USER ACCEPTABILITY AND ECONOMIC BENEFITS OF HARD-SHELL BICYCLE HELMETS - RESULTS OF A UK SURVEY

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1. INTRODUCTION

This paper describes a research project conducted at Southampton University with the aim of studying the UK market potential for a hard-shell cycling helmet.

The project included the following elements:-

- an evaluation of the risks to which pedal cyclists in the UK are exposed, including the effects of accident under-reporting on published cycling-risk data, and a comparison of cycling risks with other forms of road transport

- a study of the incidence of head injury among pedal cyclists

- a series of surveys among potential cycling helmet purchasers and users, to ascertain both current helmet usage patterns and future market requirements

- an evaluation of the national economic cost of cycling head injuries, and of the prospects for savings through helmet use.

The research methodology and sources of data are presented in detail in reference 1, and the present paper focuses on the principal results and conclusions.

2. CYCLING INJURY RISKS AND POTENTIAL FOR REDUCTION

The risks to which cyclists are currently exposed on the road, and the potential benefits associated with use of hard shell cycling helmets, have been assessed. These figures are used in later calculations of head injury costs; they could also form the basis of a future helmet advertising or publicity campaign.

However, under-reporting of the number of pedal-cyclist accidents leads to uncertainties in both the risk assessment and the estimates of national costs incurred through cycling accidents. Under-reporting with respect to the number of accidents and also injury severity occurs, in varying levels, in all forms of road transport, but is especially prevalent in pedal-cycling. We have therefore attempted to correct for under-reporting in the assessments which follow.

2.1 Annual casualty levels

Previous researchers, using comparisons between police and hospital records, have found widely varying under-reporting levels for non-fatal pedal-cycling accidents (Ref. 1). These ranged from 21% to 83% for under-reporting of "serious" accidents, and 41% to 91% for under-reporting of accidents described as "slight" (although these do not generally involve hospital admission).

The differences in these results can be explained by the variable accuracy, detail and completeness of hospital information (including errors in categorising on- and off-highway accidents), and discrepancies between police and hospital catchment areas. Conservative under-reporting levels are 21% for "serious" accidents and 41% for "slight" accidents. These levels suggest road traffic accident (RTA) casualty levels in Britain of at least 8,000 pedal-cyclists seriously injured per year, with at least a further 40,000 slight casualties (based on 1982-84 average RTA figures). The total number of on- and off-highway casualties is estimated to be in the region of 200,000 annually (Ref. 2).

2.2 Casualty rates per distance travelled

Pedal-cyclist casualty rates, in terms of casualties per 10^8 kilometres travelled, vary considerably with age. The highest rates occur in the under-14 age group, and in fact the 5-9 age group has the highest casualty rates at all severity levels. The latter group, however, cycles only a marginal distance per week compared with that covered by the 10-14 year age band, and the number of cycling casualties is correspondingly small.

An important finding (Ref.1) is that cyclists in the high risk 10-14 year age band are at least as likely to be killed or seriously injured, per kilometre travelled, as the average two wheeled motor vehicle rider (ignoring any under-reporting of accidents in either category of transport). They are at significantly greater risk (by around 30%), if under-reporting is allowed for.

2.3 Hospital loading due to bicycle accidents

In comparison with fatalities, non-fatal cycling injuries are not well documented in official statistics, and we have used hospital records to provide additional data on serious casualties. Such data avoids the under-reporting problem of section 2.1, and allows head injuries to be identified.

Information was provided by the East Anglia regional health authority for the years 1981-84, covering all cyclist and motorcyclist casualties who attended accident and emergency departments in the region (population 1.77 M). The key findings are itemised below.

(i) Annual number of cycling casualties (N), and the number with head injury as major cause of attendance (N'):

$N_{av}(1981-84) = 754; \quad N'_{av} = 429; \quad (N'/N)_{av} = 0.57$

Head injured cyclists make up 57% of hospital attendances, compared with 41% for motorcyclists (i.e. TWMV users).

(ii) The ratio R = N/P, where P is the number of serious cycling casualties reported by the police for the same region:

R_{av} (1981–83) = 1.98

The value 1.98 indicates 50% under reporting of such casualties. For motorcyclists, R_{av} = 0.79.

(iii) The ratio R' = N'/P, which allows head-injury casualties to be estimated nationally:

R'_{av}(1981–83) = 1.14

There are actually more head-injured cyclists arriving in hospital than the total reported number of serious casualties (all injuries). For motorcyclists, R'_{av} = 0.34.

(iv) The variation of R' with age, for cyclists: Table 1 below shows a marked age dependence.

Year	Age < 15	15–29	>30	All ages
1981	1.68	0.75	0.59	1.07
1982	1.70	0.93	0.63	1.10
1983	2.37	0.92	0.61	1.24

Table 1

The under-15 age group has about twice the R' value of the 15–29 age group. Possible reasons for the disparity are:

- Lack of adult witnesses prevents the police from hearing about accidents to child cyclists.

- Parents of under-15's take their children to hospital for injuries which young adults would treat less seriously. (On the other hand, 94% of head-injured cyclists were detained overnight, and 80% for 3 or more nights).

(v) The average length of stay (S), for head-injured casualties attending hospital:

S_{av} (1981–84) = 2.84 (pedal cyclists); 6.69 (motorcyclists)

Use will be made of this data in section 4. Of immediate interest is the average number of head-injury casualties each year in Britain as a whole: we can estimate this by multiplying the national seriously-injured total by R'. The result, based on police statistics for 1982–84, is 6840 cyclists and 6800 motorcyclists.

3.3 Potential for injury reduction through helmet use

National mortality statistics cite head injury as the principal cause of death in 69% of pedal-cyclist fatalities, and 44% of TWMV rider fatalities (Refs. 1,3). The study of non-fatal RTA casualties in the previous section has showncorresponding percentages of 57% and 41% respectively. Hence the chances of fatal or serious injury being caused by head impact are currently about 50%

greater for cyclists than for TWMV riders, who already wear helmets.

The efficacy of hard-shell cycling helmets in real crashes is hard to predict, but the odds of death from head injuries whilst cycling are estimated to be reduced by a factor of 19 if a 'good' hard-shell helmet is worn (Ref. 4), and it is expected that similar reductions in lesser injuries would be obtained.

3. HELMET ACCEPTABILITY AND PROSPECTIVE USER ATTITUDES

A set of questionnaires was developed to provide basic data on the attitudes and preferences of potential helmet users, and to establish the present level of use among cyclists. A total of 589 completed questionnaires were analysed.

The population was considered, in respect of cycling helmets, to be divisible into three main categories: user-purchaser, parents (non-user purchaser) and children (non-purchaser user) each of which imposes different constraints on the type of questions asked. These three groups required three separate questionnaires. Conclusions from each of the questionnaires are reviewed in turn below.

3.1 User-purchaser questionnaire

This questionnaire was administered by mail, through local cycling groups and other contacts. The direct frequencies of the results are shown graphically in Figures 1 to 10. The first group of figures (Figures 1 to 6) indicate features (sex, age, miles cycled etc) of the population interviewed, whereas the "Helmet" responses (figures 7 to 10) refer to their opinions on helmets (price, most important design feature etc). The principal observations from these frequencies are:

(i) 73% of those questioned were male.

(ii) 34% of the respondents wear reflective clothing in poor visibility. (NB although this is a relatively small percentage, the wearing of reflective clothing is evidently "socially acceptable").

(iii) 68% consider the degree of protection offered to be the most important feature in helmet design. 12% and 14% of the respondents, respectively, consider looks and comfort to be of principal importance.

(iv) The features in (iii) are correspondingly represented in the respondents' choice of the three most important design requirements.

(v) 50% of the cyclists who replied would be willing to spend at least £16-£20 on a helmet.

(vi) 8% already own some form of rigid (hard shell) cycling helmet. Of these 44% hardly ever (or never) wear their helmet, implying that approximately 4% of adult cyclists at present use a helmet regularly.

(vii) The principal reason given for not owning a helmet was "insufficient risk" (44%). A total of 30% of cyclists not owning a helmet based their decision on either cost, poor looks or lack of comfort. Only 24% of the respondents considered incovenience as the paramount reason for not owning a helmet. It may be concluded that a rigid helmet would have an optimum market of 76% of all cyclists in the user-purchaser category, given appropriate "risk education" (advertising) and suitable helmet design.

Possible connections between attitudes to helmet use and personal characteristics can be examined through use of cross-tabulations and significance tests (e.g. does age affect the price that the respondent is willing to pay for a helmet?).

From these cross-tabulations differences in attitude emerge between different categories of cyclist. Thus it was demonstrated that women cyclists appear to be more safety conscious: a significantly higher proportion, at the 5% per cent level, selected "protection" as the most important helmet design feature. However, no significant difference was found in attitudes to helmet appearance as a controlling feature.

It was considered important to test whether the choice of most important helmet feature varied with the type of cycling performed. The results are shown in Table 2.

TABLE 2

MOST IMPORTANT FEATURE	TYPE OF CYCLING							
	Recreation		Shopping		Commuting		Long Distance	
Comfort	26	(11%)	29	(13%)	31	(15%)	10	(19%)
Looks	19	(9%)	25	(11%)	14	(7%)	8	(15%)
Protection	160	(72%)	159	(69%)	150	(72%)	31	(58%)
Low cost	16	(8%)	17	(7%)	12	(6%)	4	(8%)
TOTAL	221	(100%)	230	(100%)	207	(100%)	53	(100%)

Table 2 shows that all types of cyclist consider protection the most important feature. However, long distance cyclists consider comfort and looks to a greater extent, and attach slightly less importance to the degree of protection offered. The influence of purchase price seems to remain constant across all groups (around 7% of respondents considering it the most important aspect).

The final stage of analysis involved comparing the "Helmet" responses for different categories of cyclist. The significance of these inter-relationships was assessed using a standard t-test. As a result of these tests the following conclusions were reached (based upon a 5% significance level):

(viii) As demonstrated by both the t-test and the bar chart in Figure 12, those cyclists cycling more than 50 miles per week tend to place more weight than other cyclists on comfort.

(xi) Sex and age have no significant effect on either the price the cyclist is willing to pay for a helmet, or the respondents' "mean" design choice.

(x) Cyclists who wear reflective clothing in poor visibility are willing to pay around £5 more for a helmet. Intuitively this would be expected, as cyclists who wear such clothing are generally more safety conscious.

(xi) Those cyclists who had had a serious accident within the previous 5 years were willing to pay around £5 more for a helmet.

(xii) Those cyclists who cycle over 50 miles per week, compared with those who cycle less than 11 miles, were willing to pay around £10 more for a helmet.

3.2 User-non purchaser questionnaire

In the user-non purchaser (children) questionnaire, children were shown four different bicycle helmets - Rosebank Stackhat, Skidlid, Brancale SP4 and Dalyte Pedla - and invited to try them on, while the interviewer asked a set of standard questions. From a total sample of 48 an approximately equal proportion of males and females were interviewed. All but one of the respondents was under the age of 15 years and 83% of respondents rode less than 11 miles per week. The purposes given for cycling were as follows:-

TABLE 3

Purpose	Number	Percent
Recreation	44	92
Errands	29	60
Commuting	16	33
Long Distances	6	12

Cross referencing of the people factors with each other shows them all to be independent. The rest of the questionnaire deals with attitudes towards helmets. The following conclusions can be drawn from the results:

(i) The white Rosebank Stackhat was preferred by over 75% of the children.
(ii) The proportions of children who considered each of the suggested features to be important were as follows:

TABLE 4

Feature	Number	Percent
Comfort	37	77
Protection	21	44
Looks	16	33
Other	2	4

Unfortunately the helmets available for use in the interviews were of adult sizes and consequently this result - and the choice of helmet - may have been affected.

(iii) Approximately as many children said that they would wear the chosen helmet, if given it, as said they would not. Of the 8.2% who presently own a helmet, half said that they only wore it sometimes, and half said that they never wore it. All those owning a helmet said that they had obtained it for BMX riding.

Owing to the small sample, cross referencing of helmet and people factors does not produce statistically significant results. All of the cross tabulations can be found in Reference 1, but the only significant observation is that 59% of males said that they would wear a helmet if given one whilst only 36% of females gave this response.

3.3 Non-user purchaser questionnaire

The sample characteristics for the non-user purchaser (Parents) questionnaire can be summarised as follows:-

(i) The 107 families questioned had a total of 191 children in the 8-16 year age group between them. There were 91 boys and 102 girls.

(ii) 50.5% of the families had two children, and 38.2% a single child (in this age group).

(iii) Of the children, 11.1% of boys owned a helmet whilst only 2% of girls did. This probably reflects ownership of BMX helmets among boys.

(iv) In 88.9% of families none of the children owned a helmet, whilst in 2% some did and in 9.2% all did.

Reasons given by parents for not providing their children with a helmet were as follows:-

TABLE 5

Reason	Number	Percent
Never thought	72	74
Insufficient risk	14	14
Too expensive	7	7
Unlikely to be worn	35	36

This would seem to indicate that the main problem is making parents stop and think about the subject.

The main aim of this questionnaire was to assess the effect on parental attitudes of presenting the statistics about cycle safety. It was found that

(v) Only 3.8% of families had suffered a serious cycling accident.

(vi) When presented with the (what has since proved to be exaggerated) statistic that it is twice as likely that their children, under the age of 14, would be killed or seriously injured as a cyclist than as a motor cyclist in later life, 70% of parents said that they were not surprised.

(vii) 83% of parents were impressed by the suggestion that a good helmet can reduce the risk of death or serious injury by 20 times.

Having presented the parents with these facts the questionnaire asked for their opinions of a helmet for everyday use. The results can be seen in Figure 11. It is clearly evident that when made to think about the subject and presented with the facts, the majority of parents appreciated the need to provide their children with helmets. Heed must be taken of what parents are prepared to pay, however; the limit is £16-£20, if most parents are not to be deterred by price (Figure 12).

Cross referencing of helmet responses and family characteristics indicates that:

(viii) The number of children in the family does not significantly affect the parents' attitudes towards helmets, and particularly the price that they would be prepared to pay for one.

(ix) The parents of girls are no more concerned at the problem of the helmet not being worn than those of boys.

(x) The fact of a serious cycling accident in the family does not change qualitative attitudes towards helmets, but all four of the families in this category were prepared to pay at least £16-£20 for a helmet.

It was also demonstrated that approximately 50% of children would always/sometimes wear a helmet if given it. This corresponds to the 56% wearing rate obtained from user-purchaser helmet owners.

4. COSTS OF CYCLING HEAD INJURIES AND PROSPECTS FOR REDUCTION

The data from sections 2 and 3 may now be combined, in order to assess the economic case for bicycle helmet use by ordinary cyclists.

Of the various costs incurred through cycling road accidents, those which are capable of reduction via helmet use are:

(i) Loss of output due to death or injury
(ii) Ambulance and medical treatment costs
(iii) The costs of pain, grief and suffering (PGS) to relatives, friends and colleagues of the casualty
(iv) PGS costs to the casualty directly.

Estimates are given below for items (i) and (ii). Item (iii) represents the value of the injured person to the community, over and above their paid output. Item (iv) reflects the person's value to themselves. We make no attempt to quantify these last two items, but return to them in the final discussion.

4.1 Avoidable costs of head injuries to cyclists

Table 6 below sets out estimated annual costs for the three severity categories - fatal, serious and slight - used for road accidents by the UK Department of Transport. The costs relate to pedal cyclists (aged over 5) whose main injury is a head injury. Off-road accidents are not included.

TABLE 6

Severity	Costs per casualty (£ 84)			Casualties per year	Annual cost (£M 84)
	% Lost output	% Med/amb	Total cost		
Fatal	99.75	0.25	116 866	220	25.7
Serious	48	52	1 313	4292	5.6
Slight	21	79	96	22 325	2.1

The costs per casualty are taken from Ref. 5, with a factor 0.425 applied to serious casualty costs to reflect the shorter average stay in hospital found for cyclists in section 2.3 (2.84 days, compared with 6.69 days for motorcyclists).

The annual casualty rate is the average of reported figures for 1982-84, corrected for under-reporting (section 2.1) and factored by 0.69 (fatal) or 0.57 (non-fatal) to obtain head-injury casualties.

The total annual cost of £33.4 M (at mid-1984 prices) is a conservative estimate; no specific allowance is made, for example, for long-term disability arising from severe brain damage. Around 140 such cases may be expected per year in Britain due to cycling head injuries, ranging in severity from mild epilepsy to total disablement: the estimate is based on taking 0.1 times the number of cases hospitalised beyond 2 nights (Ref. 6), and is consistent with the figure of 50-90% of head-injury fatalities given in Ref. 7.

Finally, the serious casualty figure of 4292 is likely to be low: an alternative calculation, using the figure R' = 1.14 (section 2.3) applied to published casualties, gives 6840.

4.2 Economic benefits of helmet use by cyclists

The following figures (at mid-1984 prices) illustrate the effects of a hypothetical campaign to promote the use of hard-shell bicycle helmets on British roads. Assuming the campaign leads to 1 in 8 cyclists wearing a helmet - which realistically implies helmet ownership by 1 in 4 cyclists - and 80% effectiveness in head-injury prevention (cf. 95% for fatality prevention, Ref. 4) we obtain a 10% reduction in costs (i) and (ii). This amounts to some £3.5 M annually.

5. DISCUSSION AND CONCLUSIONS

(1) Head injuries to cyclists in road accidents are responsible for some 220 fatalities - predominantly among young people - each year in Britain. This represents 69% of all cyclist fatalities in road accidents, and an even higher proportion - 75% - among those under 25.

(2) Serious (non-fatal) head injuries to cyclists total 4000-7000 annually, and are estimated to include over 100 cases of permanent brain damage.

(3) Out of 445 adult and teenage cyclists surveyed (325 M, 120 F), 50% would be prepared to buy a bicycle helmet if the price did not exceed £16-£20.

(4) "Insufficient risk" was given as the main reason for not owning a helmet by 44% of these cyclists.

(5) Promotion of a helmet that would be worn by 1 in 8 cyclists on British roads would save £3.5M per year in head injury costs (representing lost output and medical services).

(6) An additional incentive, particularly applicable to parents, is the prospect of pain, grief and suffering avoided. In a survey of 107 families with children under 12, two-thirds had never thought about providing a helmet for their children to wear while cycling; after reading some of the statistical facts, 73% said they thought a helmet worthwhile/essential.

(7) Finally, the cyclist's valuation of his/her own life would almost certainly extend to the cost of purchasing a high-quality helmet, in the case of the safety-conscious 1 in 4 at whom a promotional campaign might initially be aimed. A possible means of increasing ownership still further would be to use part of the £3.5M cost savings as a helmet subsidy to purchasers rather than for direct publicity.

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FIG.1 SEX OF RESPONDENT.

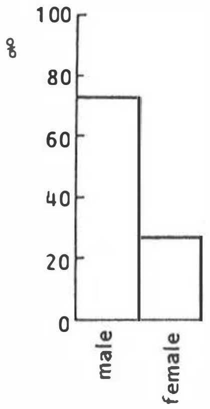

FIG.2 AGE OF RESPONDENT.

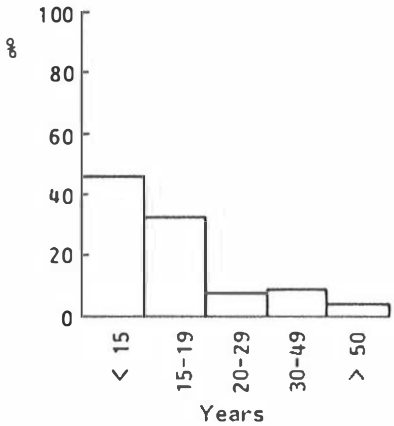

FIG.3 HELMET OWNERSHIP.

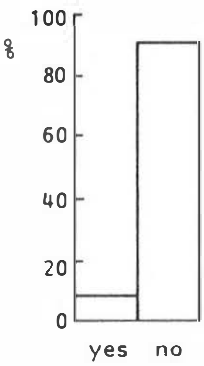

FIG.4 MILES CYCLED PER WEEK.

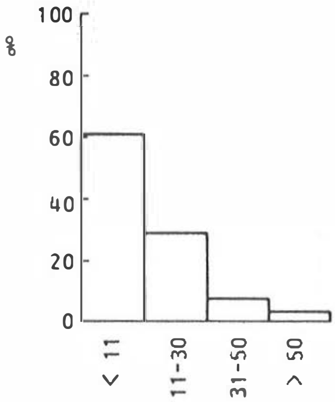

FIG.5 REFLECTIVE CLOTHING WORN. (in poor visibility)

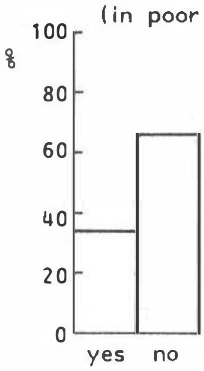

FIG.6 SERIOUS CYCLING INJURY. (in past 5 years)

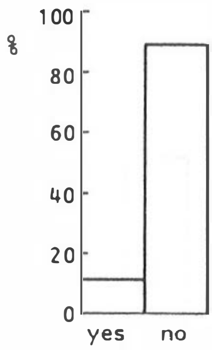

FIG.7 PRICE THAT RESPONDENTS WOULD BE PREPARED TO PAY.

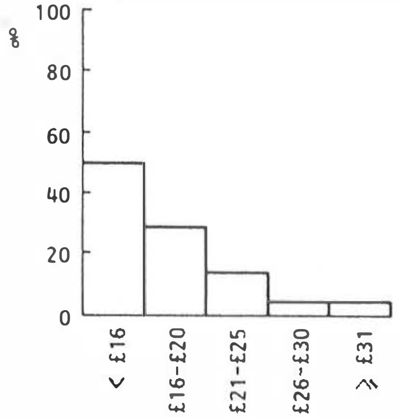

FIG.8 OWNERS' USE OF HELMET

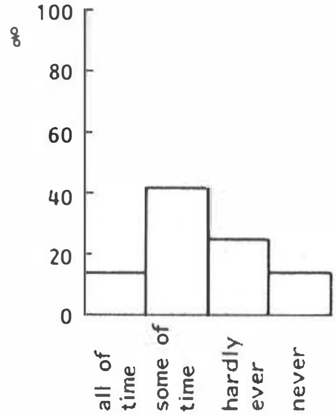

FIG.9 PRINCIPAL REASON FOR NOT OWNING A HELMET.

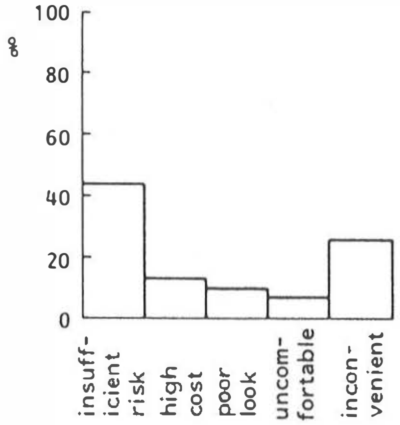

FIG.10 MOST IMPORTANT DESIGN FEATURE, BY MILES CYCLED.

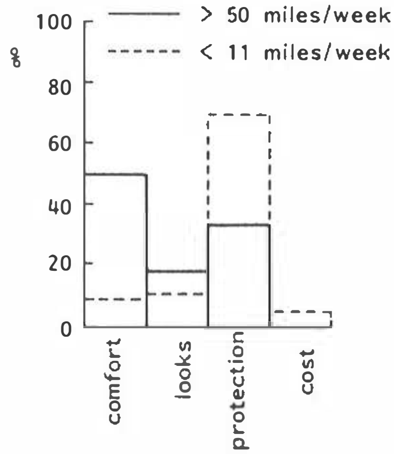

FIG.11 VALUE OF CHILD HELMET FOR EVERYDAY USE

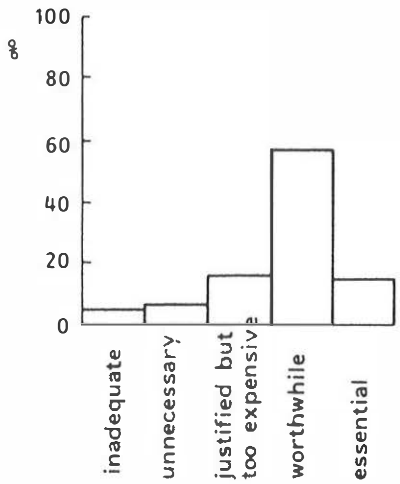

FIG.12 PRICE THAT PARENTS WOULD BE PREPARED TO PAY.