Assessing the actual risks faced by cyclists

by Malcolm Wardlaw BSc MBA.

The following are key points:
- **Pedestrians bear a higher fatality rate than cyclists, by a factor of almost 1.5;**
- **Cycling in Britain is safer than driving in many other countries, including France and Belgium;**
- **Cycling is far safer than driving anywhere when the health benefits and reduced risk to third parties are included;**
- **Cycling gets safer as it gets more popular;**
- **There is no known example in recent decades when an increase in cycling led to an increase in cyclist deaths.**

INTRODUCTION

In 1996, the then Minister for Local Transport, Mr Steven Norris, launched the National Cycling Strategy, with its goals to double cycle use from 1996 levels by 2002 and double use again by 2012. As Mr Norris pointed out in the Foreword to the NCS document [1]: 'On any examination of the needs of a sustainable transport policy, it is crystal clear that the bicycle has been underrated and underused in the United Kingdom for many years.'

A quarter of car journeys are less than two miles' distance and more than half are shorter than five miles'. Only the bicycle can match (or perhaps exceed) the car's flexibility and speed for such trips. The health benefits of moderate daily exercise are very significant [2], including much reduced risk of coronary heart disease, stroke, type II diabetes, colon cancer and obesity.

Official support for cycling is limited by concerns about safety, although in fact no thorough risk assessment for cycling has ever been published. The only known official work in Britain was by the (then) Transport and Road Research Laboratory in 1988, Risk in Cycling [3], but this was never released. The author only obtained a copy from a private library.

This paper aims to explore the risk in cycling, both as an absolute risk and risk relative to other modes of travel in Britain and other countries.

PROBLEMS WITH ASSESSING RISK IN BRITISH CYCLING

For British cycling, the most potent risk bias is probably the low number of hours per year cyclists spend travelling compared to drivers. While the average cyclist rides 100-120 hours per year, the average driver drives 280 hours per year. It has been observed for drivers and motorcyclists that doubling exposure increases the accident risk by only 30% [4], doubtless because individuals adjust their risk-taking behaviour for higher exposures. It seems fair to assume a similar rule exists for cyclists. The risk for cyclists ought to be adjusted for the low level of use, by a factor of 0.54 (ie, 2.8^0.4/2.8) vis-à-vis drivers.

There are two other biasing factors, not accounted for, but which need to be borne in mind. In contrast to driving and walking, cycling in Britain is mainly the preserve of children and young males, groups hardly noted for aversion to risk. The mean age of serious cyclist casualties (killed/seriously injured) is 24, while for drivers it is 34. Secondly, monitoring of cycle use through the Traffic Census tends to miss cycling on pavements, urban back streets and quiet country roads. This under-estimation will cause over-estimates for risk.

70% of British households have access to at least one car and about 50% of the adult population walk regularly for transport. Only 7% of the adult population cycle regularly, and only 2-3% use a bicycle on a nearly daily basis. This minority status should cause us to be cautious in our judgements.

BASIS FOR COMPARING RISK

Most bicycle journeys are quite short; one quarter is of less than a mile, while the mean distance is 2.4 miles. There will be some overlap of walking and cycling as options, so it is reasonable to compare on the basis of risk per kilometre. The standard unit is fatalities per billion kilometres (f/Bnkm).

It is also pertinent to compare the risks per hour, since for all three main modes the mean trip duration is in the range 15-20 minutes. Time-based exposure will thus indicate the mean trip risk. The standard unit is fatalities per million hours' use (f/mhu). Some comment will also be made on risk of death per year.

WALKING AND CYCLING: RISK PER KILOMETRE

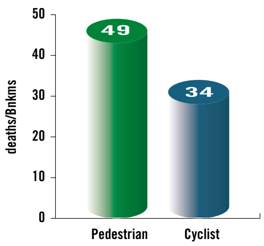

Chart 1

Comparing average fatality rates in Chart 1 makes it clear that it is pedestrians who bear the higher risk per kilometre. Analysis of the National Travel Survey shows this holds true for all active age groups except boys aged 11-14, who are much more at risk cycling [3]. Only deaths due to motor traffic have been included, since pedestrians killed in falls are not reported as road fatalities, whilst fatal cycling falls are. The risk of death in a fall when road riding is extremely low, with only 8-12 deaths annually out of an estimated 3 million regular cyclists.

WALKING, CYCLING AND DRIVING: RISK PER HOUR

Cyclists in Britain run a higher risk per hour than the other modes (see Chart 2). This does not (necessarily) mean that the same individual is exposed to 3.6 times the risk on a bicycle as in a car in Britain. The biasing factors cited earlier make a poor result inevitable. Indeed, it is not that bad. A mature individual cycling will face risks well below the average.

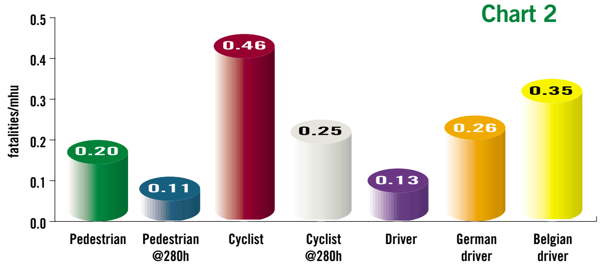

Chart 2

The difference is actually much less than these figures suggest. With one cyclist death per twenty million miles of cycling, the absolute level of risk is clearly a small one. The average cyclist is scarcely more likely to be killed per year than the average driver, because the higher risk per hour is compensated by the low number of hours use per year. A British cyclist who rides for 280 hours per year (2,300 miles) will face an annual risk of death about double that of a British driver, but the risk is low at 0.0083% per year. This risk corresponds to an expectation of travelling 280 hours' per year for 12,000 years – the same as for a German driver and safer than a Belgian driver. The extra lifetime risk of a fatal crash borne by this cyclist vis-à-vis a British driver is 0.2%. The life-extending benefits of cycling are taken to compensate this burden 10-20 times over. This cyclist will be ten times less likely to kill another road user than a driver.

CYCLING AND DRIVING: COMPARATIVE RISKS THROUGH TIME.

In the Chart 3, the trend lines for cyclist and driver fatality rates have been laid dimensionlessly one over the other so that the trends are clear: the fatality rate fell by 70% for drivers and 60% for cyclists during the period. The mobility per driver increased by some 30%, while per cyclist it remained constant. In terms of annual risk of death therefore, drivers fell behind cyclists in terms of safety.

This is a mystery. The greatly improved safety of modern cars ought to have granted drivers a clear advantage over cyclists during the course of thirty years.

Child cyclists have largely disappeared from the road network, although one third of cyclist deaths are still children. However, the fatality rates of child and adult cyclists are very similar [3], so the withdrawal of child cyclists will have had little effect on the average for all cyclists.

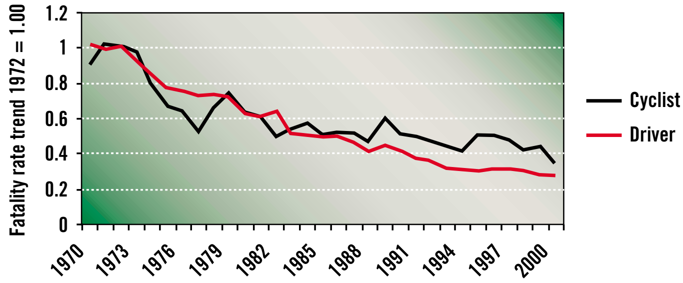

Chart 3: The trend lines for cyclist and driver fatality rates between 1970 and 2000.

Presumably most of the factors controlling risk apply equally to drivers and cyclists. Improved emergency care, better driver training and a generally older population should be considered, as should higher standards of MOT inspection, anti-lock brakes and skid resistant tyres. Congestion can reduce danger to cyclists by slowing traffic. Reduced choice for cyclists must also be a factor, as rising traffic levels have progressively deterred cyclists from using some main roads, especially at peak times.

This important issue deserves much more detailed attention than it has received.

CYCLING AND DRIVING AS CAUSES OF DEATH ON THE ROADS.

Although the hourly risks borne by cyclists are higher than for drivers in Britain, the risks imposed on others are lower. Typically only 3-7 third parties are killed in fatal bicycle crashes annually, as against 145 cyclist deaths. In fatal car crashes, 1,600 third parties (600 passengers; 650 pedestrians; 75 cyclists; 250 motorcyclists) are killed in addition to 1,100 drivers. From the viewpoint of overall road safety, the risks per hour of a fatal crash should be compared, Chart 4.

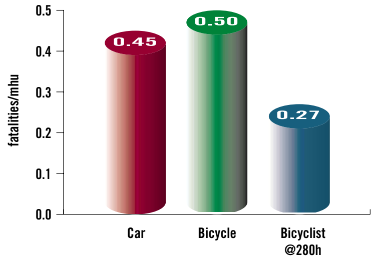

Chart 4

Evidently it cannot be maintained that road deaths are higher because there are cyclists on the roads. Rather, it is far more likely that, even as things stand, the bicycle is making a net contribution to road safety. The attitude 'more cycling means more deaths' is incorrect. More cycling would almost certainly reduce road deaths.

WHY IS CYCLING CONSIDERED DANGEROUS?

The belief that British cyclists face high actual risks is not sustained by the evidence; the actual risks are very low in everyday terms. So why did the 'danger myth' arise? Perceived danger is not revealed by casualty data. The greater performance of modern cars has increased perceived danger. Cycle campaigners have often presented their case without precision, instead using reactionary language that implied motor traffic imposed far greater danger on cyclists than on itself. Official studies have focused on comparing risk on a per-kilometre basis, without reference to the higher fatality rates borne by pedestrians. Until very recently, pedestrian fatality

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rates were not included in the official reference Road Accidents in Great Britain; the Casualty Report.

SEGREGATION VERSUS VEHICULAR CYCLING

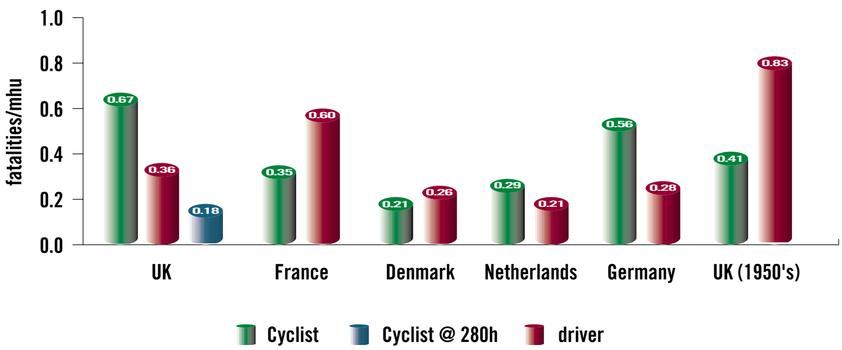
Should cyclists be segregated on specialist cycleways, or should they ride 'vehicularly' on the public highway? The comparison with pedestrian safety examined earlier (Chart 1) provides one useful perspective. The vast infrastructure of pavements installed to serve pedestrians has not made walking safer than cycling. Nor has it sustained walking as a popular choice of travel; annual distance walked has fallen by 25% since the mid-1970s, while cycle use is still similar to the levels seen thirty years ago. It is well recognised that pedestrians are safest when desegregated in precincts or Home Zones, since motor vehicles are then obliged to account for pedestrians as authentic road users. In the same way, published studies show either poorer safety for segregated cyclists, or at best no improvement over vehicular cycling [5, 6]. Segregating cyclists results in a marked reduction in convenience and priority. *Traffic Engineering and Control* has reported the dismay of cyclists presented with ill-designed infrastructure that degrades their priority and makes progress far more difficult [7].

These observations run contrary to the practice in some countries of segregating cyclists. Chart 5 is based on 1990 risk data, the only year for which international cycling data are available. Given the stability of relative risks over time demonstrated earlier, it is unlikely that the relationships below will have changed much.

The lowest absolute risks for cyclists are found in the Netherlands and Denmark. The situation in Germany is not much different from 1990 Britain, however, despite the cycleways provided for German cyclists. In France and 1950 Britain, cycling is actually safer than driving, yet infrastructure is rare in France and was non-existent in 1950 Britain. The high driver risks in both cases were not imposed on cyclists using the roads. Evidently vehicular cyclists can enjoy similar or superior safety to car occupants when there is a significant volume of bicycle traffic. In that case motor traffic will be more aware of and deferent to the presence of cyclists, reducing their exposure to high vehicle speeds. Does this 'safety in numbers' effect explain the low risks for cyclists in the Netherlands and Denmark?

The high levels of cycling in these two countries are relics from a past as 'cycling countries', not the result of infrastructure. These countries experienced the same post-war cycling declines as other countries, but from far higher pre-war levels. The cities of Oxford and Cambridge in England have likewise seen traditions of high cycle use survive. The Netherlands and Denmark achieved only modest increases in cycle use (about 30%) after the 1970s, and neither saw any material increases during the 1990s. Pedestrian safety is also much better in these countries than in Britain, despite British infrastructure for pedestrians. This suggests a road environment generally more deferent to the non-motorised. Considering all the evidence, and the author's own experience of cycling in Denmark, it is most plausible that the fine safety records of Dutch and Danish cyclists is due to their sheer numbers, not infrastructure. This point will now be explored.

Chart 5: Comparing UK risk with data from France,, Denmark, Netherlands and Germany.



KEYSTONE OF THE CYCLING CULTURE – SAFETY IN NUMBERS.

British cycling enjoyed a resurgence after the first oil crisis in 1973. The Traffic Census reported a 70% increase in bicycle traffic between 1973 and 1982, yet during this period the number of annual cyclist deaths actually fell 10%. The fatality rate per cyclist fell by 50%. Careful inspection of Chart 3 will show that during this period the fatality rate fell much faster for cyclists than for drivers.

In the Netherlands, the level of bicycle traffic increased by 30% between 1980 and 1990, yet annual cyclist deaths fell by one third. The fatality rate per cyclist declined from 43 to 25 f/Bnkms, a fall of 42% [10]. Rising bicycle use running with falling casualties has also been the experience in the British City of York [11].

0.7% of personal travel in Britain is by bicycle, but 4% of road deaths are cyclists. Would 100% of road deaths be cyclists, if 18% of personal travel were by bike? In the Britain of the early 1950s, about 25% of travel was by bicycle, but only 15% of deaths were cyclists. Back then as now, cyclists shared busy urban roads with motor traffic, with a much higher percentage of large commercial vehicles then. In Denmark today, 10% of travel is by bicycle, while 14% of deaths are cyclists.

Common events are safe and rare events are dangerous. It is no surprise that cycling gets safer with increasing cycle use – the 'safety in numbers' effect. What is surprising is that a consistent relationship exists between higher cycle flows and improved cyclist safety. This relationship has been established from observations in a number of countries.

Scandinavian researchers [12, 13] have identified a reliable power-law relationship between cycle flow and risk per cyclist, with an index value in the range -0.6 to -0.7. Thus if cycle flow doubles, deaths will increase by only 25-30%; the risk per cyclist will fall by 35-40%. Such a predictable relationship is not so implausible as it seems. A similar relationship for cars was proposed by Smeed as long ago as 1949. 'Smeed's Law' has been borne out by international experience in modern times [14].

The power-law relationship is pessimistic when applied at the level of cities or nations, since it is based on a fixed road network and excludes any benefits from alterations to reduce the risk of conflict (such as road widening, one-way streets, back street networks, speed reduction measures). The 'safety in numbers' effect combines with on-going measures to yield safety gains, not increased deaths.

There is no known example when an increase in cycling led to an increase in road deaths overall; even the original Victorian bicycle revolution did not increase road deaths, instead there was redistribution within a stable total.

HOW DO WE MAKE CYCLING MORE POPULAR?

Making cycling safer requires that it become more popular. What actions might achieve this?

Surveys of obstacles to cycle use show fear of motor traffic is a major issue. It is not clear whether this is based on hearsay (the 'danger myth') or personal experience. Lack of confidence in driver behaviour is doubtless related to another commonly cited obstacle; the low status of cyclists as road users. Despite these problems, experience still shows that the public highway provides the optimum combination of safety and convenience. If there is to be a cycling revival in Britain, the public highway has to become more attractive for cycling, through the evolution of a 'cycling culture' in which cyclists are expected and respected sharing the roads with motor traffic on an equal basis.

A cycling culture exists in France. There is mutual respect and toleration between cyclists and drivers. Perceived danger when cycling is low, since drivers may be relied on to compensate near cyclists. A cycling culture requires that cyclists ride skilfully, obey the law, co-operate with nearby motor traffic and use good lights at night. In their turn, drivers must give plenty of room in passing, slow near cyclists on country roads and be patient at large urban junctions. There are benefits for both parties. Cyclists may use the roads with confidence. Drivers will find urban congestion eased and less pressure on parking. Cycle training and national promotion should emphasise that cyclecraft is a skill like driving, that anyone can acquire.

Certain problems will arise in accommodating higher volumes of bicycle traffic on Britain's roads. Those responsible for cycle-friendly infrastructure must appreciate that it is road width – even more than traffic speeds – that determines the attraction and safety of cycling. Pinch-points or narrow stretches that force cyclists into the stream of motor traffic are anathema. Cyclists require smooth, direct, continuous routes of adequate width. Linking up networks of residential streets is valuable in providing alternatives at peak periods or for less confident cyclists. Rural back roads will require protection from inappropriate speeding. Indirect, poorly surfaced cycle paths merely deter cycling by reinforcing the lowly status of cyclists.

CONCLUSION.

Road cycling in Britain is a low-risk activity. The belief that cycling is dangerous turns out to be a factoid: opinion based on long repetition, not evidence. The actual risk of death lies well within the bracket of Western European driver experience when fair comparison is made. This disparity between actual and perceived risk in cycling has been previously reported [15].

Cycling in Britain contributes no more to road deaths overall than car use, since the higher user risks are balanced by reduced risks imposed on third parties. Cycling may even be saving lives. More cycling would dramatically improve cyclist safety through the widely observed 'safety in numbers' effect. Encouraging cycling requires primarily the social evolution of a cycling culture. Measures to widen narrow roads, protect lesser rural roads and link up back streets will also be necessary. Provided growth in cycle use is supported by measures to reduce the risk of conflict between cyclists and drivers, it is unlikely that cyclist deaths would increase.

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All information in this paper came from the principal sources, unless specific reference is cited.

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Common events are safe and rare events are dangerous – it is no surprise that cycling gets safer with increasing cycle use.

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DATA USED FOR CALCULATIONS.

Walking and cycling: risk per kilometre

Annual distance walked/capita: . . . . .190 miles
Annual distance cycled/capita: . . . . .43 miles
Annual distance/active cyclist: . . . . .800-1,000 miles
Pedestrian deaths 1999-01: . . . . .850 annually
Cyclist deaths 1999-01: . . . . .145 annually

Walking cycling and driving: risk per hour.

Mean trip speed walked: . . . . .2.5 mph
Mean trip speed cycled: . . . . .8 mph
Mean trip speed driven: . . . . .26 mph
Driver deaths 1999-01: . . . . .1,100 annually.

Cycling and driving: relative risks through time:

Cyclist deaths 1970-72: . . . . .380 annually.
Driver deaths 1970-72: . . . . .1,900 annually.

Cycling and driving as causes of death on the roads.

Bicycle fatal accident involvements 1999-01: 155 annually
Car fatal accident involvements 1999-01: . . .3,700 annually

International comparisons of cycling and driving: risk per hour. (All 1989/90 average unless otherwise stated.)

Britain: . . . .
cyclist deaths/national distance: . . . . .275/5.4 bn km.
driver deaths/national distance: . . . . .1,470/340 bn km.
Britain 1950-52:
cyclist deaths/national distance: . . . . .740/23 bn km.
occupant deaths/passenger distance: . . . . . .800/31 bn pkm.
mean car speed taken as 20 mph.