Cycle Helmets

the case for and against

Mayer Hillman
CONTENTS

SHORT SUMMARY

INTRODUCTION 6

1 CYCLING, CYCLE ACCIDENTS AND HEAD INJURIES 7
   The extent of cycling
   Casualties and head injuries among cyclists

2 HELMET DESIGN 10

3 QUESTIONING CLAIMS THAT HELMET WEARING REDUCES HEAD INJURIES 11
   The influence of personal characteristics
   Comparable survey periods and sample
   Changes in the extent of helmet wearing and traffic danger
   Classification of injuries to the head
   Evidence only available from survivors

4 QUESTIONING THE BENEFITS OF HELMET WEARING 15
   Degree of protection from cycle helmets
   The cost of cycle helmets and their usage
   Cycling comfortably
   Propensity to take risks

5 DISCUSSION 20
   Whose responsibility for minimising risk of injury?
   Who should wear helmets?
   Encouragement versus compulsion
   Life years lost versus life years gained
   Alternative approaches to reducing head injuries

6 CONCLUSIONS 26

REFERENCES
LIST OF TABLES

Table 1. Journeys per week by cycle, according to number and distance travelled, Netherlands and Great Britain.

Table 2. Incidence of head injury as a proportion of all injuries of varying severities in cycle accidents, from surveys in some countries.

Table 3. Estimates from various international studies of reduction in head injuries to cyclists by wearing helmets.

Table 4. Fatalities due to head injury, according to road user group, England and Wales, 1987 to 1991.

Table 5. Cycle fatalities and serious injuries, according to vehicle involvement, 1987 to 1991.


Table 7. Distribution of fatalities due to head injury, according to road user group and age group, England and Wales, 1987 to 1991.

Table 8. Fatalities according to cause of death among men and women, England and Wales, 1991.
SHORT SUMMARY

Over 200 cyclists have been killed and over 80,000 injured in road accidents in Great Britain in each of the last few years. The great majority of accidents are minor. They characteristically involve cyclists losing control of their cycles and falling off. Other vehicles are not involved. Injuries are rarely serious; admission to hospital usually reveals only short-term concussion.

But when accidents are serious, they generally involve damage to the head following collision with a motor vehicle. This is true for the large majority of fatalities and about one half of the serious injuries. Adult cyclists are most frequently involved.

Many studies have been carried out to establish the extent to which the wearing of helmets by cyclists reduces the incidence and severity of head injuries in the event of accident. Most conclude that helmets are highly desirable.

That conclusion would be warranted if it were also supported by evidence about the effect on cycling behaviour of wearing a helmet. The studies assume that behaviour is unaffected. That assumption is not justified. The likelihood is that when wearing a helmet cyclists feel less vulnerable and therefore ride less cautiously. As a result, they are more likely to have an accident. Consequently, the benefits attributed to helmets by the studies are at best highly exaggerated. At worst, wearing a helmet may expose cyclists to greater danger.

Wearing a helmet only marginally reduces the extent of head injury following collision with a motor vehicle. Thus, cyclists who wear a helmet do so with an inflated idea of its protective properties. Indeed, this illusion is encouraged by road safety campaigners and helmet manufacturers who set out to persuade cyclists that they will be safer with a helmet, using all the techniques of modern advertising. Cyclists are not warned of the limited benefit provided by a helmet in an accident with a motor vehicle.

An appropriate solution to the problem of serious accidents to cyclists requires an understanding of the circumstances in which accidents occur. Cyclists rarely ride into motor vehicles. It is motor vehicles driven without sufficient care which are the source of most of the danger and which pose the threat to the life and limb of cyclists. Calling on cyclists to increase their safety by wearing a helmet shifts responsibility away from the drivers, the agents of accidents, on to cyclists who are nearly always the victims. Were cycle helmets to be made compulsory, it would reinforce public perceptions of the bicycle as a dangerous form of transport and encourage the view that cyclists are responsible for their own injury.

The weight of evidence is against the introduction of a statutory requirement on cyclists to wear a helmet. Moreover, where a cycle helmet law has been introduced, it has led to a substantial reduction in cycling. That represents a public and private loss because cycling is such an efficient, healthy and environmentally-friendly form of transport. The weight of evidence is also against the encouragement of cyclists to wear helmets. Cycle helmets are a means of slightly reducing head injury if an accident occurs. Wearing a helmet does nothing to prevent accidents. The primary means of reducing serious head injury among cyclists is to create an environment in which accidents are less likely to happen.
INTRODUCTION

Much research has been carried out and discussion held on the subject of wearing cycle helmets. Many bodies, including the government, the medical profession and road safety organisations now promote this course of action. Others, mostly cyclists, question it whilst others are opposed. The cycle lobby are worried that, if it were made mandatory, cycling would be discouraged, and the industry is concerned that the sales of cycles would fall. At the end of the day, many people are confused. Without research aimed at reviewing and marshalling all the evidence, no clear way forward can be determined. This report is aimed at doing just that.

It draws on surveys and research from many countries, especially the only major study in the UK of cycle accidents, hospital-based studies in the US, and studies of the effects on the incidence of head injuries among cyclists following the introduction of a law in Australia making helmet wearing mandatory. It also includes new statistical analyses from special tabulations of road accidents involving head injury among all groups of road user.

On the basis of the review of evidence - including well over 100 documents that have been read during its preparation - the report presents the case for and against helmet wearing. It concludes with policy recommendations on three propositions: that it should be encouraged; that it should be made mandatory; and that there are other means of achieving the objective of reducing head injuries among cyclists.

Policy Studies Institute would like to thank the Bicycle Association, the Cycle Campaign Network, the Cyclists’ Public Affairs Group, the Cyclists’ Touring Club, and the London Cycle Campaign for support for this study. The author would like to acknowledge the help given by the following individuals in providing useful comments on the draft: Jo Cleary, Adrian Davis (Friends of the Earth), Robert Davis, David Collins (Bicycle Association), John Franklin, Peter Gazey, Laurence Geary, Colin Graham (Cyclists’ Touring Club), Oliver Hatch, Don Mathew, Mark McCarthy (Camden and Islington Health Authority), Hugh McClintock, John Morgan (Transport Research Laboratory), Annette Patterson and Nigel Unwin (University of Newcastle) - and especially John Adams (University College, London).

The views expressed in this report, and any errors or omissions, are of course the responsibility of the author alone.
Cycling, Cycle Accidents and Head Injuries

Cycling has many attractions. From an individual viewpoint, these include low capital and running costs; convenience and flexibility; and relatively short door-to-door journey times on most journeys up to four or five miles. Cycling can be an independent form of travel for all ages: the great majority of the population can cycle and there are now between 12 and 15 million cycles in the UK, with new purchases in recent years rising at a faster rate than that of cars (Morgan, 1991). Cycling is also an excellent means of maintaining physical fitness (British Medical Association, 1992). From a public interest viewpoint, it is 'environmentally-friendly': it contributes to hardly any of the adverse impacts of motorised forms of transport - death and injury to other road users and the generation of danger among them, air pollution, noise and road congestion (Hillman, 1992). Moreover, the costs of provision for cycling as compared with those for motorised travel, are low (Earth Resources Research, 1993).

The extent of cycling

However, in the current traffic environment in Great Britain, cycling represents an unattractive mode of travel for most people. This is in marked contrast to some other countries, such as Denmark and the Netherlands, whose governments have chosen to implement cycle-friendly policies and, as a consequence, have experienced substantial growth in cycle use. Table 1 sets out data on personal travel from the national travel surveys in Great Britain and the Netherlands. It can be seen that, in the Netherlands, where relatively high levels of provision are made for cycling, both the proportion of journeys by cycle - that is over a quarter of all journeys - and of distance travelled by cycle are roughly ten times higher than in Great Britain. Moreover, whilst there has been some small increase in recent years in younger adults cycling in Great Britain, there has been a marked decline in children and older adults doing so (Morgan, 1991).

Table 1. Journeys per week by cycle, according to number and distance travelled, Netherlands and Great Britain.

<table>
<thead>
<tr>
<th></th>
<th>Netherlands</th>
<th>Great Britain</th>
</tr>
</thead>
<tbody>
<tr>
<td>journeys by cycle</td>
<td>7.1</td>
<td>0.5</td>
</tr>
<tr>
<td>journeys by all modes</td>
<td>25.8</td>
<td>19.6</td>
</tr>
<tr>
<td>cycle journeys as proportion of all journeys</td>
<td>27.5%</td>
<td>2.4%</td>
</tr>
<tr>
<td>kilometres by cycle</td>
<td>22.8</td>
<td>1.4</td>
</tr>
<tr>
<td>kilometres by all modes</td>
<td>242.8</td>
<td>170.4</td>
</tr>
<tr>
<td>cycle kilometres as proportion of all journeys</td>
<td>9.4%</td>
<td>0.8%</td>
</tr>
</tbody>
</table>

Note: figures for the Netherlands are for 1989 and for Great Britain are for 1985/86, and are therefore not strictly comparable.
Source: figures derived from the National Travel Surveys published by the UK's Department of Transport (1988) and the Netherlands' Centraal Bureau voor de Statistiek (1990)

Casualties and head injuries among cyclists

Although cyclists in Great Britain cover just over one per cent of all personal travel kilometres, they account for five per cent of road fatalities - between 200 and 250 cyclists have been killed in each of the last few years. Of these, about 20 per cent are children (Department of Transport, 1992). In addition, adjusting the published figures of 20-25,000 cycle injuries to reflect the considerable number
not reported to the police by relating it to the number treated in hospital (James et al., 1990), it can be estimated that in fact 80-90,000 cyclists are injured annually at a cost variously estimated at £360 to £550 million (Morgan, 1991; Mills, 1989).

In terms of injury, the influence of the age of the cyclist is apparent from a study which has shown that the proportion of cycle accidents of all severities where motor vehicles were involved rose for 0-10, 11-15 and 16+ year olds from 13 to 28 to 52 per cent respectively (Simpson and Mineiro, 1992), indicating older child cyclists' greater exposure to traffic. Children are at greater risk of head injury than are adults (Colyer, 1986; Cushman, 1992), possibly because they are 'top heavy' as the ratio of their head weight to body weight is relatively high - a factor which a helmet exacerbates - and their skulls are thinner. Several studies in the UK and the US have shown that only about a quarter of children treated for head injury following a cycle accident were hit by a motor vehicle (Selbst et al., 1987), and less than a quarter where the estimated speed on impact exceeded 15 mph (Group Health Cooperative, 1989). The type of accident in which children suffer minor head injuries is generally one where no vehicle is involved and results from them falling off their cycles after losing control. Typically, they were riding too fast, were inexperienced, paid too little attention to how they rode, were using poorly maintained cycles, hit pot-holes, or were deliberately engaging in stunts (Weiss, 1987; Mills, op.cit.; McClintock, 1990).

Table 2 summarises figures showing the frequency of head injuries as a proportion of all injuries resulting from road accidents. They are derived from surveys from many countries around the world which have attempted to establish the proportion of head injuries of various severities in road accidents. They reveal a surprisingly wide range, suggesting differing interpretations and methods of classifying both injuries and what constitutes 'the head'.

The Table shows that the great majority of cyclists' fatalities and roughly half of their injuries result from damage to the head following an accident. Injuries are rarely serious: hospital studies in the UK have found that only about two per cent are severe or critical (Tunbridge et al., 1988; Mills, op.cit.; James et al., op.cit.). Few cyclists spend a long time in hospital (Galasko, 1986; Mills, op.cit.), and admission usually reveals that they have suffered the predominant form of head injury, that is of low severity, short-term concussion (Williams, 1991).

As head injury is associated with a higher proportion of cyclists' deaths than that of any other road users, it might be assumed that greater protection of cyclists' heads would offer the possibility of lowering the number of fatalities and mitigate the worst effects of head injury among them, with the result that many injuries that would have been serious would be slight and many slight injuries would be prevented altogether. The case for encouraging cycle helmet wearing, and even for making it compulsory would appear, on the face of it, to be sound. After all, any simple action, such as strapping on a lightweight helmet that need cost no more than £20 to £30, to limit damage to as critical a part of the body as the skull and as delicate a part as the brain, would seem to be sensible.
Table 2. Incidence of head injury as a proportion of all injuries of varying severities in cycle accidents, from surveys in some countries

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Injuries</th>
<th>percentage</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>slight</td>
<td>serious</td>
<td>fatal</td>
</tr>
<tr>
<td>1.</td>
<td>74</td>
<td>68</td>
<td>30</td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td>61</td>
</tr>
<tr>
<td>3.</td>
<td>64</td>
<td></td>
<td>65</td>
</tr>
<tr>
<td>4.</td>
<td>71</td>
<td></td>
<td>71</td>
</tr>
<tr>
<td>5.</td>
<td>60</td>
<td>75</td>
<td>50</td>
</tr>
<tr>
<td>6.</td>
<td>80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>90</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>90</td>
<td></td>
<td>33</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td></td>
<td></td>
<td>26</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>41</td>
<td>76</td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Such a judgement is shared by government and politicians generally - see for instance, debates on cycling in both Houses of Parliament (House of Commons, 1992; House of Lords, 1993); by organisations concerned with the promotion of safe practices, such as RoSPA (Royal Society for the Prevention of Accidents), PACTS (Parliamentary Advisory Committee on Traffic Safety), the Medical Commission on Accident Prevention, CAPT (Child Accident Prevention Trust); bodies involved in health promotion such as the Health Education Authority (Towner et al., 1993); and by surgeons, paediatricians and the medical press (see for instance, an editorial in the Lancet, 1988). All believe that wearing a cycle helmet will provide a substantial measure of protection against brain injury and skull fracture. Indeed, a surgeon has described cycle helmets as ‘the most effective means to date of decreasing fatal and non-fatal bicycle-related injuries’ (Laraque, 1993); and encouraging children to wear them has been cited as ‘probably the single most important intervention’ that could be made to reduce their likelihood of suffering serious injury (Weiss, op.cit.). As a result, Australia and many states in the US have introduced a law making helmet wearing mandatory. In Britain, a political process has been set in train and is gathering pace, backed by disturbing figures of the incidence of head injury in cycling accidents, and widely disseminated by the media, that every effort should be made to encourage, if not oblige cyclists to wear protective headgear.
2 HELMET DESIGN

Cycle helmets have to achieve an acceptable balance for the cyclist between a structure which will afford as much protection to the head as possible in the event of an accident while avoiding unacceptable discomfort owing to weight; limiting air circulation to dissipate heat from the crown of the head; or obstructing hearing or vision. Appearance is also a factor that has to be taken into account.

Helmets can protect riders falling off their cycles in two ways. First, they can absorb the shock of impact to the cranium and reduce the magnitude of its force; and second, they can distribute that force through increasing the area of exposed head surface. Helmets vary in the protection they afford: not surprisingly, when cyclists have been examined following an accident, it has been found that those wearing hard-shelled helmets suffer less severe head injury than those wearing ‘hairnet’ helmets, and far less than those with no cover to the head at all (Dorsch et al., 1987).

Considerable improvements have been made in the performance of helmets in recent years with the development of models with easily fastened chin straps, more effective ventilation slots, shock-absorbing linings of crushable expanded foams and polyfoams, a thin hard outer shell, with the weight lowered to as little as 200 to 250 grammes. However, it has to be borne in mind that, in general, lighter helmets which are generally more comfortable may provide less shielding as obviously the denser and thicker the lining, the greater the protection afforded to riders falling off their cycles.

As a consequence of these improvements, current designs that conform to recognised safety standards afford some protection against skull fracture and brain injury after an accident. At present, as a reasonable safety limit against brain injury, the British Standards specification requires that the helmet is able to withstand a force of 300g from reaching the head as a ‘reasonable’ level of protection against brain injury, that is equivalent to dropping the helmet one metre. The introduction of new European standards following more stringent tests based on higher drops, and the need to provide more cover to the forehead, temple and ear regions where many impacts occur could lead to more protection though probably less comfort.

In general, improvements to date have not led to higher prices, no doubt partly owing to the benefits of competition and the economies of scale resulting from increased consumer demand. Sales in the UK have been roughly estimated to have risen from about 10,000 in 1989, to 100,000 in 1990, and to one million in 1991 (Department of Transport, 1993a).
QUESTIONING CLAIMS THAT HELMET WEARING REDUCES HEAD INJURIES

It has been seen that when cyclists are involved in accidents, head injury is a common occurrence, apparently supporting the case for encouraging the wearing of helmets conforming to recognised safety standards. A large number of studies have been undertaken in order to establish the extent to which helmets provide protection and thereby to predict the likely reduction that universal wearing would have on the incidence and severity of this type of injury. Most have concluded that helmet wearing would be highly beneficial.

Other than studies in Australia, referred to later, the relatively low level of cycle helmet usage has precluded a major evaluation of their effectiveness. As a result, many proponents of helmet wearing have only been able to substantiate their claims by reference to small uncontrolled samples (Waters, 1986; Worrell, 1987; Wasserman et al., 1988), sometimes relying on self-reporting which results in a biased sample (Dorsch et al. op.cit.).

Table 3 sets out estimates of the reduction in head injuries by wearing helmets based on research carried out in many countries, notably the UK, the US and Australia. As can be seen, they range from a 90 per cent reduction in fatalities in perhaps the most widely quoted study based on an examination of head injuries among helmeted and unhelmeted cyclists - though the latter group was a very low proportion of the total - treated in five major hospitals in the US (Thompson et al., op.cit., 1989). The authors of the study claimed that it was the first to make a direct comparison of cyclists with and without helmets by controlling for the major influential variables and that their results actually under-estimated the likely reduction owing to their inability to include the most severe incidents. They found that head injury was six times higher in unhelmeted compared with helmeted cyclists, and that those wearing helmets achieved an 85 per cent reduction in their risk of head injury and an 88 per cent reduction in their risk of brain injury. Other studies both in the US and Australia have recorded similar percentages (Dorsch et al. op.cit.; Spaite, 1991).

Table 3. Estimates from various international studies of reduction in head injuries to cyclists by wearing helmets

<table>
<thead>
<tr>
<th>Ref.</th>
<th>fatal</th>
<th>serious</th>
<th>slight</th>
<th>All</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>90</td>
<td></td>
<td></td>
<td>84</td>
<td>hard-shell helmet with inner liner</td>
</tr>
<tr>
<td>2.</td>
<td>80</td>
<td></td>
<td></td>
<td></td>
<td>only child cyclists considered</td>
</tr>
<tr>
<td>3.</td>
<td>70</td>
<td></td>
<td>84</td>
<td></td>
<td>assuming 100% wearing rate</td>
</tr>
<tr>
<td>4.</td>
<td>50</td>
<td></td>
<td>50</td>
<td></td>
<td>based on a review of studies</td>
</tr>
<tr>
<td>5.</td>
<td>50</td>
<td></td>
<td>50</td>
<td></td>
<td>based on a review of studies</td>
</tr>
<tr>
<td>6.</td>
<td>50</td>
<td></td>
<td>50</td>
<td></td>
<td>only for cyclists aged 5-19</td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td></td>
<td>85</td>
<td></td>
<td>also 88% of the brain injured</td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td></td>
<td>&gt; 50</td>
<td></td>
<td>also much reduced for serious injuries</td>
</tr>
<tr>
<td>9.</td>
<td></td>
<td></td>
<td>20</td>
<td>42</td>
<td>with wearing rates up from 5% to 40%</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td>13</td>
<td></td>
<td>assuming 100% wearing rates</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td>&lt; 1</td>
<td></td>
<td>assuming a low wearing rate</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>30</td>
<td>32</td>
<td></td>
<td>injuries to cranium only</td>
</tr>
<tr>
<td>13.</td>
<td></td>
<td></td>
<td>0</td>
<td>32</td>
<td>based on statistical analyses</td>
</tr>
</tbody>
</table>

References: 1. Australia (Dorsch et al. op.cit.); 2. Ontario, Canada (Spence et al., 1993); 3. US (Sacks et al., op.cit.); 4. Quebec, Canada (Dussault, op.cit.); 5. Australia (Mathiesen, 1989); 6. UK (Lancet, 1988); 7. US (Thompson et al., 1989); 8. UK (Worrell, op.cit.); 9. Victoria, Australia (Vulcan et al., 1992); 10. Odense, Sweden (European Cyclists Federation, 1991); 11. UK (Downing, 1986); 12. UK (Mills, op.cit.); 13. US (Rodgers, 1988);
As the Table shows, the only major report to date in the UK which examined the subject calculated that helmet wearing would reduce head injuries overall by a third each year, that is by about 4000, and the injuries of a further 3000 would be less severe, but no fatalities would be prevented (Mills, op.cit.). At the other extreme, a study on the emergency treatment of cycle accidents in the US covering the 15 years to 1987 found ‘no statistical evidence that hard-shell helmets have reduced head injury or fatality rates’, and concluded that increasing helmet wearing is actually associated with an increase in injuries (Rodgers, 1988).

The wide variation in the estimates could be explained by a number of factors examined below which are concerned with the influence of personal characteristics, such as age, sex and the experience of cyclists and the mileage they travel; the comparability of data from ‘before and after’ surveys, including the level of reporting of injuries, the sample size, and changes attributable to relevant legislation affecting cyclists’ risk of accident, and varying weather conditions; the dangers of not comparing ‘like with like’; the lack of consistency of classification of head injury; and the attention paid to the issue of risk compensation.

**The influence of personal characteristics**

In considering the efficacy of helmet wearing from before and after surveys of the number of cyclists treated for head injuries, it is necessary to control for personal characteristics affecting recorded accident rates - as noted in the previous chapter - and for possible levels of under-reporting of accidents. For instance, parents are more likely to take children to hospital for examination for a head injury with which a young adult would not bother (Colyer, op.cit.). Helmet wearing rates vary by age and sex (ibid.). While cyclists are about 12 times more likely to be killed than car drivers per kilometre travelled, this ratio is less than three for males and just over two for females in their late teenage years (Morgan, 1988). Twice as many older child cyclists than younger ones have accidents, which probably has more to do with the fact that they cycle more on public roads than it has to their greater carelessness. Perhaps, most importantly, cyclists who buy and wear helmets are likely to be more cautious people. Surveys in the US have recorded that a higher proportion of helmet wearers are white, ride in parks for recreational purposes, and cycle on segregated paths (Di Guiseppi et al., 1989), and that helmet wearers are better respecters of the law (Gisolfi, 1988) suggesting that they are also likely to be more vigilant riders. And unhelmeted cyclists tend to be in higher impact crashes (Spaite, op.cit), suggesting that they ride faster than helmeted cyclists.

The type of error that neglect of these factors can lead to can be illustrated by reference to detailed analyses made of the cycle fatality rate per head of population in each US state which are of little value as they are related neither to cycle ownership nor, more importantly, to cycle use (National Safe Kids Campaign, 1992). Similarly, the UK Department of Transport claimed early in 1993 that the UK has one of the lowest rates of cycle fatalities among countries in the European Community, but this too was measured against the rate per head of population, ignoring the fact that their cycle ownership and use vary significantly. Compared with the UK, four times as many people in the Netherlands die in cycle accidents but this does not indicate that cycling in the UK is safer. On the contrary, it has far more to do with policy on provision for cyclists and their safety. On average, the fatality rate per kilometre travelled in Britain, is respectively, two and a half and three and a half times higher than in the Netherlands and Denmark (Mynors and Savell, 1992), countries where few people wear helmets and the subject is low on the political agenda.
Comparable survey periods and sample

In comparing the incidence of head injuries in a period following any marked change in the level of helmet wearing, it is also important to control for change in the character and conditions affecting cycling. These can vary owing to differences in the number of cyclists, the distances cycled, degree of exposure to traffic on busy roads and level of provision of segregated routes used by cyclists with and without helmets (Shepherd, 1991; Pravetz, 1992). They can vary too by time of day, season and weather condition. For instance, it is clear that more caution is exercised in wet weather, a time when people are in any case less attracted to cycling. It could be observed too, at this juncture, that any reduction in the incidence of head injuries may in fact be attributable to the greater visibility of helmeted cyclists rather than to the protection afforded by the helmet suggesting that a prominent reflective sash may prove as effective (Vulcan, Cameron and Watson, 1992).

Classification of injuries to the head

In some of the studies, there is an assumption that cycle helmets afford protection for all injuries classified as 'to the head'. However, the term 'head injury' covers a wide range of severities from cuts and bruises, via concussion leading to loss of consciousness to, in the ultimate, death (Carré, 1992). Indeed, it has been calculated that the category of 'head injuries' is several times larger than that of injuries that would have been prevented if a helmet had been worn (Juden, 1991). Clearly, care must be exercised to ensure that a distinction is made between injuries where the helmet could theoretically provide sufficient protection because face and upper neck injuries are included (Thompson et al., 1990) and to take account of the fact that many cyclists who die of head injuries would have died anyway because of other injuries (Mills, op.cit.), or because the helmet provided insufficient protection.

Further, differentiation between cyclists with and without helmets to some extent presupposes that all injuries where helmets are worn would be less severe - clearly an erroneous assumption: although the majority of cycle injuries do not involve a motor vehicle, the great majority of deaths and serious injuries involving the head do (National Highway Traffic Safety Administration, 1993).

Evidence from survivors

There is a further problem in interpreting evidence where the studies have been based on self-reporting by cyclists who suffered head injury in a road accident. Just because respondents report that a helmet saved their lives, does not necessarily mean that it did. Moreover, whilst one can identify those whose injuries have been reduced by wearing a helmet because they can recount their experiences, there can of course be no record of the experiences of cyclists who died, yet in many ways they are the most important and relevant 'respondents': if they were without a helmet, could their death have been avoided had they worn one, and if they were wearing a helmet, why was it ineffective in saving their life? Nor can cyclists be identified who did not have an accident involving head injury because they were not wearing a helmet and, as a consequence felt more vulnerable and therefore exercised more care. Likewise, those whose health has been harmed or who have died prematurely because they were dissuaded from cycling which, as discussed later, is an excellent means of maintaining fitness (British Medical Association, op.cit.) cannot easily be identified.
Changes in the extent of helmet wearing and in traffic danger

In theory, the best source of evidence on the subject of helmet wearing is from studies conducted recently in Australia where helmet wearing has been made mandatory. In Victoria, Australia, a 40 per cent decrease in head injuries and a 24 per cent decrease in severe injuries was recorded in a comparable period following introduction of a helmet wearing law (Vulcan, Cameron and Heiman, 1992). However, there were a number of other changes that coincided with the introduction of the law on cycle helmets and these will have had an influence on the decreases.

First, the legislation appears to have deterred many people from cycling - 15 per cent fewer young children, over 40 per cent fewer teenagers, and 20 per cent fewer adults (ibid.). Second, danger on the roads has reduced over the last few years owing to a decline in traffic levels attributable to the state of the economy, and other legislation on drink-driving and speeding which is likely to have affected behaviour. In combination, these have contributed to a 50 per cent reduction in road accidents in a comparable period covered by the studies (Minerva, 1993), that is a sharper fall than the percentage reduction of head injuries following the new law even discounting the reduction in the extent of cycling during the period in question.

Not surprisingly, one of the two main studies on the effect of the helmet legislation has concluded that it is 'almost impossible to isolate and measure the contribution of cycle helmets', that 'there are no reliable figures on which to base analysis' ... but that 'the law has led to an increase in helmet wearing rates' (Cameron, Heiman and Neiger, 1992).

Risk compensation

However, it is particularly important to question the wisdom of drawing conclusions from any study which has been conducted to determine what difference wearing a cycle helmet makes to the incidence of head injury unless the issue of risk compensation has been addressed. Only a limited number of researchers recording higher levels of injury among cyclists without helmets recognise that behaviour may be influenced by the perception of risk (Rodgers, op.cit.; Spaite, op.cit.). It needs to be asked how much more vulnerable a cyclist who usually wore a helmet would feel and how much more carefully he would ride if, for some reason, he had to ride without it. This critical issue is discussed in more detail in the following chapter.
QUESTIONING THE BENEFITS OF HELMET WEARING

There are grounds for questioning the benefit afforded by wearing cycle helmets. They relate to their strength, the influence of their cost and rate of usage, their efficiency in use and, most importantly, the effect of helmet wearing on the propensity to take risks.

Degree of protection from cycle helmets

Though cyclists are usually involved in accidents at lower speeds than those of motorcyclists, their head injuries are generally more serious (Waters, op.cit.). But the BSI specification makes it clear that cycle helmets only provide that degree of protection for low speed impact, that is up to about 20 kph, required to reduce injury if someone falls off their cycle and without a motor vehicle being involved (British Standards Institute, 1991). The protection afforded by cycle helmets falls well short of the heavier, more stoutly constructed and more complete coverage of motorcycle helmets which are thus better able to withstand the impact forces from collision with a motor vehicle: yet, above an impact speed of 8 metres per second - about 25kph - even the protection from wearing a motorcycle helmet is insufficient in preventing death if the rider’s head makes a direct hit on a solid object (Hopes and Chinn, 1987).

Table 4 shows the numbers of each type of road user who have died on the roads from head injury in an accident in the last five years for which the statistics are accessible for such analysis. It can be seen that cycle fatalities account for only 1 in 17 of all road fatalities and 1 in 12 of those that result from head injury. It is instructive to note that, in spite of the fact that motorcyclists are obliged by law to wear a helmet at all times and with the enhanced level of protection, 45 per cent of their fatalities result from head injury, compared with 71 per cent of those of cyclists, only a minority of whom wear a helmet.

Table 4. Fatalities due to head injury* according to road user group, England and Wales, 1987 to 1991.

<table>
<thead>
<tr>
<th>Road user type</th>
<th>All fatalities</th>
<th>Fatalities from head injury</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>number</td>
<td>% of all</td>
</tr>
<tr>
<td>pedestrians</td>
<td>7983</td>
<td>34.8</td>
</tr>
<tr>
<td>cyclists</td>
<td>1344</td>
<td>5.9</td>
</tr>
<tr>
<td>2-wheel motor riders</td>
<td>3009</td>
<td>13.1</td>
</tr>
<tr>
<td>vehicle drivers</td>
<td>6459</td>
<td>28.1</td>
</tr>
<tr>
<td>vehicle passengers</td>
<td>4159</td>
<td>18.1</td>
</tr>
<tr>
<td>All</td>
<td>22954</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Source: special tabulations from the Office of Population Censuses and Surveys.
* The percentages in the Table have been calculated on the basis of the numbers of head injuries for which a safety helmet is likely to afford some protection: the types of injury covered are fracture of skull, intracranial injury excluding skull fracture, other open wound of head, injury to blood vessels of head and neck, late effects of intracranial injury without mention of skull fracture, superficial injury of face, neck and scalp except eye, contusion of face, skull and neck except eyes, and injury to other cranial nerves.

It is clear that motor cycle, let alone cycle helmets can by no means be relied on to protect riders from all the different types of head injury. To avoid impairing vision or hearing, cycle helmets are designed to be worn high on the head and thus do not afford protection to parts of the head, face and upper neck which account for over half of the so-called ‘head’ injuries of cyclists (Mills, op.cit.). In
addition, they do not protect the head from rotational trauma which can seriously damage the brain and brain stem and which is quite common when cyclists are hit a glancing blow from a motor vehicle rather than in direct collision with it (McCarthy, 1992). It should be borne in mind too that some cycle fatalities attributed to head injury would have occurred anyway as a result of severe injury to other parts of the body (ibid).

In fact, as Table 5 shows, 90 per cent of serious injuries reported to the police and 94 per cent of fatalities in cycle accidents involve a motor vehicle - a very similar proportion to the 96 per cent recorded in the US (National Highway Traffic Safety Administration, 1993). The forces attributable to the weight and speed of the vehicle at the time of impact which can only rarely be absorbed by the cycle helmet and play a crucial role in terms of the severity of the injury (Fife, op.cit.). This is not surprising given the evidence from research into ‘safer’ cars which shows that, in each collision, the severity of accident depends predominantly on the differences in the mass of the vehicles involved, and that the heavier the vehicle, the safer it is - for the occupants (Department of Transport, 1993b)! It can be seen that nearly three-quarters of the serious injuries and two in three of the fatalities result from collision with a car, and that heavy goods vehicles account for a disproportionately high number of cycle fatalities (21 per cent) though they represent only seven per cent of total vehicle mileage on the road (Department of Transport, 1992). Analysis of fatalities in road accidents in the last seven years in inner and outer London, with their relatively high traffic volumes shows that HGVs (heavy goods vehicles) are involved in 56 and 30 per cent, and cars in 26 and 54 per cent respectively of all cycle deaths in these two areas of the capital (Gilbert and McCarthy, 1993).

Table 5. Cycle fatalities and serious injuries, according to vehicle involvement, Great Britain, 1987 to 1991

<table>
<thead>
<tr>
<th>Other vehicles involved:</th>
<th>serious injuries</th>
<th>fatalities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>number</td>
<td>per cent</td>
</tr>
<tr>
<td>none</td>
<td>2357</td>
<td>10.4</td>
</tr>
<tr>
<td>one or more*:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>car</td>
<td>16323</td>
<td>72.2</td>
</tr>
<tr>
<td>heavy goods vehicle</td>
<td>1000</td>
<td>4.4</td>
</tr>
<tr>
<td>light goods vehicle</td>
<td>1525</td>
<td>6.7</td>
</tr>
<tr>
<td>bus</td>
<td>332</td>
<td>1.5</td>
</tr>
<tr>
<td>2-wheel motor vehicle</td>
<td>617</td>
<td>2.7</td>
</tr>
<tr>
<td>bicycle</td>
<td>249</td>
<td>1.1</td>
</tr>
<tr>
<td>other</td>
<td>215</td>
<td>1.0</td>
</tr>
<tr>
<td>Total:</td>
<td>22619</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Source: Department of Transport, volumes of Road Accident Statistics Great Britain: The Casualty Report, for the five years from 1987 to 1991.

* In the Table, deaths and serious injuries in accidents involving more than one vehicle, that is 5 per cent of all, have been distributed in the same proportion as those in accidents involving only one other vehicle.

The cost of cycle helmets and their usage

The average price of a helmet is about £30. A high quality helmet costs up to £100. In the event of legislation making helmet wearing mandatory, an outlay of this size could result in some people giving up or not starting cycling. The costs would be greater for families with children whose helmets have to be replaced several times to accommodate their increasing head size. Australian experience has shown the extent to which mandatory helmet wearing constitutes a disincentive to cycling.
Even if cyclists own a helmet, they would obviously need to be wearing it at the time of the accident in order to derive the benefit attributed to it. But what evidence there is on the extent of helmet wearing among those who own one suggests that this is by no means commonplace. A survey in the UK has recorded that, at present, only 10 per cent of children wear a helmet the whole time, and only 13 per cent sometimes (Central Office of Information, 1992). A survey in Canada found that only one in six children owning a helmet were wearing it at the time of their injury (Cushman, op. cit.). One explanation is that some children are concerned about the 'sissy' image portrayed by wearing a helmet (Wood and Milne, op. cit.; Ferriss et al., 1989), with negative peer group pressure militating against them wearing one even if they own one (Howland et al., 1989). Another explanation is the inconvenience of having to carry it around and, because of its value, taking care to prevent it being stolen. In addition, many cyclists already carry such accessories as lights, a pump, reflector sash and trouser clips. A helmet is more bulky than all of these put together, and cannot easily be put away in a drawer or case as can these other items.

**Cycling comfortably**

Comfort must also be considered. For the helmet to be effective, it must be securely fastened under the chin with the strap under tension so that it cannot move in any direction by any combination of pull or twist, however hard that is attempted, without it being so tight that it hurts. Many serious head injuries among cyclists occur because the strap was loose enough to allow the helmet to come off in the accident (Illingworth, 1992), and this is not uncommon when the helmet is struck below the rim (Williams, op.cit.).

Related to this problem is the fact that the helmet must fit snugly at all times. But, in the winter, some cyclists like to wear balaclavas which prevent that occurring. Likewise, some children have thick hair which can act as a cushion. Some evidence of the significance of these considerations can be gained from a survey in New South Wales, Australia, which recorded that between a quarter and a third of cyclists under the age of 16 were not wearing their helmets correctly (Walker, 1992). In the case of women, some have hairstyles - preferred by them or expected of them as part of their job - which can be spoiled through compression by a tight fitting helmet, again making it less likely that the helmet will be used properly.

Moreover, as children grow older, their head size changes - 24 different sizes are available (Juden, op.cit.). This then requires, as noted earlier, the purchase of several new helmets during childhood to ensure that the helmet fits correctly (Consumers Association, 1991). It also has to be borne in mind that cycle helmets may be ineffective if they have been knocked or damaged, even invisibly, or badly scratched (British Standards Institute, op.cit.). If that does occur, they must be replaced (RoSPA, op.cit.). However, where there is no visible damage, it may be tempting to avoid the expense of replacing the helmet and hope that its effectiveness has not been reduced. Some indication of the extent of this among children is that, where a local authority sold helmets at a concessionary rate and undertook to replace them free if they were damaged, five per cent were returned (Smith, 1993).

A further aspect of comfort in the case of cycle helmets, as opposed to motorcycle helmets, is that attributable to ventilation. The crown of the head has a key role in regulating body temperature as one third is lost through the crown (British Medical Association, op.cit.). Much anecdotal evidence suggests that heat dissipation is a particular problem even with well-ventilated hard helmets, especially in warm weather, that is the time of year when more people are
cycling. And, of course, discomfort of this sort is likely to be exacerbated among those cyclists whose breathing is restricted by wearing an anti-pollution mask over their nose and mouth. Finally, it is clear that some people are psychologically 'uncomfortable' with helmets, whether owing to a preference for the feel of the wind in their hair, objecting to being expected to wear one, being obliged to do so by law, or, in the case of children, owing to a fear of derision from their peers.

**Propensity to take risks**

As noted earlier, considerable caution must be exercised in drawing conclusions about the likelihood of cyclists reducing their risk of head injury by wearing helmets as it is clear that such a practice affects their risk-taking behaviour (Adams, 1985; Evans, 1991). Discussion of this subject of behavioural adaptation no longer centres on whether it occurs but on how complete it is (OECD, 1990). In the first place, it must be recognised that cyclists who choose to wear helmets are likely by nature to be more cautious people and therefore to have fewer accidents, irrespective of the use of the helmet. This could account for much of the observed differences revealed in studies of the incidence of accidents leading to head injury - rather than the protection afforded by the helmet.

Furthermore, the theory of risk compensation suggests that the wearing of helmets may cause cyclists, as with motorists acquiring cars with better brakes and improved acceleration, to modify their riding behaviour (Adams, *op.cit.*). This proposition can be illustrated by considering how much more carefully a motorist will drive a car with defective brakes than one with effective brakes. The soundness of the proposition is also reflected in the description by an MP promoting a Bill in the House of Commons to make helmet wearing compulsory for horse riders - 'It was comfortable, felt safe, and *it gave extra confidence* (author's italics) to this rider, as I am sure it would to everyone else' (Greenaway, 1990). Thus, when a safety aid such as a helmet is actually used, some of its potential safety benefits may be 'consumed' as performance benefits in the form of faster or more carefree riding.

There can be no doubt that the very act of wearing a cycle helmet must encourage cyclists to feel more confident that, in the event of an accident, their risk of head injury will be reduced. Yet road safety campaigners, helmet manufacturers, and others persuaded of the benefits of helmet wearing, effectively imprint on cyclists' minds that they will be safer if they wear a helmet, but do not warn of the very limited benefit that it would offer following an accident involving a motor vehicle. This may lead cyclists to take marginally more risk as they feel less vulnerable and are thereby more likely to have accidents. A similar outcome is likely to follow if parents allow their helmeted children to cycle on the roads under the false assumption that it is then sufficiently safe to do so. It could be argued therefore that cyclists who do not wear helmets exercise *more vigilance* because they feel more vulnerable. Perhaps it is better to be more alert and apprehensive so that there is a split-second faster response to the risk of having an accident (Cleary and Hughes, 1992).

It is ironical that, on the one hand, campaigns on helmet wearing encourage perceptions of cycling as a dangerous mode - some young cyclists are thought to wear them in order to show that they are engaging in a dangerous activity (Woolf, 1993) - and that this concern is the primary reason why more people are not prepared to take up cycling. On the other hand, these same campaigns, and the publicity attached to them, give cyclists the false impression that cycling with a helmet will afford adequate protection from head injury in the event of an accident. At the same time, they divert attention away from the fact that cycling
itself is inherently safe and that the solution to reducing injury among cyclists, especially to the head, has far more to do with the actions of drivers - and those in a position to influence their behaviour - the public authorities - than it does with the actions of cyclists.

Another source of evidence often cited in support of helmet wearing is that it led to a reduction in casualties among motorcyclists when that was made compulsory in the UK in 1973. Comparison of the number of motorcyclists killed in the years before and after the introduction of this law indicates a contrary conclusion to what is thought to have happened. Table 6 shows that motorcyclists' rate per kilometre travelled fell significantly less than did that of car drivers and that of all road users. Moreover, standing out against the general trend of road accident reduction, there was an increase in pedestrian deaths and injuries in collision with motorcycles in the years after this legislation, suggesting that this may have been accounted for by more careless riding by helmeted motorcyclists (Davis, 1993). It is very telling to note, too, that following the repeal of the law in some US states requiring motorcyclists to wear helmets, the rate of increase in motorcyclists' fatalities was greater in those not repealing the law (Adams, op.cit.).

Table 6. Changes in fatality rates among two-wheel motor vehicle riders and car drivers, Great Britain, 1966 to 1980 (standardised to base year 1973 = 100).

<table>
<thead>
<tr>
<th>Year</th>
<th>Two-wheel motor vehicle riders</th>
<th>Car drivers</th>
<th>All road users</th>
</tr>
</thead>
<tbody>
<tr>
<td>1966</td>
<td>98</td>
<td>122</td>
<td>155</td>
</tr>
<tr>
<td>1967</td>
<td>91</td>
<td>111</td>
<td>134</td>
</tr>
<tr>
<td>1968</td>
<td>97</td>
<td>89</td>
<td>121</td>
</tr>
<tr>
<td>1969</td>
<td>103</td>
<td>100</td>
<td>128</td>
</tr>
<tr>
<td>1970</td>
<td>104</td>
<td>111</td>
<td>124</td>
</tr>
<tr>
<td>1971</td>
<td>101</td>
<td>100</td>
<td>117</td>
</tr>
<tr>
<td>1972</td>
<td>103</td>
<td>111</td>
<td>110</td>
</tr>
<tr>
<td>1973</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>1974</td>
<td>103</td>
<td>89</td>
<td>97</td>
</tr>
<tr>
<td>1975</td>
<td>87</td>
<td>78</td>
<td>90</td>
</tr>
<tr>
<td>1976</td>
<td>88</td>
<td>78</td>
<td>86</td>
</tr>
<tr>
<td>1977</td>
<td>97</td>
<td>78</td>
<td>86</td>
</tr>
<tr>
<td>1978</td>
<td>93</td>
<td>78</td>
<td>86</td>
</tr>
<tr>
<td>1979</td>
<td>94</td>
<td>78</td>
<td>79</td>
</tr>
<tr>
<td>1980</td>
<td>83</td>
<td>67</td>
<td>72</td>
</tr>
</tbody>
</table>

Source: calculated from annual volumes of Department of Transport, Road Accidents Statistics Great Britain.
DISCUSSION

Several key issues additional to the grounds for questioning the benefits of helmet wearing set out in the previous two chapters need to be considered before reaching policy decisions on this subject. They include ethical issues in relation to road users' differing responsibilities for promoting both their own safety and that of others; the subject of legal sanction; the influence of helmet wearing on the attractions of cycling from the broader viewpoint of cycling's link with physical fitness and therefore with policy on health promotion; and finally, alternative approaches to reducing the number of head injuries in road accidents.

Whose responsibility for minimising risk of injury?

A central theme of the case put forward for encouraging cyclists to wear helmets, if not legislating to make this mandatory, relates to the medical costs of treating cycle injuries in road accidents. If cyclists choose to adopt a form of travel known to have a high casualty rate and do not take reasonable precautions, such as helmet wearing, to reduce that rate, why should society, through the medium of the National Health Service, have to pay these costs?

However, it could reasonably be argued that it is inappropriate to shift so much responsibility for the safety of cyclists onto cyclists themselves. Cyclists are among the most vulnerable of road users and unable markedly to reduce the risk to themselves of being involved in a road accident - the prelude to head injury - other than by cycling less or giving up cycling altogether. The proposition that cycling is relatively dangerous overlooks the fact noted earlier that few cyclists ride into motor vehicles. The great majority of serious injuries or deaths result from being hit by a carelessly driven motor vehicle: indeed, one study of culpability in adult cyclists' accidents in which another vehicle was involved found that only 17 per cent of the cyclists were at fault (Mills, op. cit.).

Thus, it is drivers of motor vehicles who are the source of most of the threat to the life and limbs of cyclists. Moreover, it should be borne in mind that about one in five members of motoring organisations in Great Britain are cyclists as well as car owners (Automobile Association, 1993). If, instead of cycling, some were to use their cars, that would add to the danger for all other road users, especially the vulnerable ones - pedestrians and cyclists. Calling on cyclists to protect themselves by wearing helmets in effect shifts responsibility away from drivers onto cyclists although it is nearly always the cyclist who is the victim. In all collisions involving a cycle and a car in the last five years, 650 cyclists have been killed compared with only one person in a car. In collisions involving a cycle and a lorry, 334 cyclists have been killed while no lorry driver has lost his life.

It is also difficult to justify any proposition that seeks to transfer the primary issue of the risk of injury among cyclists, namely the motor vehicle as its source, onto the secondary issue of how to minimise the injury in the event of an accident. Again, it has to be stressed that the great majority of cyclists' deaths and serious injuries result from collision with a motor vehicle and that is the type of accident in which helmets are largely ineffective. This leaves only a relatively small number of cyclists whose head injuries could, in theory, be limited by wearing a helmet. Even in those cases, as noted earlier, the benefits would depend on the questionable assumption that their riding behaviour would not be influenced by the knowledge that their head was protected by the helmet.
Who should wear helmets?

Public concern about road accidents is more heavily focused on children than on adults, particularly with regard to the scope for reducing their risk of head injury when cycling. However, in the case of child cyclists, a number of factors need to be borne in mind. In the absence of safe routes for cycling, parents impose severe restrictions on their children’s use of cycles on public roads: a study completed in 1991 found that over 90 per cent of junior schoolchildren in England own bicycles but only one in four of them is allowed to use them as a transport mode, and only one per cent use them to go to school (Hillman, Adams and Whitelegg, 1991). As a result, most of children’s cycling is for recreation and takes place off the road where collision with motor vehicles is unlikely to occur. Indeed, it has been seen that, where children are injured, it is rarely serious: the accidents usually occur as a result of falling off at low speed. It is this type of accident for which helmets are specifically designed to limit the severity of injury.

It could be argued therefore that, in the event of an accident, cycle helmets could contribute to reducing head injuries among children more obviously than among adults. But, again, there is no reason to believe that children, as adults, are not influenced in their riding behaviour by the greater feeling of security afforded when wearing a helmet, and consequently take marginally less care.

It is instructive to observe that, if the case for encouraging child or indeed adult cyclists to wear helmets were valid, on the grounds that it would lead to a reduction in their deaths and serious injuries, then arguments could be put forward that when children are playing, they should wear helmets given the risk of them falling and hitting their heads: a survey has shown that they are between two and three times as likely to have a head injury after climbing or jumping than as a result of a cycle accident (O’Rourke, 1987). They should also wear knee, elbow and shoulder pads as well for there are three times as many serious injuries to cyclists’ upper and lower limbs as there are to their heads (Mills, op.cit.).

Similarly, logic would suggest that all other road users should be encouraged to wear helmets, especially pedestrians and vehicle drivers for, in theory, this would hold out far more significant prospect of success in saving lives in road accidents. Table 7 shows that, on average for the five years covering 1987 to 1991, cyclists accounted for only 1 in 12 of all road fatalities involving the type of head injury for which a safety helmet could afford some protection. It can be seen too that, compared with cyclists, nearly five times as many vehicle occupants and nearly five times as many pedestrians die as a result of head injury. And twice as many lives are lost by head injury to elderly pedestrians (over the age of 65) than to cyclists of all ages, partly no doubt owing to their poorer vision, declining acuity and their lower survival rates following injury.

Table 7. Distribution of fatalities due to head injury according to road user group and age group, England and Wales, 1987 to 1991.

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Pedestrian</th>
<th>Cyclist</th>
<th>Motorcyclist*</th>
<th>MV driver</th>
<th>MV passenger</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-9</td>
<td>4.14</td>
<td>0.46</td>
<td>0.06</td>
<td>0.01</td>
<td>1.38</td>
<td>5.99</td>
</tr>
<tr>
<td>10-14</td>
<td>2.38</td>
<td>1.49</td>
<td>0.06</td>
<td>0.01</td>
<td>0.64</td>
<td>4.58</td>
</tr>
<tr>
<td>15-19</td>
<td>2.65</td>
<td>1.04</td>
<td>3.73</td>
<td>3.24</td>
<td>4.36</td>
<td>15.02</td>
</tr>
<tr>
<td>20-24</td>
<td>2.41</td>
<td>0.63</td>
<td>3.53</td>
<td>5.67</td>
<td>3.14</td>
<td>15.38</td>
</tr>
<tr>
<td>25-54</td>
<td>8.62</td>
<td>2.28</td>
<td>4.04</td>
<td>12.39</td>
<td>3.83</td>
<td>31.16</td>
</tr>
<tr>
<td>55-64</td>
<td>3.46</td>
<td>0.96</td>
<td>0.22</td>
<td>1.80</td>
<td>0.64</td>
<td>7.09</td>
</tr>
<tr>
<td>65-74</td>
<td>5.38</td>
<td>0.87</td>
<td>0.24</td>
<td>0.96</td>
<td>0.73</td>
<td>8.19</td>
</tr>
<tr>
<td>75+</td>
<td>10.09</td>
<td>0.72</td>
<td>0.08</td>
<td>0.87</td>
<td>0.83</td>
<td>12.60</td>
</tr>
<tr>
<td>All</td>
<td>39.14</td>
<td>8.46</td>
<td>11.90</td>
<td>24.94</td>
<td>15.55</td>
<td>100.00</td>
</tr>
</tbody>
</table>

* including pillion passengers
Source: special tabulations from the Office of Population Censuses and Surveys.
Encouragement versus compulsion

Beyond the proposition that cyclists should be encouraged to wear a helmet lies the more extreme one that wearing should be made compulsory. This is favoured by many surgeons who only see the head injuries and perhaps understandably assume that its severity would have been limited by wearing a helmet but are unfamiliar with the issues of accident prevention (Briese, 1992; Davis, op. cit.). However, aside from questioning the benefits of helmet wearing set out earlier, there are strong grounds, both practical and ethical, for opposing this.

First, there are problems of enforcement. Only a minority of cyclists wear a helmet at present. If the law made this mandatory, an expensive publicly-funded campaign would be required and, even then, a considerable burden would be placed on the police as it would be unlikely to command wide support among cyclists. Thus, there would be a strong possibility that enforcing such a law adequately would be too difficult, thereby bringing it into disrepute. It is also worth noting that legal compulsion would be ineffective in relation to most of children's cycling which takes place off the road and is the location of the majority of their accidents.

Second, if wearing a helmet were made compulsory, it would reinforce the idea that cyclists were responsible for injuries to their heads if they were not wearing one whereas, as has been noted, in accidents in which another vehicle is involved, it is the driver who is far more often at fault. Thus, a climate of opinion could arise in which cyclists who suffered a head injury were blamed by the police, the driver and the insurance company, for failing to take adequate precautions, and were therefore guilty of contributory negligence.

Third, legislation requiring cyclists to wear helmets at all times might also reinforce public perceptions of the bicycle as a dangerous form of transport, thus discouraging its use. Yet, cycling represents an excellent means for maintaining fitness with wide benefits both for personal and public health, and these would be lost by those deterred from taking up cycling, or indeed from taking up cycling. Surveys on the subject of making helmet wearing compulsory have recorded 18 per cent of cyclists indicating that that would lead them to cycle less, and 9 per cent that they would give it up altogether (Cyclists' Touring Club, 1993); and 28 per cent of students at a university saying that they would be less likely to cycle (Unwin, 1992).

The best evidence on the influence of such legislation can be drawn from Australia where, in a comparable period following the introduction of the law making wearing compulsory, many people have stopped cycling: in two Australian states, cycle use fell by over a third among children and by about a fifth among adults (Vulcan, Cameron and Heiman op. cit.; Walker, 1992), with some further decline more recently. Compulsion is inconsistent with the ethos of cycling in terms of freedom, enjoyment and convenience - three reasons given in an attitudinal survey for the attractions of cycling (Transport and Road Research Laboratory, 1989). It is also worth noting that enthusiasts or regular cyclists who cycle more miles will acquire a helmet, while casual 'fair weather' cyclists who cycle less but are more likely to need exercise will be the ones deterred from cycling.

Fifth, there is the issue of the cumulative costs to the 'community' of cyclists having to purchase helmets. Although of course public and private funding of measures to reduce road casualties are not interchangeable, it is instructive to note that the costs incurred if all cyclists in Great Britain had to buy a helmet would initially be at least 300 million - that is conservatively, say £25 for each of the 12 to 15 million cycle owners in the UK. Given the fact that the casualty rate per kilometre has been markedly reduced in countries where a relatively safe
environment has been created for cycling, an alternative way of achieving the objective of reducing accidents involving head injury among cyclists and the medical costs of treating them, as well as the objective of promoting public health through cycling, would be to spend a comparable sum on making safer provision for cycling. It has been calculated that if only 20 per cent of non-walk trips were transferred to cycling, annual cost savings measured by reductions in the costs of health care and in working days lost would be 1.3 billion a year (Earth Resources Research, op. cit.).

Finally, in considering the issue of compulsion, a strong case exists for making it mandatory for helmet manufacturers to include a 'health warning' that the helmet provides effective protection only in accidents where cyclists just fall off their bicycle. It could be wryly observed too that, given the statutory duty of government to provide for the safety of all road users, including of course cyclists, it could be made mandatory for local authorities to make safe provision for cyclists, and for central government to allocate sufficient resources from the annual transport budget to enable this. Moreover, it does not seem to be wholly flippant to suggest that, were helmet wearing efficacious, then young car drivers and their passengers or elderly pedestrians should be the first group for whom it should be mandatory to wear a 'safety' helmet. Far more elderly pedestrians and young motorists are at risk of death through head injury than are cyclists.

**Life years lost versus life years gained**

A further issue to be addressed in determining policy on cycle helmets relates to the promotion of health. A national survey in 1992 recorded that seven in ten men and eight in ten women fall below the 'age appropriate activity level' needed to achieve a health benefit (Allied Dunbar et al., 1992). And a series of studies has shown children's levels of habitual physical activity to be surprisingly low: few experience the intensity and duration of physical activity associated with health-related outcomes (British Medical Association, op. cit.; Armstrong, 1993).

Table 8 shows that circulatory and respiratory diseases account for over half of the causes of death among both men and women. Heart disease has been targeted by the government for a reduction of 40 per cent by the end of the decade (Department of Health, 1992). A most telling and supportive argument for cycling therefore, as noted earlier, is that it is an excellent means of maintaining fitness from childhood through to old age, particularly bearing in mind the fact that, compared with those who do not cycle, those who do so at least 25 miles a week halve their risk of heart disease (Morris et al., 1990).

<table>
<thead>
<tr>
<th>Cause:</th>
<th>males</th>
<th>females</th>
</tr>
</thead>
<tbody>
<tr>
<td>circulatory diseases, mainly heart</td>
<td>45.6</td>
<td>46.1</td>
</tr>
<tr>
<td>neoplasms</td>
<td>27.4</td>
<td>24.1</td>
</tr>
<tr>
<td>respiratory diseases</td>
<td>11.1</td>
<td>10.6</td>
</tr>
<tr>
<td>other diseases</td>
<td>11.7</td>
<td>16.4</td>
</tr>
<tr>
<td>injury and poisoning</td>
<td>4.2</td>
<td>2.2</td>
</tr>
<tr>
<td>All causes</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Source: Office of Population Censuses and Surveys.
The gain of 'life years' through improved fitness among regular cyclists, and thus their increased longevity exceeds the loss of 'life years' in cycle fatalities (British Medical Association, 1992). An analysis based on the life expectancy of each cyclist killed in road accidents using actuarial data, and the increased longevity of those engaging in exercise regimes several times a week compared with those leading relatively sedentary lives, has shown that, even in the current cycle-hostile environment, the benefits in terms of life years gained, outweigh life years lost in cycling fatalities by a factor of around 20 to 1 (Hillman, op.cit.). In these terms, a price is paid in not promoting cycling.

However, it is apparent that cycling is viewed by most people as a dangerous form of travel owing to the prominence given to cyclists' greater risk of injury in road accidents and the fact that their general injury accident rate per mile travelled is many times higher than that of car or bus users.

Two problems stem from the promotion of helmet wearing to reduce the dangers of cycling. First, as noted earlier, cyclists who wear a helmet do so with an exaggerated expectation of the helmet being effective in preventing injury to their head in collision with a motor vehicle. Indeed, it is paradoxical that the main reported barrier to helmet use is lack of knowledge of its 'importance' (Sacks, op.cit.). Second, as has been seen in Australia, mandatory wearing discourages people from cycling. In view of cycling's considerable scope for improving the nation's health - not only fitness resulting from exercise but also reduction in pollution if the alternative is travel by car - the health benefits of this invaluable means of maintaining fitness are lost and a higher cost burden is borne by the health service (Sports Council, 1993).

Alternative approaches to reducing head injuries

As has been observed, helmet wearing does not address the principal issue, namely the source of cyclists' serious injuries which, in most instances, is traffic moving too fast and thereby posing a threat to vulnerable road users. For drivers, the difference between colliding and not colliding with an object is measured in fractions of a second: an experiment based on over 1000 observations, which was aimed at establishing how long it takes to avoid a particular road hazard, revealed a wide variation in drivers' reaction times with most being between 1.5 and 4.0 seconds (Evans, op.cit.). A simple calculation shows that, at 1.5 seconds, with travel at only 32 kph (20 mph), a distance of 13 metres (44 feet) is covered and, at 4.0 seconds, the distance is 36 metres (117 feet).

In the context of accident avoidance, both speed and reaction time are critical. Thus, the first requirement is greater awareness among motorists and lorry drivers, through the medium of road safety campaigns, of the need to exercise a high level of vigilance on the roads in view of the vulnerability of cyclists to injury. The change in drivers' behaviour following a better understanding of the consequences of colliding with a cyclist is likely to be far more effective in lowering the number and severity of head injuries among cyclists than the protection afforded by a few millimetres of polystyrene after an accident has occurred. It is clear too that traffic speed plays a crucial role. Recent evidence shows that a 1 mph reduction in traffic speed leads to 5 per cent fewer casualties and 7 per cent fewer fatalities. This is not surprising given the complementary figures that when pedestrians are hit by vehicles travelling at 20, 30 and 40 mph, the proportions killed are 5, 45 and 85 per cent respectively (Department of Transport, 1993c).

For this reason there are strong grounds for believing that public provision of cycle routes, traffic calming, 20 mph speed limit zones which have been shown to
reduce casualties by more than 50 per cent (Carlisle, 1993) and for which 80 per cent of urban road networks are eligible (Chope, 1992), proper enforcement of existing speed limits and improved road maintenance to minimise the risk of accidents caused by cyclists riding into potholes or swerving to avoid them, are effective ways of reducing the number and severity of head injuries among cyclists. After all, other than possibly increasing the visibility of cyclists, the helmet only provides some protection in the event of an accident - it does nothing to prevent accidents occurring. It is worth noting that helmets are far less on the road safety policy agenda of countries such as Denmark and the Netherlands which give a much higher priority to cycling in their transport policies. In those countries, fatality rates per kilometre cycled are between a quarter and a third of those in Great Britain, and perhaps a critical mass of cycling has been reached ensuring safer cycling because of sheer numbers (Mynors and Savell, *op.cit.*).
CONCLUSIONS

Over the past few years, considerable effort has been invested in persuading cyclists to wear helmets as a means of reducing the incidence and severity of head injury among them. The attention given to this subject goes to the heart of policy-making for the safety of cyclists.

The basis of the argument in favour of the general promotion of helmet wearing appears to be that 'it stands to reason' - injury from knocks on the head will be reduced if some protection is adopted. However, this study has shown that the claims made to justify support for such a policy are at best exaggerated and at worst counterproductive: they have been derived more from the findings of surveys with flawed methodology and unsubstantiated assumptions than from an objective assessment of the evidence.

The argument is based on the assumption that helmets would provide additional protection while not changing behaviour. There is no evidence for the second part of the assumption. Indeed, the evidence suggests, not surprisingly, that protective devices encourage higher levels of risk-taking. As a result, cyclists are likely to ride less cautiously when wearing a helmet owing to their feeling of increased security. In this way, they ‘consume’ some, if not all, of the benefit that would otherwise accrue from wearing a helmet. After all, the message of the advocates of helmet wearing is that such a practice will protect the cyclist’s head adequately in the event of any accident, not just a minor one when cyclists are hit by slow-moving vehicles or fall off and hit their heads on the ground.

Moreover, by wearing helmets, cyclists are at best only marginally reducing their chances of being fatally or seriously injured in a collision with a motor vehicle which is the predominant cause of these injuries. Even the most expensive helmets provide little protection in these circumstances. From this perspective, cyclists will benefit from wearing a helmet only if they understand that it will not spare them from serious injury in the event of most accidents in which they are likely to be involved. Cyclists may be less likely to have an accident if they are not wearing a helmet, and are therefore riding with greater care owing to an enhanced sense of their vulnerability.

People are discouraged from cycling as public perception is heightened that it is a ‘dangerous’ form of travel and that it is only safe to do so if a helmet is worn. As a result, the considerable latent demand for cycling - an ideal mode for the majority of the population for a significant proportion of their journeys - continues to be suppressed. However, as cycling is also a convenient and routine way of maintaining fitness, this is a public health issue as well. This report cites evidence of the benefits of its promotion. Levels of morbidity and mortality among non-cyclists owing to lack of fitness are higher than levels among cyclists in spite of their greater risk of injury in road accidents. And the life years lost in cycle accidents are far outweighed by the life years gained by regular cycling even in the current hostile traffic environment.

There remain three questions to be answered which lay behind this study being undertaken. First, should helmet wearing be made mandatory? Second, if not, should it at least be encouraged? And third, if both answers are in the negative, what alternative action should be taken to reduce head injuries among cyclists?

In answer to the first question, the review of studies in this report has not supported the case for making helmet wearing mandatory. The balance of evidence does not suggest that mandatory helmet wearing would reduce the level of head injuries. Moreover, where such a law has been introduced, it has led to a significant reduction in cycling, with a likely adverse outcome in terms of the promotion of public health.
The second question to address is whether, whilst not making it mandatory, cyclists should nevertheless be encouraged to wear helmets. Again, the conclusion has to be that an approach to helmet wearing by persuasion, rather than by coercion through legislation would be similarly ineffective in achieving the objective of reducing the risk of head injury.

This leads to the third question which is concerned with alternative ways of reducing the risk of accidents, and therefore of head injury, among cyclists. Prefacing any remarks on this is the important distinction that must be made between policy on preventing cycle accidents and on minimising the extent of injury once an accident has occurred. These two concepts are often carelessly and critically confused. It is clear that cycle helmets are a secondary and not a primary means of reducing head injury and that helmet wearing does nothing to prevent accidents in the first place.

The primary means of reducing serious head injury among cyclists is to create an environment in which accidents are less likely to occur. A strategy with this objective in mind would contain four key elements. First, cyclists' time exposure to the careless or irresponsible behaviour of drivers of motor vehicles would be minimised by providing more segregated routes for cycling. Second, more traffic calming would be introduced and lower speed limits adopted and enforced. Third, road maintenance would be improved so that cyclists do not have to devote such a high proportion of their attention to 'reading' the surface in order to steer clear of bumps and potholes, with the attendant risk of accident that entails. Fourth, awareness among drivers of lorries at least as much as those of cars, would be heightened of the exceptional vulnerability to injury of cyclists in collision with motor vehicles.

Thus, in answer to the third question, a strategy based on tackling the source of accidents in which cyclists are injured has far greater scope for reducing head injuries than the questionable benefits of promoting helmet wearing among cyclists.
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