THE ROYAL SOCIETY FOR THE PREVENTION OF ACCIDENTS
RoSPA

THE EFFECTIVENESS OF CYCLE HELMETS

A synopsis of selected research papers and medical articles

LAST UPDATED: JUNE 2003

1. "Should pedal cyclists wear helmets? A comparison of head injuries sustained by pedal cyclists and motorcyclists in road traffic accidents", E A Waters, Injury Vol. 17 1986

A study of 538 motorcyclists and 523 pedal cyclists who attended the A&E Ward of University Hospital in Nottingham following a road accident, including post mortem reports of 19 pedal cyclists and 87 motorcyclists who died. Pedal cyclists who died more commonly suffered head injuries than motorcyclists who died. Pedal cyclists who survived also sustained head injuries more commonly than motorcyclists who survived.

Head injury was more likely to be the main (or only) cause of death for pedal cyclists whereas motorcyclists who died usually suffered other major injuries, but less severe head injuries. The report concludes that head protection could reduce the incidence and severity of head injuries among pedal cyclists

2. "Head Injuries in Pedal Cyclists: How Much Will Protection Help?" J Worrel, Injury No. 18, 1987

A study of 100 consecutive head injuries in cyclists admitted to the Queen Alexandra Hospital in Portsmouth found that 70% of the cyclists' heads hit the road first, and 17% hit a flat, yielding surface, like a car body panel. The sites of impacts on the cyclists' heads were plotted, and it was estimated that at least 50% of the impact sites would have been covered by a helmet.

3. "Do Bicycle Safety Helmets Reduce Severity of Head Injury in Real Crashes?" Margaret Dorsch et al, Accident Analysis & Prevention Vol. 19, No 3 1987

An Australian study which investigated 197 cycling accidents in which the cyclist struck his/her head or helmet. At the time of the accident 75 were not wearing any helmet, 69 were wearing a hairnet-style helmet, 37 a 'poor' hardshell helmet, and only 16 were wearing a 'good' hardshell helmet. Those who were not wearing helmets were more likely to suffer head injuries. The report concluded that 'good' hardshell helmets would prevent 90% of the deaths due to head injury in a group similar to the unhelmeted group in the study.

4. "When Are Cyclists Going to Wear Helmets" Lancet Jan 23 1988

An editorial article stating that a high proportion of cyclist casualties sustain head injuries and that the use of cycle helmets is one way of reducing death and serious injury. The author writes that "support from the Medical Community is paramount".

5. "Bicycle Helmets: How Effective Are They In Real Accidents?" C L Morfey, University of Southampton 1988

A questionnaire survey of non-fatal bicycle accidents. There were 78 head impacts reported, with 8 of the cyclists involved wearing helmets. These 8 were compared to 24 unhelmeted cyclists involved in similar accidents. Only two of the helmeted cyclists were admitted to hospital compared with 15 - 17 of the unhelmeted ones.

In Sweden hospital accident records of 36 helmeted cyclists were matched to the records of 36 unhelmeted cyclists involved in similar accidents. The injury saving due to wearing a helmet was calculated to be between 1 in 3 and 1 in 2.

Laboratory reconstructions, using a drop rig, of six bicycle accidents in the U.S.A. in which helmets were worn showed a substantial difference between helmets which met the ANSI Z 90.4 standard and those that did not.

6. "Cyclists Need Helmets" John P Bull, British Medical Journal Vol. 296, 23 April 1988

A discussion of the nature of cycling accidents and injuries that argues that many injuries to cyclists could be prevented by better behaviour by other road users and by the use of cycle helmets. It quotes several of the studies listed here and concludes: "the medical evidence for cyclists to wear helmets is strong".

7. "Bicyclists, Helmets and Head Injuries: A Rider-Based Study of Helmet Use and Effectiveness", Wasserman et al American Journal of Public Health, Vol 78, 1988

In the USA 1,000 deaths and 50,000 emergency room visits result from bicycle accidents. Head injuries account for about 85% of the deaths and two-thirds of bicycle related hospital admissions. For this study 516 cyclists aged 10 years or over were interviewed at the roadside during the Summer of 1984 in Burlington. 19% owned a helmet but only 8% were wearing them at the time.

21 of the riders (4%) had struck their head in a riding accident in the previous 18 months, seven of whom sustained a head injury. 8 of the 21 riders were wearing a helmet at the time and 13 were not. None of those wearing a helmet sustained a head injury while 7 of the 13 not wearing a helmet did receive a head injury.

8. "Head Injuries, Helmets, Cycle Lanes and Cyclists" Simpson et al, BMJ Vol. 296, 23 April 1988

A study of 1,831 pedal cyclists who attended the Accident Service in Oxford following a road accident between January 1983 and May 1985. Of these, 52% sustained an injury to the head and/or face. Less than 1% had been wearing a helmet. Head injuries sustained by motorcyclists in built-up areas were compared with head injuries occurring to pedal cyclists. A significantly higher proportion of pedal cyclists (33%) compared with motorcyclists (15%) had head injuries. The report concludes that if cyclists wore helmets the number of head injuries would be reduced. It also concludes that cycle lanes are safer than ordinary roads for pedal cyclists.

9. "Pedal Cycle Accidents - A Hospital Based Study" P Mills, TRRL RR220, 1989

A study of 776 cyclist casualties who attended hospital between June 1984 and May 1985. Over half (53%) of them received a head injury. The report estimated that at least £80m per year could be saved in hospital costs if all cyclists wore helmets.

10. "A Case-Control Study of the Effectiveness of Bicycle Safety Helmets" Thompson et al, New England Journal of Medicine, May 1989

A study conducted at five major hospitals in the Seattle area, USA between December 1986 and December 1987 of cyclists admitted to an emergency room. Of 776 cyclists admitted, 269 had head injuries. 235 of these, and 433 of the 507 cyclists who were admitted with non-head injuries, completed a questionnaire. The study concluded that cycle helmets reduce the risk of head injury by 85% and of brain injury by 88%.

11. "Consumer Reported Helmet Accidents: 600 Swedish Cases", R.Bell, Child Accident Prevention Conference, Sept. 1989

Purchasers of a Swedish cycle helmet for toddlers on bicycle seats were given a five year warranty which allowed them to exchange a helmet damaged in an accident for a new one if they provided a report of the accident which caused the damage. 608 reports were received between 1986 and 1989. All of the accidents resulted in damage to the helmet, but only 4% of the children involved child received a head injury.

12. "Cycle Injuries and Attitudes to Safety Helmets" Ferris et al, British Journal of Accident and Emergency Medicine, December 1989

A three month study of cyclist casualties admitted to Cork hospital, plus a survey of 280 schoolchildren. Nearly half (49%) of the casualties had a head injury, and 80% of these were admitted as in-patients (compared to only 11% of those with other injuries). The school survey showed a resistance to helmet wearing, mostly due to peer group pressure.

13. "Causes of Fatal Childhood Accidents Involving Head Injury in Northern Region, 1979-86" Sharples et al, BMJ November 1990

In the Northern region between 1979 and 1986, 255 fatal child accidents involved head injury. 195 (76%) were fatally injured in road traffic accidents. Of these 135 were killed as pedestrians and 33 as cyclists. The report states "There is an urgent need to provide safe and stimulating play areas close to home in overcrowded and deprived areas and to institute town planning measures to make the urban environment safer for child pedestrians and cyclists".

14. "A Prospective Analysis of Injury Severity Among Helmeted and Nonhelmeted Bicyclists Involved in Collisions with Motor Vehicles" Spaite et al Journal of Trauma Vol. 31, November 1991

284 pedal cyclists were treated in an Emergency Room in the University Medical Centre, Tucson between 1986 and 1989. 116 (41%) were wearing a helmet at the time of the accident and 168 (59%) were not. Of the 168 non-helmeted cyclists, 37 received a major head injury while only 1 of the 116 helmeted cyclists did so. Helmeted cyclists were less likely to sustain severe injuries to the body as a whole than non-helmeted cyclists (possibly because cyclists who wear helmets are more careful riders).

15. "Keep Your Head" Which? August 1991

Which? investigated 18 different helmets (9 samples of each helmet) to assess their performance against the British Standard BS 6863:1989. Which? concluded that 8 of the helmets did not meet the requirements of the British Standard and recommended that consumers not purchase these types.

16. "Cycling: Towards Health & Safety" M. Hillman, British Medical Association, 1992

A review of the overall situation for cyclists in the UK; the health, exercise, transport and environmental benefits of cycling and the risks involved in riding a bicycle. The issue of helmets is one of the topics dealt with by the report, and one of the report's recommendations is that "Children and other cyclists should be encouraged to wear protective helmets". It also concludes that helmets should be seen in the context of other measures that would actually prevent accidents.

17. "Evaluation of the Bicycle Helmet Wearing Law in Victoria During its First 12 Months" M Cameron et al, Monash University Accident Research Centre, Report 32, 1992

A law requiring cyclists to wear an approved helmet was introduced on 1 July 1990 in the State of Victoria. Prior to this, helmet wearing rates had risen from 5% in 1982/83 to 31% in 1989/90. Following the law's introduction, wearing rates rose to 75% in 1990/91. Surveys conducted in 1990 and 1991 revealed a 36% decrease in cycling by children between the two years, but adult bicycle use had increased by 58% since 1987/88.

There was a reduction of 37% to 51% in the number of cyclists killed or admitted to hospital with head injuries in the year following the law. There were also substantial reductions (21% to 24%) in the number of severely injured cyclists who did not have head injuries. The percentage of severely injured cyclists who suffered a head injury in the year following the law was significantly lower than that which would have been expected had pre-law helmet wearing rates continued unchanged. There was an indication that increased helmet wearing following the law had not been as effective in reducing the risk of head injury to crash-involved cyclists as would have been predicted before the law.

18. "Helmets for Pedal Cyclists", Helen Trippe, "Do Cycle Helmets Prevent Serious Head Injury?" Mike McCarthy and Cynthia Illingworth, British Medical Journal Vol. 305, 10 October 1992

Two articles discussing the case for and against the cycle helmets. The first article summarises the debate. It notes that the best ways of protecting cyclists are improved road engineering, traffic calming, segregated cycle facilities and better training and education. But helmets are a good secondary safety measure. It recommends that doctors encourage helmet promotion initiatives, especially ones aimed at children.

The second article comprises two parts: "**Cycling Without Helmets"** and **"The Argument for Helmets"**. The author of the first part argues that car drivers bear the greatest responsibility for road accidents and that helmets are of little use in accidents with other vehicles. Cycling has major health and environmental benefits and should be promoted not deterred.

The second author quotes the high incidence of head injuries among cyclist casualties and several studies in the UK and abroad that have concluded that the use of cycle helmets reduces the risk of head injury.

19. "Cycle Helmets: the Case For and Against" M. Hillman, Policy Studies Institute 1993

An examination of the issues surrounding cycle helmets. It accepts that a large number of studies have concluded that helmet wearing "would be highly beneficial" but criticises them for being based upon small, and sometimes, self-reporting samples. It stresses that helmets are primarily designed to protect cyclists in accidents that do not involve a collision with a motor vehicle. It also claims that cyclists who wear helmets feel safer and so ride in a less careful manner which increases the risk of being involved in an accident.

20. "Effectiveness of bicycle helmets in preventing head injury in children: case-control study" S Thomas et al, British Medical Journal Vol. 308, 15 January 1994

445 children aged 14 years and under attended the Emergency Ward of the two main Children's Hospitals in Brisbane, with bicycle related injuries between April 1991 and June 1992. Of these, 102 sustained injuries to the upper head or lost consciousness. They were compared to 278 children who had other injuries and to 65 children who received facial injuries. It found that wearing a helmet reduced the risk of head injury by 63% and of loss of consciousness by 86%.

21. "Injury patterns in cyclists attending an accident and emergency department: a comparison of helmet wearers and non-wearers" C Maimaris et al, British Medical Journal Vol. 308 11 June 1994

The type of accident and injuries received by helmet wearing and non-helmet wearing cyclists who attended the Accident and Emergency Department of Addenbrooke's Hospital between 1 January 1992 and 31 December 1992 were compared. Of the 1040 cyclists who attended the hospital, 114 had been wearing a cycle helmet at the time of the accident. The study found no difference between helmet wearers and non-helmet wearers in the type of accident in which they were involved, nor in the nature of their non-head injuries.

However, there was a significant difference in the nature of head injuries between the two groups. 4% of the helmet wearers sustained head injuries, compared to 11% of non-helmet wearers. Head injuries were more likely in accidents that involved a motor vehicle (18%) than those that did not (7%).

22. "International literature review of cycle helmets" M Royles, TRL Project Report 76, June 1994

A review of research concerning cycle helmets in the UK, Europe, Australia and the USA. It looks at cyclist accident and injury patterns; the effect of cycle helmets in reducing head injuries; strategies used to increase helmet use; attitudes towards cycle helmets and wearing rates.

It concludes that cyclists have a higher risk of being injured than most road users and are more likely to sustain head injuries. It shows that most studies indicate that helmets reduce the severity of head injuries, but notes that some studies are concerned about their limited protective value. The review also found that helmets are promoted in similar ways across the world and that the attitudes to them are often similar. Children are reluctant to wear them because they feel silly and are concerned about peer pressure. Cost is identified as another deterrent.

Wearing rates vary considerably and are highest in Australia due to legislation. In the UK, one study found that in 1993, 39% of Junior schoolchildren owned a helmet, but only 13% always wore it. The figures for secondary schoolchildren were 34% and 11%. Another survey found wearing rates for girls were between 3% to 14% and for boys between 5% and 28%.

23 "Children and Bicycles: What is Really Happening? Studies of Fatal and Non-fatal Bicycle Injury", C Acton et al, Injury Prevention I:86-96, 1995

An Australian study of cycling accidents of children under 15 years old between 1981 and 1992. All of the fatal accidents involved a collision between the cyclist and a vehicle, whereas only 5.5% of the non-fatal accidents involved such a collision. 56% of the cyclists who were killed died from a head injury and a further 27% died from multiple injuries including head injury. Data on helmet wearing was not collected for these fatal accidents.

Of the non-fatal accidents, 36% of the children hit their head, with 21% sustaining an injury or losing consciousness. Helmet use was recorded for these accidents: 84% of the children involved said they owned a helmet, however, only 43% were wearing one at the time of the accident.

Although, the studies main recommendations concern measures that would prevent child cycling accidents, it also emphasises the need for child cyclists to wear helmets whenever they ride.

24 "Bicyclist Head Injuries in Victoria Three Years after the Introduction of Mandatory Helmet Use" S Newstead et al, Monash University Accident Research Centre, Report 75, 1995

This study investigated the effect of cycle helmet wearing on head injuries three years after the introduction of mandatory wearing in Victoria. The study used data from motor vehicle involved cyclist injury claims from the Transport Accident Commission (TAC) and hospital admissions records. In each of the three years following the helmet law, head injury rates for cyclists injured in crashes not involving a motor vehicle was significantly lower than before the law. A significant inverse relationship between helmet wearing and head injury rate was found for cyclists involved in accidents with motor vehicles. However, while cyclist head injury rates were significantly below pre-law trend predictions in the second post-law year, this benefit appeared to have been lost in the third post-law year, when head injury rate increased from the second year.

25 "Evaluation of the Bicycle Helmet Wearing Law in Victoria during its First Four Years" D Carr et al, Monash University Accident Research Centre, Report 76, 1995

Data for all cyclists admitted to a hospital in Victoria after a crash suggested that an apparent increase in cyclist admissions in the third and fourth years following the helmet law was most likely the result of changes in the funding arrangements for hospitals. When corrected for this effect, the results indicated that the number of cyclist admissions in the first four years of the helmet law were 42% below the number expected on the basis of pre-legislation trends. This reduction was largely due to the helmet legislation, although it is possible that a part of the change relates to the reduced exposure to crash risk of cyclists since the legislation's introduction. The severity of head injuries for crash-involved cyclists had also declined following the law. The report concluded that the mandatory helmet wearing law in Victoria has had a significant, positive effect on the number and severity of injuries amongst bicyclists, and this has persisted for the four years since the introduction of the legislation.

26 "Cycle Helmet Wearing in Great Britain", S B Taylor & M E Halliday, TRL Report 156, 1996,

A study to quantify cycle helmet use in Great Britain and to gauge attitudes of cyclists to their use. The helmet usage of over 27,000 cyclists (72% of whom were male and 5% were children) at 61 urban sites was monitored in the Autumn of 1994. Around 16% of the cyclists wore a helmet. Females were more likely to wear one than males, children were more likely to wear one than adults and the proportion of cyclists wearing helmets was the greatest in the morning and evening rush hours. Almost 84% of cyclists who wore a helmet said it made no difference to their cycling.

The Attitude Survey involved face-to-face interviews with 978 people (cyclists and non-cyclists) in households, at school and on the street. Cyclists aged 25 years and over were more likely to wear a helmet on every journey than those under 25 years. Cyclists were more likely to wear a helmet when cycling for leisure purposes, on a social visit or when traveling to school or work. Over a third of the cyclists who wear a helmet said they did so to protect their head, 28% cited the risks or consequences of not wearing one, and 13% said it made them feel safer. Discomfort, 'looking silly' and 'head getting hot' were the main dislikes about helmet wearing.

About 40% of the cyclists who did not own a helmet said they had no particular reason for not having one, 16% said they 'looked silly', 8% cited their cost as a deterrent and 8% did not think there was enough risk to justify wearing one. About one third of the cyclists interviewed on the street were not wearing a helmet and said they never did so. Of these, 14% said helmets 'looked silly' and 14% said they could not afford one. nearly 40% had no particular reason.

27 "The Effect of Bicycling helmets in Preventing Significant Bicycle-Related Injuries in Children" K A Finvers et al, Clinical Journal of Sport Medicine, University of Calgary, 1996.

699 cycling accidents involving children that occurred between April 1 1991 and September 30 1993 and in which the child received treatment at an Emergency Department were studied. 13.7% of the child casualties had been wearing a helmet at the time of the accident. Of the children who received serious head injuries, 94.7% were not wearing a helmet and. Only 5.3% of the children wearing a helmet suffered a serious head injury.

28 "Trends in Cycle Injury in New Zealand Under Voluntary Helmet Use" P A Scuffham et al, Accident Analysis and Prevention, Vol. 29, No 1, 1997.

One year before helmet use was to become mandatory in New Zealand, voluntary wearing rates were quite high at 84% for primary school children, 62% for secondary school children and 39% for adults. This study examined changes in the proportion of cyclist head injuries in relation to changes in helmet wearing rates. The study found that increased wearing rates had little association with serious head injuries to cyclists as a percentage of all serious injuries to cyclists.

29 "Can A Combination of Local, Regional and National Information Substantially Increase Bicycle Helmet Wearing and Reduce Injuries? Experiences from Sweden" Accident Analysis and Prevention, Vol. 29, No 3, 1997

This report describes the results of a long term campaign to promote the use of cycle helmets in Skaraborg County in Sweden over the period 1978 to 1993. By the end of this period helmet wearing rates among pre-school children were around 90%, 45% among children up to 10 years old, 31% for children up to 15 years old and only 9% for adult cyclists.

The study uses hospital data to analyse changes in all injuries to cyclists and changes in head injuries to cyclists. Over the period, all bicycle related injuries in the County declined by 48% and nationally by 32%. Head injuries amongst cyclists, however, declined by 59% in Skaraborg County and 43% in Sweden as a whole. The researchers conclude that cyclists who use helmets receive around one third less head injuries than cyclists who do not wear them.

30 "Damage to Bicycle helmets Involved with Crashes" R P Ching et al, Accident Analysis and Prevention, Vol. 29, No 5, 1997.

This study aimed to evaluate the relationship between helmet damage and head injury to the cyclists wearing the helmets. 527 helmets that had been involved in a cycling accident were examined. 60% of them had little or no damage and 40% had significant damage. A high proportion of helmet damage was along the front edge and a high proportion of the head injuries were to the front of the head. This indicated that helmets were not always protecting the forehead, perhaps because they were being worn incorrectly. The study points out that without a helmet, all of the impact forces would be transmitted directly to the head of the cyclist.

31 "Pedal Cycle Helmet Effectiveness: A Field Study of Pedal Cycle Accidents" Accident Analysis and Prevention, Vol. 30, No 2, 1998

Forty-two cases of cyclists who were involved in an accident while wearing a cycle helmet, and in which the helmet suffered an impact, were examined to assess the effectiveness of the helmets. All but one of the helmets conformed at a safety standard. 62% of the accidents involved a collision with another vehicle and the remainder were bicycle-only accidents. 75% of cyclists in these accidents did not receive a head injury.

Most of the head injuries were minor, although four of the cyclists were killed in the accidents. The study concluded that helmets are effective in preventing or reducing the likelihood of head injury, but more coverage over the temple region would be an improvement. Soft shell helmets were more likely to disintegrate under impacts.

32 "Rates of, and Factors Affecting, Cycle Helmet Use Among Secondary Schoolchildren in East Sussex and Kent" Accident Analysis and Prevention, Vol. 30, No 4, 1998

A questionnaire survey of cycle helmet use among pupils at 23 secondary schools in East Sussex and Kent, conducted in December 1994. 3.082 completed questionnaires were returned from pupils who rode bicycles.

32% of boys and 29% of girls aged 10 - 12 years, and 14% of boys and 10% of girls aged 14 - 16 years, said that they always wore a cycle helmet when riding. The factors that they reported as most influencing their decision to wear helmets were "parental encouragement", closest friend wears a helmet", belief that mandatory helmet use would be good" and "sometimes ride off-road".

33 "Epidemiology of Bicycle Injury, head Injury and Helmet Use Among children in British Columbia: a Five year Descriptive Study" Accident Analysis and Prevention, Vol. 30, No 4, 1998

A study of 1,462 cyclists aged 1 to 19 years who attended hospital between 1991 and 1995 following a cycling accident. Bicycle injuries comprised 4% of all injuries seen at the hospital during the period, however, cyclists were more likely to be admitted than non-cyclists.

Over 70% of the cyclist casualties were not wearing a helmet at the time of their accident. Helmet use was lowest among children aged below five years and highest among those aged 15 - 19 years. Wearing rates increased over the five year period from 5% in 1991 to 32% in 1995.

A higher proportion of injured cyclists who were not wearing a helmet were admitted to hospital than those who had been wearing a helmet. Those not wearing helmets were more likely to suffer head and face injuries, although helmet users had a slightly (but not statistically significant) higher rate of dental injuries.

34 "Cycle Helmets" British Medical Association, June 1999

A BMA report investigating whether wearing cycle helmets should be made compulsory. The report examined data concerning cyclist accidents and injuries, standards for cycle helmets and evidence on the effects on cycling behaviour of helmet legislation. The BMA concluded that the wearing of cycle helmets by all cyclists, but especially children, when riding on the public highway should be strongly recommended, but that the use of helmets should not be made compulsory. Wearing rates in the UK were too low for a law to be practical and extensive awareness raising and promotion campaigns would be needed before legislation could be introduced.

The BMA recommended that cycle manufacturers and retailers consider supplying free helmets with bicycles and that there should be no VAT on cycle helmets. The report calls for cycle helmets to be seen as part of a wider safer cycling strategy that includes the provision of cyclist training courses and the inclusion of cycle awareness in driver training and the Driving Test.

35 "Urban and Rural Patterns of Bicycle Helmet Use: Factors Predicting Usage" S Harlos et al, Injury Prevention, Vol 5 No:3, 1999

This study documented bicycle helmet use in Winnipeg, Manitoba and nearby rural communities, and aimed to identify target groups for a helmet promotion campaign. Cyclist helmet use was observed between 28 May and 20 August 1996 at a sample of urban and rural locations. Age, gender, helmet use, riding companions, location type, correct helmet use, and use of headphones were recorded. 2,629 cyclists were observed: 2,316 at 183 urban locations and 313 at 25 rural locations.

Overall helmet use was 21.3%, with lower use in males (18.9%) than females (26.3%). Urban helmet use was considerably higher (22.9%) than rural use (8.9%). The study concluded that there was low helmet use in the region, emphasising the need for a regional helmet promotion campaign as well as future helmet legislation. A marked urban-rural difference in helmet use that had not been previously reported was also identified. Target groups for a future campaign include adolescents, males, rural cyclists, and those with low income.

36 "Cycle Helmet Effectiveness in New Zealand" L J Povey et al, Accident Analysis & Prevention Vol 31 No 6, 1999

Since late 1989, the cycle helmet wearing rate in New Zealand has risen from around 20% for adults and teenagers, and 40% for younger children, to more than 90% in all age groups. Cycle helmet wearing became mandatory in 1994. This paper considered the effect of cycle helmet wearing on hospitalised head injuries between 1990 and 1996, using cyclist limb injuries as a measure of exposure to the risk of cycling trauma. The relatively large increase in helmet wearing associated with the passing of a compulsory law in 1994 reduced head injuries by between 24% and 32% in non-motor vehicle crashes, and by 20% in motor vehicle crashes. No increase or decrease in the severity of head injuries for which cyclists were hospitalised over this period could be detected. This may have been due to the small and highly variable number of 'high severity' injuries.

37 "Florida's Bicycle Helmet Law and a Bicycle Safety Educational Program: Did They Help?" S Borglund et al, Journal of Emergency Nursing Vol 25, 1999

This study examined the effectiveness of Florida's mandatory bicycle helmet law for children and a community campaign to promote helmet use. The use of helmets and the level of head injuries sustained in bicycle crashes before and after the introduction of the law were evaluated in two groups (a study and a control group) of 7 – 12 year old children, mostly boys. Cycle helmet use increased from 5.6% to 20.8%, with the greatest increase (27%) being among 10 – 12 year old children. Changes in the type and extent of head injuries were mixed. Injury severity was higher for non-helmeted children in the after-law group. Although helmet use increased after passage of the law, the authors stated it still remained "too low", and cited the need for education programmes to promote helmet use in addition to compulsory helmet laws.

38 "Exploration of the Barriers to Bicycle Helmet Use Among 12 and 13 Year Old Children" P Loubeau, Accident Analysis & Prevention, Vol 32 No 1, 2000

The study was based on four focus groups with 31 12 and 13 year old children from schools in an urban New York City area. A majority of both boys and girls did not perceive a need to wear cycle helmets for routine riding or short trips, and felt that helmet use was uncomfortable and made them appear dumb. Only a small percentage of children routinely wore their helmets.

39 "Age gradient in the Cost-effectiveness of Bicycle Helmets", B Kopjar et al, Preventive Medicine, Vol 30, 2000

This study analysed the reduction in risk of head injuries associated with use of bicycle helmets among cyclists aged 3 to 70 years old between 1990 and 1996, and discussed the cost-effectiveness of helmet use. The report was based on data from a Norway's comprehensive injury data system and research about the effects of helmet use. The risk of head injury was highest among children aged 5 –16 years. The greatest reduction in absolute risk of head injury occurred among children who started using a helmet between the ages of 3 –13 years. Estimates indicate that it would cost approximately $2,200 in bicycle helmet expenses to prevent any one upper head injury in children, but it would cost $10,000 - 25,000 to avoid a single injury among adults. Bicycle helmets appear to be several times more cost-effective for children than for adults, primarily because of the higher risk of head injury among children. The report recommended that initiatives to increase helmet use should consider the differences in injury risk and cost-effectiveness among different age groups and target their efforts accordingly.

40 "Police Enforcement as Part of a Comprehensive Bicycle Helmet Program" J Gilchrist et al, Pediatrics Vol 106(1) 2000

The State of Georgia passed a law requiring children to wear cycle helmets from July 1993. One rural Georgia community council instructed the police to impound the bicycle of any unhelmeted child. This study evaluated the effect of active police enforcement of this, combined with a helmet giveaway and education program. Before the program began, none of 97 observed riders wore a helmet. During the next five months, helmet use among 358 observed children averaged 45%, a significant increase in all race and gender groups. Adult use did not increase significantly. Police impounded 167 bicycles during the study, an average of 1 per day.

Two years after the initiative began, 21 of 39 child riders (54%) were observed wearing helmets. The report concluded that state and local laws on their own did not increase helmet use, but laws supported by active police enforcement, and helmet giveaways and education, were effective and lasting.

41 "Population Preventable Fraction of Bicycle Related Head Injuries" B Kopjar, Injury Prevention Vol 6(3) 2000

Using mathematical models (based on the population attributable fraction [PAF]) this study sought to estimate the proportion of cyclist head injuries due to not wearing cycle helmets, the expected proportion of helmeted cases among all head injuries, and the likely helmet use rate in the population. It used a sample of cyclist injuries from the town of Stavanger in Norway. The study estimated that 133 out of 210 injuries could have been avoided in Stavanger between 1990 and 1996 if all children aged 0 to14 years had used cycle helmets. The authors suggested that the PAF is a valid indicator of the effects of bicycle helmets and may help to interpret and predict the effects of helmet promotion within a given population.

42 "Bicycle Helmet Efficacy: a Meta-Analysis" R Attewell et al, Accident Analysis and Prevention, Vol 33 (3), 2001

This review examined published, peer-reviewed research conducted in several countries to quantify the effectiveness of bicycle helmets. Using a systematic meta-analysis approach, the effects of cycle helmets in reducing head, brain and facial injuries were estimated. This indicated that cycle helmets provide a strong protective effect.

43 "Why Teenagers Owning a Bicycle Helmet Do Not Use their Helmets" T Lajunen et al, Journal of Safety Research, Vol 32 (3), 2001

This study investigated why teenagers do not use cycle helmets, even if they have one. Data were collected at two schools in Helsinki, Finland. Almost one thousand (965) high school students completed a questionnaire about their cycling habits and bicycle helmet use. This indicated that parents' positive attitude to bicycle helmet use was the strongest predictor of the student having a helmet. Responses from the students who owned a bicycle helmet showed that having friends who used a helmet was strongly related to a student's decision to wear a helmet. In addition, parents' positive opinion of helmet wearing increased the likelihood of the student wearing their helmet.

The study suggested that the most efficient way of increasing bicycle helmet use by students is to influence peer opinions and to inform students' parents about the safety benefits of bicycle helmets.

44 "Bicycle Helmet Use Among Schoolchldren - the Influence of Parental Involvement and Children's Attitudes" P Berg et al, Injury Prevention, Vol 7 (3), 2001

This study examined attitudes about the use of bicycle helmets among schoolchildren to determine whether these attitudes are associated with the involvement of parents and school in bike safety. The study was conducted in nine intermediate level schools and five upper level schools in two Swedish municipalities. A survey of 1,485 pupils aged 12 -15 years was conducted during 1997. Helmet use decreased significantly during children's school years - at some point, most of the children stopped wearing bicycle helmets. Around 80% of 12 – 13 year old pupils said that they had used helmets when they were younger but only 3% of those aged 14 -15 years were still using their helmets. The majority stated they stopped using helmets because they felt the helmets were ugly, silly, uncomfortable, or inconvenient.

There was a strong association between parental involvement, children's attitudes, and helmet use. However, parent involvement decreased as the children grew older.

45 "Effect of Legislation on the Use of Bicycle Helmets" J C Leblanc et al, Canadian Medical Association Journal, Vol 166 (5), 2002

About 75% of the 50 Canadian children and adolescents who die each year from cycling injuries, die from head injuries. This study measured helmet use before, during and after the introduction of mandatory cycle helmet use in Novia Scotia in 1997. In the Summer and Autumns of 1995, 1996, 1997, 1998 and 1999, observers recorded cycle helmet use on arterial, residential and recreational roads during peak traffic times. Details of the number and type of bicycle-related injuries treated at the main Health Centre during the period were collected. The Police conducted regular education and enforcement campaigns to support the law, but there were no mass media campaigns after 1997.
The rate of helmet use rose dramatically after legislation, from 36% in 1995 and 38% in 1996, to 75% in 1997, 86% in 1998 and 84% in 1999. The proportion of injured cyclists with head injuries in 1998/99 was half that in 1995/96.

45a "Hats Off (Or Not?) to Helmet Legislation" M L Chipman, Canadian Medical Association Journal, Vol 166(5), 2002

In response to the above study, this author argued that the decrease in head injuries following the helmet law was partly due to less cycling. The author states that the number of cyclists observed per day fell from nearly 90 in 1995/96 to 34 in 1997 and 52 in 1998/99. The proportion of the child cyclists decreased from 8.1% before the legislation to 6.1% in the year it was introduced to 3.7% two years afterward. These reductions may be due in part to changes in observation sites or to bad weather in some years that discouraged all but the most dedicated cyclists. But may also be due to people being discouraged from cycling by a helmet law.

45b "Butting Heads Over Bicycle Helmets" M Wardlaw, Canadian Medical Association Journal, Vol 166(5), 167(4), 2002

This author also responded to the above report by stating that it showed that the risk of head injury per cyclist did not change as a result of the law, but the risk of other injuries nearly doubled. He claimed that the number of cyclists observed fell by 40% – 60% after the law was passed, from 88 per day to 33 or 52 per day. The number of head injuries has fallen by half, but so has the number of cyclists, although the total number of injuries has increased.

45c "Butting Heads Over Bicycle Helmets: A Reply to the Critics" J C LeBlanc, Canadian Medical Association Journal, Vol167 (4), 2002

The author of the original report responded to the above criticisms. The changes in the number of cyclists observed before and after the law were probably due to the fact that the observations took place at different times each year. The author added that major bicycle shops said that although bicycle helmet sales surged after the introduction of the legislation, there was no reduction in the sale of bicycles and no discernable impact on cycling activity.

The author stated that other research has shown that initial decreases in cycling following a helmet law do not continue and referred to an assessment of the impact of helmet legislation on cycling in Toronto, which found that the rate of child cycling increased after the introduction of helmet legislation.

46 "Bicycle Helmet-Wearing Variation and Associated Factors in Ontario Teenagers and Adults" A Irvine et al, Canadian Journal of Public Health, Vol 93(5), 2002

The Ontario Health Survey was used to asses the incidence of, and factors associated with, bicycle helmet use in Ontario in 1996. Of the 7,693 respondents, 41% reported wearing their helmets on a regular basis when riding a bicycle. Helmet use was greatest among 12 -14 year olds (72%) and lowest among 15 -18 years old (33%). In teenagers, drinking alcohol and smoking were strongly associated with helmet non-use. In the adult group, female gender, high income, higher education, non-smoking status and abstinence from alcohol were associated with helmet use. Living in a rural area was also associated with helmet use. The study indicates that several factors are associated with helmet non-use and so any strategy for increasing helmet-wearing rates requires multi-dimensional interventions.

47 "A local bicycle helmet 'law' in a Swedish municipality - the Structure and Process of Initiation and Implementation" S Nolén et al, Injury Control and safety Promotion, Vol 9 (2), 2002

In 1996, the Municipality of Motala in Sweden introduced a local bicycle helmet 'law' for child cyclists aged 6 – 12 years (this was not an official law with legal penalties, but a municipally endorsed recommendation). The study evaluated the implementation of the 'law', and concluded that local bicycle helmet laws of this type have a potential to produce a long-lasting effect on helmet use, provided that they are supported by a co-ordinated education and publicity campaign, involving the continuous engagement of local government, the mass media and other agencies.

48 "State Level Estimates of the Incidence and Economic Burden of Head injuries stemming from Non-Universal Use of Bicycle Helmets" J Schulman et al, Injury Prevention, Vol 8(1) 2002

The aim of this project was to develop national and state level estimates of preventable bicycle related head injuries, and associated direct and indirect health costs, from the failure to use bicycle helmets. Research about the effectiveness and use of cycle helmets was combined to estimate the proportion of bicycle related head injuries that could be prevented if all cyclists wore helmets. The resulting figure was multiplied by the expected number of head injuries to provide an estimate of the number of preventable cases. Direct and indirect health costs were estimated for the number of preventable head injuries to assess the potential cost savings if all riders wore helmets.

The study estimated that over 100,000 cycling head injuries could have been prevented in 1997 in the USA if all cyclists had been wearing helmets. These deaths and injuries cost an estimated $81 million in direct and $2.3 billion in indirect health costs. The authors suggested that this method of estimating preventable injuries and costs can help to quantify the number of preventable head injuries and the costs and benefits of helmet promotion programmes.

49 "Effects of State Helmet Laws on Bicycle Helmet Use by Children and Adolescents" G B Rodgers, Injury Prevention, Vol 8(1), 2002

A study of the factors associated with the likelihood of helmet use by children and adolescents was conducted to evaluate the effectiveness of state helmet laws in increasing the use of bicycle helmets by cyclists under the age of 16 years. The study was based on responses from a USA-wide random telephone survey of cyclists. A multiple logistic regression analysis was used to quantify the independent effect of the state helmet laws on helmet use. State helmet laws increased the average probability of helmet use by 18.4%. The report concluded that State helmet laws significantly increase helmet use by children and play an important part in wider education and promotional programmes.

50 "The importance of the Use of Bicycle Helmets for Head Injuries Among Injured Bicyclists Aged 0-15 years" L B Larsen, Ugeskr Laeger, Vol 164(44), 2002

A case-control study of all youngsters aged 0 -15 years, who were treated at Odense University Hospital between 1993 and 1999 after a cycling accident. 3,285 cyclists were treated for cycling injuries during this period. Of these, 409 had injuries to the head or brain and 2,876 had injuries to other body regions. Regression analysis showed that the use of helmets decreased the risk of head injury by a factor of 0.4 and the risk of concussion by a factor of 0.6. Only nine bicyclists with more severe brain injury were included in the study. Collision with a motor vehicle increased the risk of head injury in any given accident and helmets did not reduce the risk of head injuries in such accidents. The report concluded that helmets offer cyclists aged up to 15 years old protection against head injury, but did not provide the same level of protection in accidents involving a motor vehicle.

51 "Bicycle Helmets – A Review of their Effectiveness: A Critical Review of the Literature" Elizabeth Towner et al, Department for Transport Road Safety Research Report 30, 2002

This report, commissioned by the DfT, is an independent objective critique of the evidence on the efficacy of bicycle helmets. The authors noted that most of the research was conducted outside Britain: only 1 of 16 observational studies and only 2 of 19 intervention studies on the promotion of bicycle helmets were conducted in Britain. Bicycle helmet wearing rates in Great Britain have increased steadily in the previous decade but are still low. In 1999 on busy roads the wearing rate was 22% and on minor roads, 8%.

The reports concludes that there is a considerable amount of scientific evidence that bicycle helmets are effective at reducing the incidence and severity of head, brain and upper facial injury. They have been found to be effective in reducing injury for all ages of cyclists, though particularly for children. While most studies indicate that helmets offer protection from head injury, the relative risk of injury between helmeted and unhelmeted cyclists has varied in different studies, and there is some equivocal evidence relating to the link between helmet use and neck injury. They found very little evidence relating to helmet use and cycling style.

The report states that most bicycle helmet educational campaigns have been targeted at children, and that younger children and girls showed the greatest effects from the campaigns. Reducing the costs of helmet through discounts, and give-away programmes helps to increase helmet ownership and use.

The report also discusses the issue of helmet legislation, which it states, is an effective means of increasing observed helmet use, when supported by educational activities. The authors found some evidence that legislation may have resulted in decreased levels of cycling (for example in Victoria, Australia) but there are confounding factors and no clear long-term trends.

The reports states that cycle helmet promotion and legislation needs to be seen as one part of a broader package of measures to enhance cycling safety. Experience in countries such as Australia and New Zealand suggest that this process takes time. Barriers to helmet use can be overcome, but an infrastructure which promotes cycling and provision for bicycle helmet is needed (for example employers, schools providing facilities for bicycle helmet storage).

52 "Bicycle Injuries and Safety Helmets in Children" Review of Research, S Coffman, Orthopedic Nursing, Vol 22, 2003

This article summarised the research about bicycle injuries and helmet use and examined the effectiveness of legislation and injury-prevention strategies. It concluded that the evidence indicates that children who wear helmets experience fewer, and less severe, head injuries. Community-wide helmet-promotion campaigns combined with legislation are most successful in increasing helmet use and decreasing injury. The author stated that nurses can participate both at the institutional level and in community advocacy groups to promote bicycle safety for children.

53 "Bicycle-related Head Injuries Plummet" Natalie Dunleavy, Canadian Medical Association Journal, Vol 13, 168(10), 2003

The Canadian Institute for Health Information reported a 12.5% decrease over a five year period in the number of hospitalisations due to bicycle-related injuries among Ontario children aged 5 to 19 years. During the same five year period, the number of bicycle-related head injuries in that age group dropped by 26%. The report states that this was related to the 1995 introduction of Ontario's bicycle helmet legislation, which required children to wear a helmet while riding a bicycle. The report also notes an overall drop in the rate of hospitalisation for the 5-19 year age group in Ontario, from 28.6 per 100 000 population in 1997/98 to 23.6 per 100 000 population in 2001/02, but found little change in the data for other age groups. Overall, the report shows that injury-related hospitalisations declined by 7.5 % in Ontario in the five year period.

54 "Helmets for Preventing Head and Facial Injuries in Bicyclists (Cochrane Review)" D C Thompson et al, Issue 1, 2003

This is a review of the validity and findings of five, previously published, case-controlled studies from different countries into the effectiveness of cycle helmets. The review found that all the studies provided consistent evidence that wearing an approved cycle helmet significantly reduces the risk of head or brain injuries in a crash or collision. It concluded that overall, cycle helmets decrease the risk of head and brain injury by 65% to 88%, and decrease the risk of facial injury by 65% (but do not protect the lower face or jaw). The review also stated that helmets are effective for cyclists of all ages and in accidents involving collisions with motor vehicle as well as those which do not.

It is a feature of Cochrane Reviews that responses to the review from other researchers are published along with the replies by the original authors. This review generated several responses that were critical of the review's findings, mainly on the following grounds:

- helmets are not designed to protect the brain from rotational injuries, which are the most serious type
- helmet laws discourage cycling which is one reason for any apparent reduction in head injuries and also means the health and environmental benefits of cycling are lost
- cyclists who wear helmets feel safe and so cycle in a less cautious manner, hence increasing their accident risk (risk compensation).

The authors disagreed with these arguments on the grounds that:

- helmets do protect against the most common types of head and brain injuries, and the research studies prove this
- there is no scientific evidence that mandatory cycle helmet laws discourage cycling
- there is no scientific evidence that cyclist who wear helmets take more risks.