban **on the use of babywalkers**
Specific changes to British and European standards for nursery and childcare products to increase the safety of these items, in particular high chairs, safety gates, window restrictors and babywalkers
Effective implementation of **playground standards**

Head injuries are more common in the 1-4 age group. In addressing this issue, home based social support and/or parenting programmes would be beneficial in reducing the risk of head injuries in this age group. Current Welsh Government guidance, *Parenting in Wales* (2014), advocates a number of parenting programmes. However, unintentional injury prevention is only included as a core part of one namely the Incredible Years programme[19]. The opportunity exists in Wales for home safety to be included into all of the government approved parenting programmes.

With the risk of head injury being substantially higher for those living in the most deprived fifth of Wales, combining parental education with the provision of free home safety equipment would help to reduce inequitable injury risk.

6.3 Preventing head injuries - cycling

For many years, cycle helmet use has been globally recognised as being effective in reducing the number and severity of head injuries in children. The WHO, ECSA, Eurosafe, NICE and the NHS all recommend the use of correctly fitted and properly worn helmets for children.

Estimates show that each euro spent on cycle helmets leads to a saving of €29 in health care spending (WHO 2008). Given the known benefits of cycle helmet use, some countries have chosen to introduce legislation to ensure that children and young people wear helmets, whilst others promote helmet use through educational interventions, which include the provision of free helmets.

The *Burden of Injury in Wales 2012* report identifies two studies that have used both of these interventions effectively. The non-legislative intervention (Owen et al 2011) showed that community based intervention and those that provide free helmets are most effective, followed by school based interventions. Those delivering education along with free helmets worked better than education only. The study also found that interventions targeting children under the age of 12 years has a statistically significant impact. Those targeting over 12 years of age, did not. In the legislative study (Macpherson et al 2008) it was found that legislating helmet use increased usage and reduced the incidence of head injuries. A 45% reduction in head injuries was reported in Canadian provinces following helmet legislation.

In October 2014, Jersey introduced legislation making it compulsory for children aged 13 years and under to wear cycle helmets when riding a bicycle on a road or a cycle track. In gathering information for this legislation, the government of Jersey commissioned the Transport Research Laboratory to review the evidence. In the *Jersey Scrutiny Review: Compulsory wearing of cycle helmets* (TRL 2014)[20], the following conclusions were made:

Table 6: Findings from the Jersey Scrutiny Review: Compulsory wearing of cycle helmets (TRL 2014)

Findings from the Jersey Scrutiny Review

The effectiveness of helmets in the event of a collision Although they cannot be expected to be protective in all collision types, the evidence is clear that helmets are effective at reducing injuries: • Helmets dramatically reduce head injury metrics in tests with crash dummy head-forms and paediatric skulls. • A large number of studies show that helmet wearers, if involved in a collision, suffer fewer head injuries than un-helmeted cyclists. • When considering the situations in which helmets will be most effective it should be noted that these tend to be the types of collision which are most common among cyclists (non-vehicle collisions such as falls). • It should also be noted that most studies focus on the prevention of head injuries; there may be benefits associated with reducing the severity of an injury, e.g. from severe to moderate, that are not accounted for in these studies.
The impact of helmet legislation on injuries The evidence as a whole suggests that mandatory cycle helmet legislation is associated with a reduction in reported head injuries (including injuries to the face and neck), for cyclists of all ages.
The impact of helmet legislation on cycling activity The evidence on the impact of helmet legislation on cycling activity does not provide a definitive answer, although the weight of evidence suggests that if legislation has any effect on the amount of cycling, it tends to be a small and short-term reduction in child cycling. The very large reductions often sometimes cited by opponents of cycle helmet legislation, which have been based on early analyses of observations of cycling rates in Australia in the 1990s, have not been observed elsewhere.

The Jersey Scrutiny Review concluded that legislation requiring the wearing of cycle helmets in Jersey is expected to have a beneficial effect on the injury rates of those impacted by the legislation, especially in collisions that do not involve motor vehicles and that such legislation seems unlikely to have a major impact on cycling activity in Jersey.

There are a number of individuals and groups that are opposed to compulsory helmet wearing on the grounds that most of the injuries are caused by collisions with motor vehicles and that sufficient investment needs to be made in safe cycling routes. This report also supports the development of safe cycling routes and measures to reduce brain injuries in children by increasing cycle helmet usage.

6.4 Preventing head injuries – on the road

There are numerous road safety interventions that are recognised as effective in reducing the number of children and young people who are injured on the road. An overview of these evidence based interventions is given in table 7. These recommendations target road injury prevention in general and are therefore also relevant to the prevention of head injuries.

Table 7: Overview of recommendations to reduce road injuries (WHO, ECSA and NICE)

Recommendation	What action should be taken (overview)
Engineering measures (WHO[6])	- Reducing speed through safer road design: speed humps, mini-roundabouts, pedestrian crossing and islands, visual changes, redistribution of traffic - Setting the speed limits (minimum of 30km/h in residential areas and around schools - Safe play areas and safe access to them - Safe routes to school, including 'walking buses', school safety zones with further reduced speed limits - Separation of cyclists from other road user, including cycle lanes, barriers or kerbs
Vehicle design (WHO[6])	Including crumple zones, side impact bars, redesigning car front, facilities to fit child restraints (car seats), increased visibility aids for reversing (audible alarms, reversing lights)
Safety equipment (WHO[6])	Child restraint systems, seat-belts, cycle helmets
Graduated driver licensing (WHO[6])	These schemes typically address restrictions to passengers, speed, driving at night, mobile phone use
Rear facing car seats until age 4 years(ECSA[16])	Provide access to appropriate training. Ensure the training helps to develop an understanding of the importance of preventing unintentional injuries and the preventative measures available
20 mph zones (NICE[21])	Implement city or town-wide 20mph limits and zones on appropriate roads
Popular routes (NICE[21])	Consider opportunities to develop engineering measures to provide safer routes (commonly used by children and young people), including to school

The problem here is that investment in these interventions have been too little and small scale. There are many benefits from slow speed environments. Some cities, e.g. Portsmouth, have introduced 20mph zones throughout whereas in others it is piecemeal. The Advocacy for Pedestrian Safety study showed that only about a quarter of schools in deprived areas of England and Wales had 20mph zones or Safe Routes to School in 2007[22].

6.5 Preventing head injuries – sports

There is considerable interest in concussive injuries in sport currently, particularly for rugby union. Much of the focus has been on the identification of concussion and management, particularly designed to reduce second impact syndrome. Guidelines were recently published, supported by Welsh Government, on identifying and dealing with such injuries[2]. It is too soon to measure the impact of these guidelines.

The use of protective headgear is often cited as effective in reducing head injuries. In a systematic review of the relevant literature, Benson et al (2009) concluded that whilst helmet use has been shown to decrease head and brain injury risk among cyclists and head injury among skiers and snowboarders, there is inconclusive evidence that helmets are effective in reducing concussion risk. Their review also considered the use of headgear during rugby and although results varied between studies, the review found no significant differences in concussion rates between headgear and non-headgear wearing players[23].

Table 8 shows evidence based recommendations that are supported by national organisations in United States of America and Canada.

Table 8: Overview of recommendations to reduce head injuries in sport (Canadian Concussion Collaborative (CCC[24]), The British Columbia Injury Research and Prevention Unit (BCIRPU[25]), Brain Injury Alliance (BIA[26]) and American Society for Sports Medicine (ASSM[27])).

Recommendation	What action should be taken (overview)
Policy development (CCC)	All sport organising bodies, including schools, amateur and professional bodies, should be required to develop/adapt and implement a concussion management protocol. In order to define roles, this requires the development of regulations or legislation by national sports bodies, public health organisations and government.
Safe equipment (BCIRPU, BIA, ASSM)	The use of helmets and padded posts, where appropriate. All equipment should be well maintained, properly fitted and correctly used at all times and appropriate to the sporting activity.
Basic skills (CCC, BIA, BCIRPU, ASSM)	Teaching basic skills and techniques of a specific sport (e.g. tackling or heading a ball).
Respect and fair play (CCC, BCIRPU, BIA, ASSM)	Teaching respect and fair play and ensuring stringent enforcement of, and strict adherence to the rules.
Concussion awareness(CCC, BCIRPU, BIA, ASSM)	Education for players, parents, coaching staff, managers, schools and other educational bodies, medical staff and amateur sporting bodies
Legislation (ASSM)	Concussion related legislation in many states requires education of athletes, parents and coaches, removal from play protocols, return to play protocols (signed off by a healthcare provider trained in the evaluation and management of concussion).

7. Conclusion

Head injuries are common among Welsh children with some 33,000 attending emergency departments each year.

The numbers appear to be increasing but the causes behind this are not well understood.

Head injuries are more common in boys and rates are highest in those aged 1-4 years where falls are the leading cause.

Head injuries are around twice as common in children from the most deprived communities.

Improvements in the coding of emergency department data, with the introduction of the Joint Action on Monitoring Injuries in Europe (JAMIE) Minimum Data Set, will further our understanding of the scale and underlying causes.

There is considerable evidence for many short and long term adverse consequences of head injury, including psychological and behavioural problems and poorer school performance for those worst injured.

There are a number of evidence based guidelines on the prevention of childhood injuries that, if implemented in full, would reduce the incidence and consequence of injuries, including those in the home (parenting and safety equipment) and on the road (slower speeds, safe routes to school, etc).

Potential risks and benefits from sports participation are not very well characterised and there are opportunities to carry out further research in this area to clarify these issues.

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Appendix 1

High chair injuries

The UK Home and Leisure Accident Surveillance System (HASS & LASS) identified an average of 3,432 children attending ED as the result of an injury caused by a high chair (average over 3 year period between 2000-2003). From the available data, it is not possible to gain detailed information as to how these unintentional injuries happened. However, based on the narrative information of HASS and LASS, the majority of children who were injured were either not strapped into their high chair or were poorly/incorrectly strapped.

The European Child Safety Alliance (ECSA) and Eurosafe have identified that the majority of injuries from high chairs are as a result of a fall, primarily when restraining straps are not used properly[28].

ECSA also identifies that the majority of deaths occur when children slip down under the tray and are strangled. Most often, these children were either unrestrained or were restrained only by a waist belt.

Of the 14 participating 'JAMIE' countries, head injuries sustained by falling from a high chair accounted for 1.68% (0-1 year) and 0.89% (1-4 years) of all injuries and 2.46% and 1.65% respectively of all head injuries. Whilst these injuries are small in number, it is of note that 81% (0-1 year) and 56% (1-4 years) of all high chair falls did result in a head injury (JAMIE IDB 2010-2012).

Figure 1a: High chair injury trends by age and gender, (JAMIE countries 2010-2012)

Source: EU IDB (Injury Database) 2008-2012

In preventing falls from high chairs, ECSA and Eurosafe recommend that the high chair is fitted with a five-point harness (waist, shoulder and crotch straps). Under the current regulations and standards (EN & BS) in Europe and the UK, there is no mandatory requirement that high chairs are fitted with a five-point harness, only that high chairs must be manufactured with fixing points for such items.

The cost of a five-point harness is around £3.00.

Appendix 2

Head injuries in sports

The JAMIE data shows which sports are most commonly associated with head injuries. It should be noted that popularity of specific sports may differ between countries and therefore this data is not necessarily reflective of sports commonly associated head injuries in Wales.

Tables below show top 10 sports across Europe resulting in head injuries, by age group. These are derived from analyses of the European Injury Data Base (IDB).

Table 1a: Top 10 sports most commonly associated with head injuries (2010-2012) across 14 participating JAMIE Countries

Most common sports for head injuries, 5-9 years	Most common sports for head injuries, 10-14 years	Most common sports for head injuries, 15-19 years
Swimming	Soccer	Soccer- unspecified
Soccer – outdoor	Trail or general horseback riding	Soccer - outdoors
Ice skating/ice dancing	Soccer - unspecified	Trail or general horseback riding
Gymnastics – unspecified	Hockey – ice	Hockey – ice
Cycling - unspecified	Swimming	Other specified team bat or stick
Trail or general horseback riding	Gymnastics - unspecified	Handball - team
Soccer - unspecified	Handball - team	Snowboarding
Skiing - slalom	Skiing - slalom	Hockey - field
Unspecified ice or snow sport	Ice skating/ice dancing	Basketball
Gymnastic trampoline	Cycling - unspecified	Gymnastics - unspecified

The data for sports that are commonly associated with head injuries are not available for Wales. However, Welsh data are available on the types of sports that children most commonly participate in. Whilst this is not reflective of which sports are most commonly associated with head injuries in Wales, when viewed in conjunction with the head injury information in table 1a, may provide a greater understanding of which sports in Wales are likely to increase the risk of head injuries.

The information in tables 2a, 3a, 4a and 5a is taken from the School Sport Survey 2013: Headline results – Years 3-11, Sport Wales. Further information on sports participation can be found at:
http://sportwales.org.uk/research--policy/surveys-and-statistics/statistics.aspx

Table 2a: Most common participation in sport, ages 7-16 years, Wales 2013

Most common participation in sport, any setting (extracurricular, club or other). Years 3-11 (7-16 years)
Football
Swimming
Rugby
Tennis
Cycling
Rounders/baseball/softball
Athletics
Dodgeball
Dance
Netball

Source: School Sport Survey Wales 2013, Sport Wales

Table 3a: Most common extracurricular sports activities undertaken by 11-16 year old in Wales 2013

Most common extracurricular sports activities undertaken by 11-16 year olds
Football
Rugby
Netball
Athletics
Gymnastics
Hockey
Swimming
Dance
Cross county running
Cricket

Source: School Sport Survey Wales 2013, Sport Wales

The final tables (4a and 5a) show the most common curricular sports activities undertaken in secondary schools by gender.

Tables 4a and 5a: Most common curricular sports activities undertaken in secondary schools, by gender in Wales 2013

Most common curricular sports activities undertaken by boys in secondary school	Most common curricular sports activities undertaken by girls in secondary school
Football	Netball
Rugby	Athletics
Athletics	Gymnastics
Basketball	Baseball/rounders/softball
Gymnastics	Hockey
Cricket	Dance
Baseball/rounders/softball	Tennis
Cross country running	Cross country running
Circuit training	Circuit training
Tennis	Fitness classes

Source: School Sport Survey Wales 2013, Sport Wales

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February 2015