How methods and levels of policing affect road casualty rates

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CONTENTS

Page

Executive Summary 1

1 Introduction 3

2 Aims 3

3 Literature searches 3

4 Scope of the review 4

5 General issues regarding studies of police enforcement 5

6 The relationship between enforcement levels and accident and casualty rates 5

7 Methods of enforcement 8

7.1 Methods used to enforce speed limits 9

7.1.1 Stationary and visible enforcement 9

7.1.2 Effects of enforcement over time and distance 9

7.1.3 Randomisation of stationary and visible policing 10

7.1.4 Stationary and hidden enforcement 11

7.1.5 Mobile enforcement 12

7.1.6 Speed cameras 12

7.2 Methods used in drink driving enforcement 13

7.3 Methods used to detect red light violations 14

7.4 Enforcement of seat belt laws 14

8 Conclusions and Recommendations 14

8.1 Levels of police enforcement 14

8.2 Methods of police enforcement 15

9 Proposal for a project to investigate how levels of policing affect road accidents and casualties in London 15

9.1 Background and objectives 15

9.2 Research method 16

10 Acknowledgements 16

11 References 16

Page

Appendix A: Summary of stationary and visible methods for enforcing speed limits 20

Appendix B: Studies of time and distance halo effects 22

Appendix C: Studies of speed cameras 23

Appendix D: Studies of drink-driving enforcement 24

Appendix E: Studies of red light cameras 25

Abstract 26

Related publications 26

Executive Summary

In London in 2002, over 41,000 people were injured in road accidents, more than 5,500 of whom were killed or seriously injured. Road traffic law is one of the main tools available to society to reduce the number and severity of road accidents, by defining behaviour which is held to be unduly risky - such as drink-driving - as illegal. These laws are only effective if they are obeyed. The likelihood of an offender being caught depends on the level of enforcement of traffic laws, by human policing and increasingly by automatic equipment such as speed cameras. Moreover, a significant level of enforcement is likely to have a deterrent effect and to persuade potential offenders to observe traffic laws. This report presents the results of a review of the relevant technical literature that was undertaken by TRL on behalf of Transport for London (TfL) to investigate *'How methods and levels of policing affect road casualty rates'*.

The main aims of the review were:

- To evaluate the findings from existing literature in order to determine whether increasing the level of traffic policing is likely to reduce the number of casualties in road accidents.
- To summarise the main pieces of work and draw conclusions, including any quantitative relationships between the level of enforcement and the numbers of accidents and casualties.

In order to identify relevant material for inclusion in the review the TRL knowledge base (which comprises a number of databases, including the main catalogue of publications held both in the TRL library and elsewhere) was searched. In total 66 studies were included in the review: 30 were studies of speed or primarily speed enforcement campaigns, 5 were UK studies of speed camera enforcement, 13 were studies of drink-driving enforcement, 14 studies of red light camera enforcement, and 4 studies of seatbelt enforcement. In addition, three studies that have been conducted recently to investigate the mean effects of increased enforcement generally on accident rates were included in the review.

The main findings were as follows:

- The great majority of studies in the literature have found that increasing the level of traffic policing reduces the number of road accidents and traffic violations.
- Theory suggests that the relationship between levels of policing and accident/casualty rates is non-linear. At zero enforcement level, accidents and casualties are expected to be at their highest levels. Increases in enforcement will have no noticeable effect at first but at a certain level, when drivers become aware of the increased police presence, accidents and casualties can be expected to begin to fall. Once a saturation point is reached, however, further increases in enforcement levels can be expected to have little or no effect. The challenges for road safety researchers are to establish the levels of policing that are required to bring about the initial decrease in accidents or casualties and to reach the saturation point, and to establish the accident and casualty reductions that can be achieved with these levels of policing.
- Unfortunately, it is difficult in practice to establish the relationship between levels of policing and accident or casualty rates. It has not proved possible to establish the relationship by generalising from studies in the literature because appropriate information about enforcement levels is not given consistently by the different studies. The difficulty in establishing the relationship in London is compounded by the fact that the majority of studies in the literature were conducted outside the UK and that few studies assessed the effects of traffic policing in busy urban areas such as London. Those studies that were conducted in the UK were either small scale, having investigated the effects of policing on a limited number of roads, or were conducted many years ago. Therefore, new research appears to be required in order to establish how the level of policing in London affects the number of accidents and casualties. The results of the research would allow the likely implications for accidents and casualties to be taken into account when adjusting the level of traffic policing in any part of London.
- Despite the difficulty of establishing the precise relation between policing levels and accident or casualty rates, some studies have provided limited information about the levels of enforcement required to improve safety. It seems as though stopping 1 in every 6 speeding offenders, for example, should have a noticeable effect.
- On the basis of the literature it is also possible to discriminate between stationary and mobile methods of traffic policing. Each method can involve visible policing in either marked or unmarked police vehicles. Stationary and highly visible policing appears to be the most effective method for reducing violations and accidents, although stationary enforcement in unmarked vehicles has also been found to be effective. Mobile policing methods appear less effective, especially when unmarked police vehicles are used.
- The effects of increased stationary enforcement seem to last for a limited amount of time after the police presence has been removed. The largest time 'halo' appears to be 8 weeks, although sustained police presence is required to produce such large effects. The distance halo of stationary policing appears to be in the range of 1.5 miles to 5 miles from the enforcement site.
- There is evidence in favour of deploying traffic police largely at random over the whole road network. Theoretically it is likely to increase deterrence. In practice, the random allocation of stationary policing methods to different locations on the road network has been found to be effective, producing substantial impacts on accident rates and reductions in mean speeds and large distance halo effects. The main advantage of this method of traffic policing is that it requires relatively low levels of police manpower.

- Speed cameras have been found to be particularly effective enforcement tools. They appear to be more effective than physical policing methods in reducing mean speeds and accidents. However, physical policing methods have still been found to be effective and the effects of speed cameras appear to be mainly limited to the speed camera site. On the basis of the literature reviewed, the minimum distance halo associated with physical policing is about 5 times greater than the minimum associated with speed cameras.
- Studies of the enforcement of the drink-drive law have also shown that increased policing tends to reduce accidents and casualties.
- Red light running cameras have been found to be very effective in reducing accidents and casualties. The best estimate for the effects of red light cameras is a reduction of between 25-30% in injury accidents.
- Although few studies have investigated the effects of seat belt enforcement on accidents, a number have found that increased enforcement of seatbelt laws can increase wearing rates, which is likely to reduce casualties.

1 Introduction

In Great Britain in 2002 over 300,000 people were killed or injured in over 220,000 road traffic accidents, with the majority occurring on roads where the speed limit was at most 40 mph (Department for Transport, 2003a). In London, there were over 41,000 casualties with more than 5,500 involving fatal or serious injuries (Transport for London, 2003). Road traffic law is one of the main tools available to society to reduce the number and severity of road accidents. Traffic laws attempt to improve driving standards by defining as illegal those types of behaviour which are held to be unduly risky, such as drink-driving or driving too fast. Research conducted over the last decade or so has established the strength of the links between such risky driving behaviour and accident liability (e.g. Finch *et al.*, 1994; Taylor *et al.*, 2000; Parker *et al.*, 1995).

These laws are only effective if they are obeyed, but drivers frequently violate traffic laws without being caught. The likelihood of an offender being caught depends on the level of enforcement of these laws by human policing and increasingly by automatic equipment such as speed cameras. The level of human policing is influenced by many factors, including the overall number of officers available and the demands on police time for non-traffic duties.

There have been press reports that the number of officers being employed on traffic duties in Great Britain has fallen over recent years, with several Police Forces disbanding their specialist traffic police units. At the same time there has been anecdotal evidence that standards of driving behaviour have tended to fall. Falling driving standards might be linked to a fall in the level of enforcement, since the perception that the risk of being caught had fallen could lead some drivers to be more willing to violate traffic laws.

Recent developments in France have provided powerful evidence of the potential effectiveness of increased enforcement in reducing accidents and casualties. No scientific assessment of this evidence has so far been completed because of the very short timescale, but this account has been compiled from official statistics and advice from French colleagues. Following a widely publicised motorway accident in late 2002, President Chirac ordered a major increase in enforcement of existing traffic laws together with a range of other measures that would take longer to implement. The number of people killed on French roads in January 2003 was 33% less than in January 2002, and the number of casualties fell by 30%. Provisional estimates of the 2003 totals are 22% and 18% less than the 2002 totals respectively. National reductions on such a scale are virtually unprecedented, and greater enforcement of existing laws (or, at the least, a perception among French drivers that enforcement had increased) is likely to have been the principal cause.

This report presents the results of a review of the relevant technical literature that was undertaken by TRL on behalf of Transport for London (TfL) to investigate ‘How methods and levels of Policing affect road casualty rates’.

2 Aims

The main aims of the review were:

- To evaluate the findings from existing literature in order to determine whether increasing the level of traffic policing is likely to reduce the number of casualties in road accidents.
- To summarise the main pieces of work and draw conclusions, including any quantitative relationships between the level of enforcement and the numbers of accidents and casualties.

Section 3 of this report describes the methods that were used to identify appropriate literature for inclusion in the review. Section 4 defines the scope of the review. Section 5 outlines some general issues regarding studies of police enforcement. Subsequent sections outline the main findings. Section 6 discusses the relationship between policing levels, on the one hand, and violation, accident and casualty rates, on the other, and Section 7 deals with methods of enforcement. The summary and conclusions are presented in Section 8. Finally, a proposal for a new study to investigate how levels of policing affect road accidents and casualties in London in presented in Section 9.

3 Literature searches

Searches of the TRL Knowledge Base were conducted in order to identify literature to be reviewed. The Knowledge Base comprises a number of databases, including the Transport Research Abstracting & Cataloguing System (TRACS). This is the main catalogue of publications held both in the TRL library and elsewhere. It contains bibliographic references and abstracts of English and foreign language articles from journals, books and research reports. It is the English language version of the world-wide ITRD database (International Transport Research Documentation) and contains abstracts from publications in the USA, Australia, Scandinavia, the Netherlands and Canada in addition to UK material. The database has been updated daily since 1972 and now comprises some 260,000 items. This is the prime literature resource for transport research. The Knowledge Base also includes the PROJEX database that contains summaries of current and recently completed research projects undertaken in ITRD member countries. In addition, the Knowledge base includes the TRLINFO database, which contains information about TRL including the full text of all Broadcasts issued since they were started in 1995 together with all Intranet Announcements and News Items. The searches of the Knowledge Base were conducted using a number of combinations of the following key words, including: enforcement, police/policing, casualties, accidents, and violation terms (e.g. speed/speeding, drink-driving, red light running).

As well as searching the TRL Knowledge Base, studies were also identified by browsing (e.g. using the reference lists of other publications to identify relevant pieces of work) and, where possible, researchers working in the field of law enforcement were contacted for advice and assistance with identifying appropriate literature.

This report summarises the findings of the literature review. The next section of the report describes the scope of the review and provides details of the types of studies reviewed and the number of studies reviewed.

4 Scope of the review

Studies included in the review related the level of police presence to any subsequent effects on accident, casualty or violation rates. Studies examining the effect of automatic methods of policing (e.g. speed and red light cameras) were also included so that comparisons can be made between automatic and 'physical' policing methods. Although a number of studies were identified from the literature searches that related to the effects of harsher penalties for traffic offences (e.g. increased fines, imprisonment and driver rehabilitation programmes) and to the public acceptability of legislation and enforcement, these studies were outside the scope of this project and were therefore not included in the review.

In addition to searching for literature on the effects of conventional policing on violations, accidents and casualties, we also searched for studies of such alternatives to conventional traffic policing. For example, there are anecdotal reports that positioning empty police vehicles at the side of the road or on motorway flyovers can affect drivers' behaviour. Similarly, the use of card-board cut outs of police vehicles or personnel has been mentioned as having a deterrent effect. However, no such studies were identified.

The use of safety cameras for traffic related enforcement activity other than speeding or red light violations are beginning to be introduced. In London, safety cameras for bus lane enforcement are being introduced and they will be used to enforce moving vehicle violations and parking violations in the near future. Given this is a new application for enforcement no studies have been conducted to evaluate the effects of these methods. However, this is a potential avenue for future research.

The main aim of this review was to explore how methods and levels of traffic policing affect *casualty* rates. However, almost all of the studies in the literature have examined the effect of policing on *accident* rates, so this review focused on the effects of enforcement on accidents in the most part. Information about casualties are given where possible in this report but where it was unavailable it may be presumed that any reduction in the accident rate due to increased enforcement will tend to reduce the casualty rate.

Research has demonstrated that the frequency and extent of driving violations is related to the risk of a road traffic accident (e.g. Taylor *et al.*, 2000). Thus, reducing the frequency and extent of driving violations will have considerable safety benefits in terms of accident and casualty savings and studies using violation rates as the dependent safety measure provide useful information about the effectiveness of traffic policing on safety. A number of such studies were included in this review.

Ideally, this literature review would have focused on studies that have been conducted in busy cities throughout the world, so that the results could be generalised to London. However, the literature searches soon demonstrated that much of the research had been conducted on motorway or rural roads and relatively little specifically in busy urban areas. Therefore, this review included studies across a range of road and area types, and information regarding these characteristics in the various studies has been provided in this report where possible.

A requirement of this project was to consider using meta analysis techniques to establish any quantifiable relationships between levels of enforcement and casualty reductions. Meta-analysis is the statistical analysis of a large collection of results from individual studies. The aim is to pool the findings from similar research studies in order to determine the mean effect size of interest across those studies (in this case, the effect of levels of policing on casualty rates). In the present study, a meta analysis would require information from a number of studies about the numbers of accidents occurring before and after an enforcement intervention along with information about the levels of police enforcement. Ideally, information about the numbers of accidents for a control group would also be required. Unfortunately, such a meta analysis was not feasible because information about levels of enforcement was not provided by many studies and it was not possible to combine the few studies that did provide information about enforcement levels because enforcement levels were defined and measured differently across the different studies. This conclusion has previously been reached by other researchers (e.g. Elvik, 2001) and this issue is discussed in detail in Section 6 of this report.

A number of meta analyses have been conducted recently to investigate the mean effects of increased enforcement generally on accident rates. With respect to police enforcement of speed limits, a recent report by Zaidel (2002) cited a meta analysis of 17 international studies conducted by Elvik *et al.* (1997). Another recent meta analysis, which is currently being conducted by SWOV institute for road safety in the Netherlands, included 31 studies of police enforcement of speed limits. Elvik *et al.* (1997) also conducted a meta analysis to investigate the effects on accident rates of increased police enforcement of drink-driving violations, which included 26 international studies, and the effects of speed cameras, which included 9 international studies. Finally, a recent meta analysis of the effect of red light violation cameras on accidents was conducted by Retting *et al.* (2003). Particular attention is given to the results of these meta analyses in the appropriate sections of this report and evidence from specific studies is used to provide additional information where appropriate[1]. In addition to the meta analyses reported above, there were 69 individual studies included in this review: 30 were studies of speed or primarily speed enforcement campaigns, 8 were UK studies of speed camera enforcement, 13 were studies of drink-driving enforcement, 14 studies of red light camera enforcement, and 4 studies of seatbelt enforcement.

5 General issues regarding studies of police enforcement

Much of the research evidence that was reviewed in this project came from evaluations of small scale enforcement efforts, e.g. investigating the effect of a limited number of police patrols (typically, 1 or 2) on a limited number of roads or road sections. Though these studies provide useful insights into the effectiveness of police enforcement on violation, accident and casualty rates, evaluations of area wide, larger scale enforcement efforts are perhaps more useful for the present purpose. Although a number of such evaluations have been conducted, only a few were in busy cities which are comparable to London. In addition, almost all of the research identified in this review was conducted abroad. Those studies conducted in the UK were either small scale studies of the kind mentioned above or were conducted about 30-40 years ago. Given the changes in driving conditions and behaviour over the past 40 years, it would seem that new research conducted in the UK is required. More specifically, research conducted in London is required to fully answer the question of how methods and levels of policing affect road traffic casualties in London. A proposal for an appropriate research project is provided in Section 9 (see also Section 6).

Enforcement programmes are rarely conducted without accompanying publicity and education campaigns. Indeed, publicity and enforcement are seen as mutually reinforcing methods of deterrence (Hakinen, 1988), e.g. using publicity to make drivers aware of an increased enforcement effort in an area. Without publicity, enforcement may not have much effect on perceived risk of being apprehended for violating. If drivers are not aware of the enforcement, however, they may believe that they are unlikely to be caught for committing traffic violations, so actual police enforcement is needed to back up the claims of the publicity. In cases where enforcement and publicity go hand-in-hand, it is impossible to assess the independent effects of enforcement on violation and accident rates. It should be borne in mind when reading the following sections that almost all studies have used media campaigns to publicise the enforcement programme that has been evaluated.

A number of studies in this area are flawed by their failure to recognise ‘regression to the mean’. With any type of phenomenon that occurs over time, such as road accidents in a specific area, there is a tendency for a high number (relative to the long-term mean) in one interval to be followed by a decrease in the following interval - even if nothing has been done to reduce the number (Rothengatter, 1982). Therefore, when enforcement campaigns are directed at sites or areas selected on the basis of their high accident counts (which in many cases they are), the full reduction in accidents cannot be attributed to the programmes themselves. In order to control for regression towards the mean effects, it is necessary to use sophisticated statistical modelling techniques, for example as described by Zaidel (2002). Few studies in the literature actually control for regression towards the mean in this way. However, many studies do attempt to reduce the effect by using accident data from several years before the implementation of an enforcement programme. The yearly, monthly or daily accident rates are then compared with the accident rates that occur during the programme. It should be noted that although regression to the mean may potentially be a limitation of many studies in this area, it is likely that at least some of the observed accident reductions will be due to enforcement.

A recent report by the European Transport Safety Council (1999) stated that the main objective of traffic law enforcement is to deter drivers from committing offences and not to maximise the number of drivers caught for offending. The underlying mechanism of deterrence is that road users’ behaviour can be modified by making them fearful of the consequences of committing traffic violations (Zaal, 1994). Road users are deterred from committing illegal acts (e.g. speeding or drink-driving) to a greater extent if they perceive that they are more likely to be apprehended, prosecuted and convicted for doing so, and if they perceive that the eventual penalty will be severe and swiftly administered. A person’s perceived risk of apprehension for committing road traffic offences is related to their perceptions about the intensity of police enforcement activities. Objective risk of apprehension relates to the actual risk of apprehension. The perceived risk of detection for committing a traffic offence is often dependent upon the objective risk but the relationship is not necessarily a direct one.

The most desirable situation occurs when a driver’s perceived risk is greater than the objective risk. One way of achieving this would be to deploy traffic police largely at random over the whole road network, so that drivers would be unable to predict where and when they might be observed by police. This approach contrasts with the more common approach of targeting police resources on roads where traffic violations are known to be most likely (e.g. where traffic speeds are known to exceed the posted speed limits). Thus, the goal of maximising deterrence may conflict with the goal of catching as many offenders as possible. The ‘random’ approach to traffic policing is discussed in detail in Section 7.1.1, which discusses a number of studies that have found it can reduce violations and accident rates with relatively low levels of police man-power.

6 The relationship between enforcement levels and accident and casualty rates

The relationship between levels of policing, on the one hand, and accident or casualty rates, on the other, is not easy to establish. A theoretical relationship is provided in Figure 6.1. Policing levels are shown on the x axis and accident and casualty rates are shown on the y axis. The relationship is not linear: an S-shaped curve is hypothesised (e.g. Oei, 1996). At zero enforcement level, accidents and casualties are expected to be at their highest levels. An increase in enforcement would have no noticeable effect at first. However, drivers will become aware of the police presence at a certain level of enforcement and can be expected to modify their

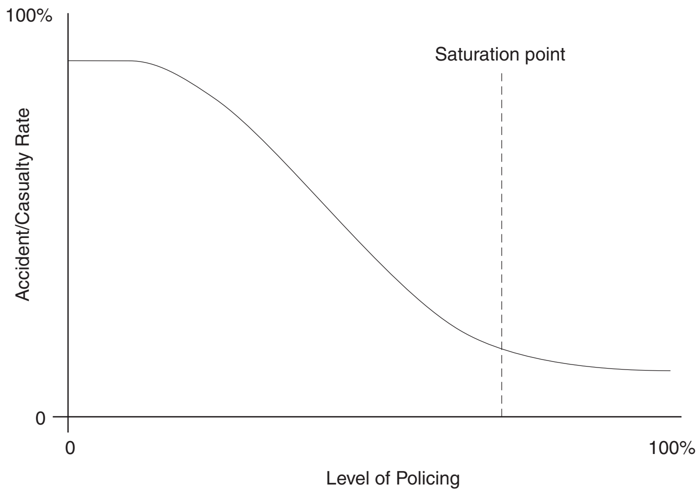

Figure 6.1 Theoretical relationship between level of policing and accident or casualty rates

behaviour (i.e. reduce their violations), so the number of accidents and casualties would start to drop. As enforcement increases, the numbers of accidents and casualties can be expected to decrease, but only up to a certain point - after which increased enforcement would have little or no effect because of a saturation effect.

A similar relationship is hypothesised with respect to policing levels and violations, except that it is likely that violation rates can be reduced to a greater extent than can accident or casualty rates. Enforcement could theoretically be increased so far that every violation of the traffic laws would be detected; the violation rate would probably fall to almost zero (it is likely that some drivers would still occasionally violate). However, accidents and casualties would not fall so far since accidents are caused by a multitude of factors both related and unrelated to violations of traffic laws.

The challenge for road safety researchers is to establish the levels of policing that are required to bring about the initial decrease in the curve and to reach the saturation point. It is also important to establish the violation, accident and casualty reductions that can be achieved with these levels of policing. The information about enforcement levels that would be needed to plot the relationship shown in Figure 6.1 may differ depending on the driving violation under consideration. For example, in the case of speeding, which is a relatively easy driving violation to detect, an ideal measure of enforcement would be the proportion of traffic or road network under police surveillance. If this information were available it could be related to proportion of speeding violations observed (in road side surveys, for example), or the number of accidents or casualties in an area. However, on the basis of the existing literature it is not possible to extract details about the proportion of the road network under police surveillance. In terms of drink-driving, which is more difficult to detect in moving traffic, information about the proportion of the road network under police surveillance is probably less appropriate. The ideal measure for this violation, albeit very difficult to obtain, would be the proportion of those driving with illegal alcohol levels who are actually breath-tested by the police. It is not surprising that none of the studies reviewed had included such details.

In the context of this review, one would ideally like to be able to extract information from each study on the policing levels used and relate it to the observed violation, accident or casualty reductions. Unfortunately, this is not possible for a combination of reasons:

- Many studies do not quantify the enforcement levels - such studies may merely state that enforcement was increased.
- Some studies may state the percentage increase in enforcement efforts from the before period, but this is of limited value without knowing the prior enforcement levels used. For example, the impact on casualty rates expected from a 50% increase in enforcement would depend on where the prior enforcement level lay on the x axis on Figure 6.1.
- Different studies have defined enforcement in different ways. For example, some reports provide information about enforcement levels in terms of police hours devoted to traffic policing, whereas others provide information in terms of the numbers of citations or arrests made during the enforcement period, or details about the numbers of drivers' prosecuted for offending. It is not possible to compare between these groups of studies.
- Although information is often provided about the enforcement effort under study (e.g. the number of police hours devoted to traffic policing), it is often of limited value because of a failure to report the area over which the enforcement was applied. 100 extra hours of police traffic surveillance, for example, may have little impact on violations, accidents or casualties when spread over a large area, but a larger effect when concentrated in a smaller area.

In sum, it is not practical to generalise across the previous research studies using meta analysis procedures in order to investigate the relationship between levels of policing and road accident or violation rates. It is possible, however, to identify a limited number of studies that provide some information about the enforcement levels required to bring about a reduction in accidents. The studies reviewed below were the main ones identified in this review that provided the most appropriate information about the effects of levels of policing.

A study by De Waard and Rooijers (1994) in the Netherlands investigated the effects of three levels of intensity of police enforcement on driving speed and speeding violations on motorways in the Netherlands. The enforcement method involved stopping at the roadside every 100th offender, every 25th offender or every 6th offender. Driving speed data were collected at a control site and at the treatment sites for 2 consecutive weeks prior to the enforcement effort, for 4 consecutive weeks during the enforcement period and for 4 consecutive weeks after the enforcement period ended. Table 6.1 has been adapted from De Waard and Rooijers (1994) and shows that there was a small increase in mean driving speeds at the control site, which was not statistically significant. The table also shows that there was no effect on driving speeds when the enforcement method involved stopping every 100th offender. When every 25th offender was stopped by the police, there was a small but statistically significant effect on driving speeds. Mean speeds reduced by between 0.6km/h (0.4mph) and 1.2km/h (0.8mph) in the right and left lanes of the motorway, respectively. When every 6th offender was stopped, there was a larger effect. Speeds reduced by between 2.7km/h (1.7mph) and 5.2km/h (3.3mph) in the right and left lanes, respectively. When the enforcement period ended, mean speeds increased to what they were before the enforcement period in the 1:100 and 1:25 conditions. However, when every 6th offender was stopped mean speeds remained 2km/h slower than they were pre-enforcement. Table 6.2, which has also been adapted from De Waard and Rooijers (1994), shows that similar effects were found when the percentage of vehicles exceeding the speed limit was studied. By far the largest reduction in the proportions of vehicles exceeding the speed limit was in the 1:6 condition where the proportion of vehicles exceeding the speed limit dropped from 19.9% pre-enforcement to 14.4% during the enforcement period. Overall, this study suggests that rather high levels of policing are required to bring about reductions in mean speeds and in speeding violations.

Table 6.1 Mean speeds of vehicles in pre-, during and post-enforcement periods (De Waard & Rooijers, 1994)

Condition / Lane	Mean speed (km/h): Pre-enforcement (2 weeks)	During enforcement (4 weeks)	Post-enforcement (4 weeks)
Control (no enforcement)			
Right	106.6	107.1	107.3
Left	117.4	118.2	118.2
Stopping every 100th offender			
Right	108.2	108.8	108.8
Left	116.6	116.4	116.5
Stopping every 25th offender			
Right	112.5	111.9	112.9
Left	121.1	119.9	121.4
Stopping every 6th offender			
Right	114.9	112.2	113.6
Left	125.3	120.1	121.8

Table 6.2 Percentage of vehicles exceeding the speed limit in pre-, during and post-enforcement periods (De Waard & Rooijers, 1994)

Condition / Lane	% vehicles exceeding speed limit: Pre-enforcement (2 weeks)	During enforcement (4 weeks)	Post-enforcement (4 weeks)
Control (no enforcement)			
Right	7.3	8.3	7.2
Left	15.5	18.0	16.6
Stopping every 100th offender			
Right	Not given	4.3	3.6
Left	Not given	14.7	13.5
Stopping every 25th offender			
Right	9.0	8.1	12.2
Left	23.3	22.7	26.9
Stopping every 6th offender			
Right	19.9	14.4	17.8
Left	Not given	24.4	30.6

Another study by Henstridge *et al.* (1997) was conducted to assess the effects on accidents of random breath testing (RBT) in Australia. Fatal, serious and single vehicle accident data from 1976 to 1992 were obtained along with data on enforcement levels since the introduction of RBT in December 1982. Increases in testing levels from 100 to 6000 per day were plotted against percentage reductions in serious and single vehicle night-time accidents (it was not possible to do the same for fatal accidents due to the lack of statistical power caused by the small numbers). For both serious and single vehicle night-time accidents, a non-linear relationship between enforcement levels and accidents was found. For serious accidents, an increase in the daily testing rate from zero to 1000 resulted in a 5.9% reduction in accidents and an increase from zero to 3000 tests per day resulted in a 16.6% accident reduction. For single vehicle night-time accidents (accidents typically associated with drink-driving), an increase of 1000 tests per day resulted in a 19.3% reduction and an increase of 3000 tests per day resulted in a 47.3% reduction.

A report by Koornstra *et al.* (2002) compared the development of road safety in three countries. Police enforcement was one aspect considered and a relationship between the intensity of police enforcement and the level of traffic law violations was presented. The authors acknowledged that establishing this relationship requires detailed information on enforcement levels, road user behaviour and accident rates and that further empirical research would be required to establish a definitive relationship. Nevertheless, the report presents a powerful example of how, once sufficient data had been collected, it would be possible to predict the effect of increased enforcement on the level of violations and casualties.

Figure 6.2 reproduces the report's Figure B.1; this was fitted to the following national data from Sweden, the Netherlands and Great Britain:

- seatbelt violations (the proportion of drivers who do not wear belts, found from roadside surveys) and the number of convictions expressed as the number per driver per year (these data are labelled 'Belt' in the figure);
- drink-driving violations (complicated by different legal limits in the 3 countries, so measured by the proportion of drivers who died with BAC exceeding 100mg/100ml of blood) and the number of drivers breath-tested per year expressed as a proportion of the national total (these data are labelled 'DWI' in the figure).

The violation measure (not the intensity of police enforcement as claimed by the axis label) is plotted on the x axis, while the rate of violations is plotted on the y axis. In order to combine the two distinct types of violation, the measures are scaled using different values of x (the confusing use of the symbol x for the scaling factor comes from the original report). For Sweden, for example, 1 in 130 drivers per year are fined for this offence; 1/130=4/520 so the point representing seatbelt violations in Sweden is plotted with abscissa=4/x. 10%=50%/5 of drivers fail to wear their belts, so the point 'Belt(Sw)' is plotted at (4/x, z/5). Although the labelling of the x axis is unfamiliar, the axis actually has a conventional log scale, with 'police enforcement' activity increasing as the abscissa increases.

As an example of the results that can be achieved, the report estimates that if the level of breath-testing were to be increased nine-fold in Great Britain then the proportion of drivers who died with BAC in excess of 100mg/100ml of blood would fall from 20% to 12%. There would also be (unquantified) benefits for other groups of casualties in drink/drive accidents. While the report acknowledges the limitations of the data currently available, it does show how the benefits of increased enforcement could be calculated - once the necessary information had been collected by appropriate research. The violation rate could be used as an interim measure of enforcement, but it is far from ideal since it is an index of output rather than input. The benefits could then be compared with the costs, as part of a rational approach to determining the optimal level of enforcement.

Of course, it is difficult to establish whether these effects on casualties due to such an increase in police enforcement would also apply to London because, as mentioned above, information is required about the existing level of enforcement to establish where London lies on the curve. Research is needed in London in order to estimate the increase in policing that would be required to bring about any specific reduction in casualties in London, and a brief proposal for such research is given in Section 9.

7 Methods of enforcement

Assessing the effect of different enforcement *methods* on violations, accidents and casualties is an easier task than is assessing the impact of *levels* of enforcement. That said, many studies in the literature have also not given precise descriptions of the enforcement methods used. In addition, many studies have investigated the effects of more than one method which make it difficult to determine the effectiveness of any one specific method (European Transport Safety Council, 1999). However, on the basis of the literature reviewed, it is possible to discriminate between the following methods, for which at least some evidence is available:

Physical policing methods

- Stationary and highly visible:
  This method involves the use of visible police units positioned at the road side. In many cases, but not all, automatic speed measuring devices (e.g. photo radar) are used to record drivers' speeds. Speeding drivers are stopped and issued either warnings or speeding fines. This method is also used in the enforcement of drink-driving (e.g. Random breath testing).

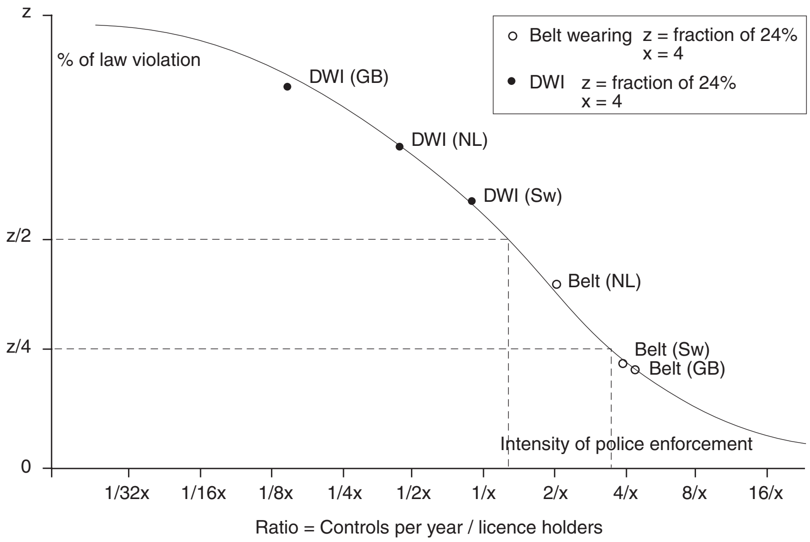

Figure 6.2 Relationship between enforcement intensity and law violation levels (Koornstra, 2002)

- Stationary and hidden:
  This method involves the use of unmarked police vehicles hidden at the roadside. Typically, police officers will operate photo-radar instruments from the unmarked vehicle and record drivers' speed. Rather than stopping drivers when they commit speeding offences, the photo evidence is processed and fines and notification of penalty points are sent to the vehicle owner.
- Mobile enforcement in marked police cars
  This method involves allocating a stretch of road or an area for enforcement by police operating from marked police cars. Police will stop drivers who commit road traffic violations and take the appropriate action.
- Mobile enforcement in unmarked police cars
  This method is similar to the one mentioned above (mobile enforcement in marked police vehicles), but involves police officers operating from unmarked police vehicles.

Fully automated methods

- Speed cameras.
- Red light cameras.

7.1 Methods used to enforce speed limits

Summaries of studies investigating the effects of physical police enforcement on speeding violations and on accident rates are presented in Appendix A.

7.1.1 Stationary and visible enforcement

The effect of stationary enforcement on accidents is encouraging. In a recent review of the literature on enforcement and accidents, Zaidel (2002) presented a meta analysis of 17 international studies of stationary enforcement methods (either stationary methods only or stationary methods used in combination with other methods), which was conducted by Elvik *et al.* (1997). The results are summarised in Table 7.1, which has been adapted from Zaidel (2002).

The meta analysis showed that the overall effect of mainly stationary methods of physical policing was a statistically significant reduction in the number of accidents by 2%. This reduction may seem small but the effect of enforcement on fatal accidents was found to be a 14% reduction and the effect on injury accidents was found to be a 6% reduction (both results were statistically significant). The meta analysis also found a small, but not a statistically reliable, increase in property damage only accidents.

Table 7.1 Results of a meta analysis of the effects of physical police presence using stationary speed enforcement (Elvik *et al.,* 1997)

	Percentage change in the number of accidents	
Accident type	*Best estimate*	*Confidence interval (95%)*
All accidents	-2	-1 to -4
All fatal accidents	-14	-8 to -20
All injury accidents	-6	-4 to -9
All property-damage only accidents	+1	+3 to -1

A current research project by the Institute for Road Safety Research (SWOV) is also attempting to quantify the relationship between speed enforcement and accident reductions. Information about this research has been provided in the form of a summary leaflet, which has been recently received by TRL. A meta analysis of 31 studies has been carried out and the results appear to show greater benefits than were found by Elvik *et al*. (1997). Overall, a mean reduction in all accidents by 15% has been found. For serious injury accidents and fatal accidents, reductions of 24% and 17%, respectively, have been found.

It is not clear why the recent meta analysis conducted by SWOV found substantially greater effects of speed enforcement than the Elvik *et al.* (1997) analysis in 1997, though it is possible that the SWOV analysis will provide more reliable estimates of the effects of policing on accidents due to the greater number of studies that are included. Nevertheless, the picture that emerges from both meta analyses is clear: stationary speed enforcement does seem to have a desirable impact on accident rates. This finding is also borne out by inspecting the individual studies presented in Appendix A. In most studies, increases in enforcement have led to accident reductions, and some studies suggest that large reductions can be achieved in the total numbers of accidents, in fatal accidents and in serious accidents (e.g. Leggett, 1988; Munden, 1966; Newstead *et al.*, 2001; Sali, 1983).

Only one study identified in this review investigated the effect of stationary enforcement on casualties (Fuller, 2002). Significant net reductions in serious casualty rates (compared with a control area) were found (18% reduction). In addition, a 9% net decrease in slight casualties was found due to enforcement. However, the study did not find a net reduction in fatal casualties.

As well as having desirable impacts on accident rates, increased enforcement using stationary and visible methods has also been shown to have desirable impacts on speeding violations. The studies presented in Appendix A show that reductions in mean speeds typically appear to be around 3mph. Absolute reductions in the proportions of drivers exceeding the speed limit can range from 3% to 64%. Studies in which control groups have been used have shown that speed violations on the enforced sections of road have decreased whilst speed violations on control roads have increased or that violations on the enforced sections have decreased to a greater extent than on control roads. When net reductions in speeding violations have been calculated (i.e. the decrease in violations in the enforced area compared with a control area), they have been in the range of 2.6% to 34%. Only two of the studies reviewed found no effect of enforcement on speeding violations or mean speeds.

7.1.2 Effects of enforcement over time and distance

In addition to assessing the effects of stationary enforcement on speed behaviour at the enforcement site during police presence, some studies have investigated the time and distance ‘halo effects’ of enforcement. ‘Time halo’ refers to the length of time that the effects of enforcement on drivers’ speed behaviour continued after the police presence was removed. ‘Distance halo’ refers to the distance that the effects of enforcement last after drivers pass the enforcement site. Appendix B summarises the studies that have investigated the time or distance halo effects of enforcement.

With respect to time halo effects, research has shown that the effect of police presence on driving speeds can last between 1 hour and 8 weeks after police activity has ceased. It seems as though the studies in which larger time halo effects have been found are associated with longer periods of police presence. It is, however, difficult to establish the duration of police presence that is necessary to bring about long-lasting effects. On the basis of the studies reviewed it would appear that less than 6 days of police activity at a given location will have little or no effect on drivers’ behaviour after the enforcement effort has been removed. Even when police presence lasts for longer periods of time, the time halo effect can be expected to last for a limited period only. This suggests the need for sustained enforcement efforts to influence drivers’ behaviour.

The distance halo effects of police presence on speed behaviour that have been found also vary between studies. It seems that the effects of police presence on driving speeds last between 1.5 and 5 miles after drivers have passed the enforcement site. Hauer *et al.* (1982) estimated that the effects of visible and stationary policing on driving speeds are halved for every 900 metres (0.6 miles) downstream of the enforcement site.

Two studies, however, showed that police enforcement can have considerable distance halo effects (Edwards & Brackett, 1978; Brackett & Beecher, 1980). In these studies, visible stationary enforcement was used in a ‘random’ fashion in an attempt to create a sense of a large scale enforcement effort. It involved dividing the roads in the study areas into sections and the hours of the day into blocks of time. Road sections to be visited by the police and the time when they were to be visited were chosen at random. These studies found a distance halo effect of 14 miles from the enforcement sites. These large halo effects are likely to be due to the fact that random policing makes it difficult for drivers to predict where and when police will be present. If drivers perceive a high level of enforcement, this is likely to increase the deterrence effect and increase compliance with traffic laws over more of the road network. The issue of randomisation of enforcement is discussed further below.

7.1.3 Randomisation of stationary and visible policing

Zaidel (2002) states that most attempts to increase the impact of police traffic enforcement involve substantially increasing police presence. However, this approach is limited because the limitations on resources for traffic policing often means that increases in enforcement can only be short term. Short term, high intensity policing is referred to as a ‘blitz’ approach. Edwards and Brackett (1978) suggested an alternative approach in which low levels of policing could be used to achieve long-term and wide spread benefits in terms of violation and accident reductions. The approach involves the deployment of traffic police at random over the whole road network.

Theoretically, the randomisation of enforcement is likely to enhance the deterrent effect because it would give the *impression* of a large-scale enforcement effort. In addition, motorists would not know where or when the police would be present and so drivers may be more inclined to modify their behaviour across the whole road network as opposed to modifying their behaviour at specific sites where they know the police will be present (through experience). In other words, this method of traffic policing is likely to increase motorists’ perceived risk of apprehension for violating, even though the objective risk of apprehension is unlikely to change substantially. Such an approach would clearly be beneficial because, if effective, then the benefits in terms of violation and accident reductions ‘could be maintained routinely and indefinitely from normal levels of police manpower, overcoming the drawback of the blitz approach’ (Leggett, 1988).

A number of studies have shown that the randomisation of policing has desirable effects in practice (Edwards & Brackett, 1978; Brackett & Beecher, 1980; Leggett, 1988; Newstead *et al.*, 2001). In these studies similar methods were used. The total lengths of the roads investigated were divided into smaller (typically 1km long) sections and marked police vehicles visited those sections for approximately 2 hour periods. The section of road to be visited and the time at which it was to be visited were chosen at random.

In the USA, Edwards and Brackett (1978) evaluated the effectiveness of this method along a total 27km rural road and found a 4.8km/h (3mph) reduction in mean speeds at various measuring points across the route. Brackett and Beecher (1980) also evaluated this method on 24 experimental roads compared with 24 matched control roads in Texas, USA. The experiment lasted for 18 months. It was found that across all experimental roads net mean speeds reduced by 1.8% and the proportions of drivers exceeding the speed limit (55mph) reduced by 9%.

In Australia, Leggett (1988) investigated the effectiveness of this technique on three stretches of rural highway over a two year period. During the hours of enforcement the mean speeds across all experimental sites reduced by 3.6km/h (2.3mph) whereas in matched control sites speeds reduced by 0.5km/h (0.3mph) only. Accidents during the 5 years prior to the study were compared with accidents during the two years of the study. Fatal and serious accidents reduced by 58% compared with a 4.2% reduction in fatal and serious accidents in the control areas. Though there was an increase in all accidents at the experimental sites during the enforcement programme, there was also an increase in the total number of accidents in the control areas which was of greater magnitude (12% compared with 27%).

In Queensland (Australia) an enforcement programme called Random Road Watch (RRW) was progressively introduced into all eight of Queensland police regions between 1992 and 1997. The programme was based upon the principle of low intensity random enforcement. The hours of 06:00 to 00:00 were divided into 2 hour periods and each police jurisdiction was divided into sections. The sections to be visited and the time at which they were visited were chosen at random. 279 police stations in Queensland participated in RRW. Each police station operated their own programme that covered as many routes as possible in its territory. 55% of the accidents that occurred across all the police regions in the 12 months before the introduction of RRW occurred on the routes that were included in the RRW programme.

Newstead *et al*. (2001) evaluated the effects of RRW on accidents. These researchers used accident data from the beginning of 1986 (i.e. 6 years before RRW started to be introduced) to mid-1997. The evaluation involved a before-after time series analysis (which took into account the fact the RRW was introduced in the different police regions at different times) with control group comparison. The accident data during the RRW hours (i.e. 06:00 to 00:00) was compared with the accident data for the remaining period of the day and accident data for the roads enforced under the RRW programme was compared with the accident data for all other roads in Queensland. The estimated accident reductions due to RRW were large and statistically significant for both urban and rural areas taken together and for urban areas separately. Overall, it was estimated that fatal accidents had decreased by 31% (26% in urban areas), serious accidents requiring hospitalisation decreased by 13% (21% in urban areas) and slight accidents requiring medical/first aid treatment decreased by 9% (13% in urban areas).

Using data provided by Newstead *et al.* (2001), Zaidel (2002) calculated that the total RRW deployments per year in Queensland equalled 40,000 hours and that this provided about 4 hours (or two deployments) per site per year. Thus, it can be seen that very small levels of enforcement can bring about substantial safety benefits if police resources are used in the random manner used in RRW.

Overall, studies of low intensity random police enforcement have demonstrated that this method can bring about reductions in mean speeds in the order of 2mph to 3mph and can have substantial impacts on accident rates. In addition to the impacts on speeds and accidents, the distance halo effects associated with random policing are large (see above).

7.1.4 Stationary and hidden enforcement

Studies that have evaluated this method of policing have come from New Zealand (Keall *et al.,* 2001, 2002) and Canada (Chen *et al*., 2000, 2002). Each study has evaluated the effects of stationary and hidden policing in terms of speed and accident reductions. Keall *et al.* (2001) evaluated the effectiveness of speed cameras (radar guns) operated by police from unmarked vehicles hidden at the road side in one police region in New Zealand. This method of policing replaced the 'traditional' method which involved highly visible and stationary (physical police) enforcement. The trial began in June 1997 and the evaluation covered the first year of the programme operation. All speed camera areas were on 100km/h (62.5mph) open roads. Speed and injury accident data were collected from the enforced roads and from all other open roads in the trial area. These data were compared with speed and injury accident data obtained from all open roads in New Zealand that were outside the trial area. One month of speed data were collected before the trial and compared with the monthly average speeds that were collected over several months during the trial. Accident data were collected from 1993 and statistical models were used to calculate the estimated accident reductions due to the enforcement programme. It was found that mean speeds at the sites where police operated the hidden speed cameras reduced by 2.3km/h (1.4mph), and mean speeds reduced by 1.6km/h (1mph) on all open roads in the trial area. It was estimated that injury accidents were reduced by 22% at the enforcement sites and casualties were reduced by 29% (both results statistically significant at the 10% level). On all open roads in the trial area, accidents were reduced by 11% and casualties by 19%.

In a follow-up study to evaluate the impact of the hidden speed camera programme over the first two years of its operation, Keall *et al.* (2002) found that mean speeds reduced by 1.3km/h (0.8mph) on all open roads generally (results for speed reductions at the enforcement sites were not given). Injury accidents had reduced by 17% and casualties had reduced by 31%.

At face value, these studies would appear to suggest that replacing highly visible stationary policing with hidden policing provides beneficial impacts on safety. However, it should be noted that during the hidden speed camera trial in New Zealand, the number of drivers photographed for exceeding the speed limit increased from 1% before the trial to 5% during the first year. Thus, one cannot suggest that hidden stationary enforcement is better that visible enforcement because the change in the enforcement levels provides a confounding factor. In addition, extensive publicity accompanied the trial and it may have been the case that there was no publicity associated with the general enforcement activities before the trial.

A similar evaluation of hidden stationary enforcement to that conducted by Keall *et al.* was conducted in British Columbia by Chen *et al.* (2000). Speed and accident data were collected before and after the introduction of the 'photo radar programme' which involved enforcing speed limits across the whole state using photo radar (mobile speed cameras) operated by police officers in unmarked vehicles. The study evaluated the effectiveness of the programme over the first 12 months. Speed data were collected for the three months prior to the introduction of the programme and for each month during the study. Mean speeds reduced by 2.4km/h (1.5mph) at the photo radar sites throughout the state and the proportion of drivers exceeding the speed limit reduced by 50%. Across 19 independent monitoring sites within British Columbia that were not near the photo radar sites the proportion of drivers exceeding the speed limit reduced from 69% before the programme to 61% during it. Statistical modelling showed that speed related daytime accidents reduced by 25% during the first year of the programme and casualties reduced by 11%. Fatal casualties reduced by 17%.

In a later study, Chen *et al.* (2002) evaluated the effectiveness of photo radar programme after 2 years since its introduction on one highway corridor (a 22km long, 4-lane divided highway with 80-90km/h speed limits running through rural and light residential land). Mean speeds reduced by 2.8km/h (1.8mph). Accident modelling using two years of accident data prior to the enforcement programme and the first two years of accident data during it showed that the photo radar programme reduced accidents by 16% across the whole road.

In summary, these studies of stationary and hidden policing methods suggest that comparable reductions in accidents can be found to those that can be found using highly visible methods. However, the speed reductions associated with the visible method seem to be around 1mph greater than those using the hidden method. It should be noted that based on such a small number of studies, it is difficult to conclude firmly that the stationary hidden method is as beneficial as the stationary visible method.

7.1.5 Mobile enforcement

As mentioned above, a number of studies have investigated the effects of mobile enforcement methods in combination with stationary methods. However, stationary enforcement has been the primary method used and it is not possible to draw any conclusions about mobile enforcement on the basis of these studies. Only a few studies do provide information on the effects of increased mobile enforcement. Although none of the studies identified in this review investigated the effects on accidents or casualties, some investigated the effects on violations, which enables some conclusions to be drawn about the effectiveness of increased mobile enforcement methods.

Christie and Downing (1989) investigated the effects of increasing police presence on four motorways in the UK. Two of the motorways (M4 and M6) experienced a larger increase in enforcement and the other two (M1 and M3) experienced a smaller increase in enforcement (definitions of what was meant by ‘high’ and ‘low’ enforcement were not provided). The two lower enforced motorways experienced reductions in mean speeds in the centre and near-side lanes during the enforcement effort of less than 1mph. However, in the offside lane on both motorways mean speeds increased. On the higher enforced motorways, mean speeds reduced in all three lanes. On the M6 mean speeds reduced by less than 1mph in each lane. On the M4, mean speeds were reduced by less than 1mph in the nearside lane but by 1.2mph in both the centre and offside lanes. Even in the high enforcement conditions, these speed reductions appear to be much smaller than those that can be achieved using stationary methods (see above).

Perhaps the most useful information about the comparative effects of mobile enforcement was provided by a study conducted in the USA by Hool *et al.* (1983). These researchers compared the effects of stationary and mobile enforcement methods on speeding violations on two roads (a dual lane highway and a four lane interstate), each matched with a control road where no enforcement was present. In one experimental condition a single stationary marked patrol vehicle was used on each of the experimental roads. The police vehicle was randomly moved to different locations and was present at each of the locations for 30 minute intervals. In a second experimental condition, a single moving marked patrol vehicle was used on each road. They patrolled the length of the roads at 40-45mph. In a third experimental condition, a single moving unmarked patrol vehicle was used on each road. As with the marked police vehicle, the unmarked vehicles patrolled the length of the roads at 40-45mph. The results of the study have been summarised in Table 7.2. They showed that on the 2-lane highway there was little difference between the visible stationary method and the mobile marked patrol method. However, the unmarked mobile police vehicle was less effective. On the 4 lane interstate the stationary method was more effective at reducing speed violations and mean speeds than was either of the mobile methods. The mobile method of enforcement in unmarked police vehicles had no effect on this road type. This result is in support of Shinar and McKnight (1985) who also found no effect of mobile enforcement in unmarked vehicles.

Table 7.2 Comparative effects of stationary and mobile enforcement methods (Hool *et al.,* 1983)

	2 lane highway		*4 lane interstate*	
Method	*Percentage change in drivers exceeding the speed limit*	*Percentage change in mean speeds*	*Percentage change in drivers exceeding the speed limit*	*Percentage change in mean speeds*
Visible stationary	-3.3	-1.8	-2.6	-1.6
Mobile in marked police vehicle	-3.5	-1.9	-1.5	-0.9
Mobile in unmarked police vehicle	-2.6	-1.4	No change	+0.1

Although it is acknowledged that Hool *et al.* (1983) found that mobile policing in marked cars was as effective as stationary policing on the 2-lane road, the overall conclusion on the basis of the available literature summarised above is that mobile enforcement is not as effective as stationary enforcement. In particular, the effect of mobile enforcement in unmarked vehicles does not compare favourably with highly visible policing methods. From a psychological perspective, this can be partially accounted for by the deterrence process (see Section 5). It is unlikely that policing will deter many drivers from violating if it is not visible because it would have little effect on drivers’ perceived risk of apprehension. Highly visible methods, on the other hand, are likely to increase perceived risk because drivers can actually see the police effort occurring.

7.1.6 Speed cameras

A meta analysis of 9 studies on the effect of speed cameras (fixed-based and mobile) on accidents was conducted by

Elvik *et al.* (1997). The results are presented in Table 7.3. The table shows that the increased enforcement achieved a 19% reduction in all accidents, on average. Injury accidents were found to reduce by 17%, on average (no detail about the effects on fatal accidents was provided because the accident data did not allow such an investigation). Speed cameras were found to be less effective in reducing accidents in rural areas than they were in urban areas. In rural areas there was found to be a mean reduction in all accidents of 4%. In urban areas, the effects were found to be a 28% reduction in all accidents. This finding is consistent with the results of the recent meta analysis conducted by researchers at SWOV who have found a 24% reduction in accidents due to speed cameras.

Table 7.3 Results of a meta analysis of the effects of automatic speed enforcement (Elvik *et al.*, 1997)

	Percentage change in the number of accidents	
Accident type	*Best estimate*	*Confidence interval (95%)*
All accidents	-19	-18 to -20
All injury accidents	-17	-16 to -19
All accidents in urban areas	-28	-26 to -31
All accidents in rural areas	-4	-2 to -6

These meta analytic results are also comparable with studies that have been conducted in Great Britain specifically (summarised in Appendix C). Estimates vary but following the introduction of cameras these studies have found reductions in (fatal) accident rates at speed camera sites by up to 56% , and (fatal) casualty reductions of up to 71% have also been found (London Accident Analysis Unit, 1997). On the basis of the studies cited in Appendix C it also seems that fixed-based speed cameras are more effective in reducing speeds, accidents and casualties than are mobile speed cameras. For example, the studies by Gains *et al.* (2004) and DfT (2003b) have shown that mean speeds reduce by around 5mph at fixed-based camera sites and by between 1.6mph and 3.4mph at mobile camera sites.

However, while the research cited above suggests that speed cameras are effective enforcement tools, the Parliamentary Advisory Council for Transport Safety (2003), note that some critics of speed cameras have argued that the violation, accident and casualty reductions found at speed camera sites represent a regression to the mean effect. Regression to the mean is a potential problem in many studies, because the accident rates following the introduction of speed cameras have been compared with a few years of prior accident data only, and appropriate statistical controls have not been used. However, a number of studies have controlled for regression to the mean and still found significant safety benefits of speed cameras. For example, TRL research by Gorell and Sexton (2004) showed that, after controlling for regression to the mean, the estimated reduction in all injury collisions due to 77 (fixed-based) speed cameras in London was 12.4%, and the reduction in fatal and serious injury collisions was 20.6%. Similarly, Mountain *et al.* (2004) found that, within a distance of 250 metres of the speed cameras, the overall effect of a sample of 62 (fixed-based) speed cameras in the UK was a 25% reduction in all injury collisions.

The research by Mountain *et al.* (2004) also suggested that speed cameras are associated with lower but still significant reductions in accidents over a distance of 1 kilometre upstream and downstream of the camera sites. These findings are supported by research from Finland which has shown that the effects of speed cameras extend to between 4km (2.4 miles) and 10km (6 miles) from the speed camera site (Makinen & Rathmayer, 1994; Makinen & Oei, 1992). Other research, however, suggests that the distance halo effects of speed cameras are not as large as those reported by these studies. Keenan (2002), for example, found that by 500 metres after passing a speed camera mean speeds increased to the same levels they were 500 metres before the camera. At these points, around 80% of drivers were exceeding the speed limit. This finding is consistent with research by Nilsson (1992) who also found that the distance halo effect due to speed cameras was 500 metres. On the basis of the studies reviewed in Section 7.1.1, the minimum distance halo effect due to stationary visible policing is 2.4km (1.5 miles) (Hauer *et al.*, 1982). This is almost 5 times greater than the minimum distance halo effect that has been found due to speed cameras (i.e. 500 metres).

In summary, the evidence for the impact of speed cameras seems to indicate that they are more effective than physical policing methods at reducing violation and accident rates. In addition, speed cameras appear to have safety benefits over a distance of 500 metres or more from the speed camera site. That said, larger distance halo effects seem to be associated with physical policing, especially if the policing method is ‘randomised’ (see Section 7.1.2) and the literature indicates that physical policing methods are still effective at reducing violation and accident rates.

7.2 Methods used in drink driving enforcement

A selection of studies identified in this review that have evaluated the policing of drink-driving are summarised in Appendix D. The studies show that the effects of drink-driving enforcement on violations are associated with large decreases in violation rates and each study found net decreases in accident rates following enforcement campaigns.

Most studies in the literature that have evaluated policing methods used to enforce drink driving laws have studied the effects of random breath testing on accident rates. This involves providing enforcement in a random manner - i.e. there is no requirement to suspect drink driving before stopping a driver to apply a breath test.

In a recent review on enforcement and accidents, Zaidel (2002) presented the results of a meta analysis of 26 studies conducted by Elvik *et al.* (1997). The majority of these studies were conducted in Europe, Australia and New Zealand. The results are summarised in Table 7.4, which has been adapted from Zaidel (2002). The table shows that police enforcement of drink-driving has resulted in statistically significant reductions in most types of accident. The only exception was accidents involving pedestrians - there was no effect of enforcement found on this type of accident.

Table 7.4 Results of a meta analysis of the effects of drink-driving enforcement (Elvik *et al.,* 1997)

	Percentage change in the number of accidents	
Accident type	*Best estimate*	*Confidence interval (95%)*
All accidents	-4	-3 to -4
All fatal accidents	-9	-6 to -11
All injury accidents	-7	-7 to -8
All fatal and injury accidents at night-time/single vehicle	-7	-5 to -9
All fatal and injury accidents in day time hours	-12	-9 to -15
All accident in urban areas	-3	-2 to -4
All accidents in rural areas	-3	-2 to -4
All accidents involving pedestrians	0	+2 to -3

7.3 Methods used to detect red light violations

A number of studies investigating the effects of cameras which detect red light violations were identified, but none that involved human traffic police officers. The paper by Retting *et al.* (2003) is perhaps the most useful; it provided a comprehensive review of the international literature on the effects of red light cameras on violations and accidents. The tables presented in Appendix E are adapted from this paper and summarise the studies that have investigated the effects on red light violations (Table E1) and on accidents (Table E2). The conclusion is that red light cameras are associated with substantial reductions in violation rates at camera sites. Though all studies have found that the total number of injury accidents at camera sites has decreased due to the red light cameras, it appears that red light cameras are associated with an increase in the proportion of rear-end accidents. Presumably this is related to drivers stopping suddenly to avoid being caught for committing red light violations, though there is no direct evidence for this. In most studies, it appears that red light cameras have resulted in a reduction in the total number of accidents at camera sites. However, in two studies (Mann *et al.*, 1994; Andrassen, 1995) the overall effect was an increase in the total number of accidents at camera sites.

Retting *et al.* (2003) conducted a meta analysis on the studies listed in Table E2 to show the overall effects of red light cameras on injury accidents. It was concluded that although results vary between studies, the results indicate that red light cameras have a beneficial impact on injury accidents, with the best estimate being a 25% to 30% reduction at camera sites

7.4 Enforcement of seat belt laws

Few evaluation studies have been conducted to assess the direct effects of seat belt enforcement on accidents or casualties. Zaidel (2002) concluded that estimating the separate effect of policing seat belt laws on accidents was impractical based on the literature. However, Zaidel also stated that two U.S. studies (Wells *et al.*, 1992; Williams *et al.*, 1996) reported reductions in accidents of 4% to 8% as a direct consequence of police seat belt enforcement. However, these reductions were not statistically significant.

Other U.S. studies have also shown that enforcement of seat belt laws leads to increases in wearing rates (e.g. Jonah *et al.*, 1982; Jonah & Grant, 1985). In particular, Streff *et al.* (1992) found that a combined education and enforcement campaign over a 13 month period led to an increase in wearing rates. Before the campaign, wearing rates were measured at 56.7%. During the campaign they reached 65.1%, which reduced slightly to 62.7% after the campaign.

In Europe a study by Gundy (1988) examined the effect of an enforcement campaign that was conducted over a 2 month period. It included police enforcement plus an extensive media campaign. On the basis of the Gundy (1988) paper it was difficult to identify the levels of policing used in the campaign. The author stated that the amount of police time devoted to enforcement varied widely from week to week and varied between jurisdictions with the study area. However, it was found that the increased enforcement effort led to a 25% increase in wearing rates and, at 6 and 12 months after the enforcement period ended, the wearing rates were still 15% higher than they had been before the campaign. Two years after the campaign, wearing rates remained higher than before the campaign. However, the researchers could not conclude that this was due to the enforcement programme alone because another seat belt enforcement programme ran after the end of the first year of the original campaign.

Countries which have succeeded in raising seatbelt wearing rates, for example when wearing became compulsory in the front seats of cars and vans in Great Britain in 1983, have experienced considerable casualty reductions which demonstrate the benefits that can be achieved by raising the wearing rates. Thus, in spite of the apparent lack of research evidence on this point, increases in wearing rates due to policing are likely to be accompanied by reduced casualties in road accidents.

8 Conclusions and recommendations

8.1 Levels of police enforcement

- The majority of studies in the literature have found that increased levels of traffic policing have reduced road accidents and traffic violations. However, it is difficult in practice to establish the relationship between levels of policing and violation, accident or casualty rates. Unfortunately, it is not possible to establish the relationship by generalising across the studies in the literature because appropriate information about enforcement levels is not given consistently across the different studies. Some studies do provide limited information about the levels of enforcement required to have an effect on safety. It seems as though stopping every 1 in 6 offenders, for example, will have a noticeable effect (see Section 6).

- Theory suggests that the relationship between levels of policing and accident/casualty rates is non-linear (see Section 6). At zero enforcement level, accidents and casualties are expected to be at their highest levels. Increases in enforcement will have no noticeable effect at first but at a certain level, when drivers become aware of the increased police presence, accidents and casualties can be expected to drop up until a saturation point is reached, after which further increases in enforcement levels can be expected to have little or no effect.
- It will be a challenging and important task to establish the form of the relationship. This information will allow the likely implications for accidents and casualties to be taken into account when setting the level of traffic policing in an area. Section 9 outlines the type of research that would be needed to establish the relationship between policing levels and accident/casualty rates in London.

8.2 Methods of police enforcement

- On the basis of the literature it is possible to discriminate between stationary and mobile methods of traffic policing. Each method can involve visible policing in marked police vehicles or can involve the use of unmarked vehicles (see Section 7). Stationary and highly visible policing appears to be the most effective method for reducing violations and accidents (see Section 7.1.1), although stationary enforcement in unmarked vehicles has also been found to be effective (see Section 7.1.2). Mobile policing methods are less effective, especially when unmarked police vehicles are used (see Section 7.1.3).
- The effects of increased stationary enforcement of speed limits seem to last for a limited amount of time after the police presence has been removed. The largest time halo effects appear to be 8 weeks. However, sustained police presence is required to produce such large effects (see Section 7.1.1). The distance halo effects of stationary policing appear to be in the range of 1.5 miles to 5 miles of the enforcement site (also see Section 7.1.1).
- There is evidence in favour of deploying traffic police largely at random over the whole road network. Theoretically it is likely to increase deterrence. In practice, the random allocation of stationary policing methods to different locations on the road network has been found to be effective, producing substantial impacts on accident rates and reductions in mean speeds and large distance halo effects. The main advantage of this method of traffic policing is that it requires relatively low levels of police manpower.
- Speed cameras (see Section 7.1.4) have been found to be particularly effective enforcement tools. They appear to be more effective than physical policing methods in reducing mean speeds and accidents. However, the effects of speed cameras appear to be mainly limited to the speed camera site and physical policing methods have still been found to be effective. On the basis of the reviewed literature, the minimum distance halo effects associated with physical policing are about 5 times greater than the minimum distance halo effects associated with speed cameras.
- Studies of the enforcement of drink-driving violations (see Section 7.2) have also shown that increased policing using random breath testing tends to reduce violations and accidents.
- Red light running cameras have been found to be very effective in reducing violations and accidents (see Section 7.3). The best estimate for the effects of red light cameras is between 25 to 30% reduction in injury accidents at speed camera sites.
- Though few studies have investigated the effects of seat belt enforcement on accidents, a number of studies have found that increased enforcement of seatbelt laws can result in increased wearing rates, which is likely to reduce the numbers of road accident casualties (see Section 7.4).

9 Proposal for a project to investigate how levels of policing affect road accidents and casualties in London

9.1 Background and objectives

It has been found in this review that the relationship between an increase in the level of policing and a reduction in accidents or casualties is difficult to establish. It is impractical to generalise from previous research studies using meta analytic techniques because measures of enforcement levels are not consistently provided by the different studies. Furthermore, the majority of studies in the literature have been conducted outside the UK and few studies have assessed the effects of traffic policing in busy urban areas. Those that have been conducted in the UK are either small scale studies that investigated the effects of policing on a limited number of roads (e.g. Holland & Conner, 1996) or were conducted many years ago (e.g. Munden, 1960). In sum, it is difficult to generalise the findings of previous studies to busy urban areas such as London. To establish the relationship between levels of policing in London, on the one hand, and accident and casualties, on the other, new research would be needed. The results of that research should allow the likely implications for accidents and casualties to be taken into account when adjusting the level of traffic policing.

Summarised below is a brief proposal for an appropriate research project that would be needed to establish the relationship between levels of policing and accident and casualties. Although the following methodology would allow the relationship between levels of policing and casualties or accidents in London to be established, it should be noted that the proposed methodology would also be appropriate to investigate the relationships between levels of policing and casualties or accidents in other areas, not just London. The proposed research would require the commitment and co-operation of the Police, working in partnership with appropriate Government Agencies and possibly other stakeholders.

9.2 Research method

The first phase of the research would be to investigate what statistics are currently collected by the police that would allow the level of traffic policing to be measured within each operational area. On the basis of that research, an appropriate measure of enforcement would need to be defined.

A number of study areas would then be selected for the main phase of the research. Analysis of past accident and casualty data will help to identify the number and size of areas that would be required to identify changes with an appropriate level of statistical confidence. These 'treatment' areas would be subject to various increases in traffic policing (e.g. 2×, 3×, 4× their base levels) over a substantial period of time (e.g. 3 months). At the end of this period, traffic policing would return to its previous level. Suitable control areas would also be identified in which the level of police activity would not change.

The following data would be needed from the treatment and control areas:

- Information about the base level of traffic policing in each area (i.e. prior to any increase in enforcement levels).
- Information about the levels of traffic policing in each area during the experimental phase (i.e. once enforcement levels had risen in the treatment areas).
- Accident and casualty data for each area for several years prior to the experimental phase (available from the regular STATS19 accident reporting system).
- Accident and casualty data for each area during the experimental phase to establish the changes associated with the increased enforcement.
- Accident and casualty data in each area for a number of months after the experimental phase to establish how long the effects of the increased policing last once the policing levels return to their base levels.
- Corresponding accident and casualty data from areas adjacent to the treatment areas.

Appropriate Time Series Models would be fitted to the accident and casualty data to identify the changes that had occurred in each treatment area. The results would be compared with the measures of traffic policing, to produce a function of the form illustrated in Figure 6.1. These models would also show whether there had been time halo effects, i.e. safety benefits that lasted after the end of the increased policing. Modelling of accident and casualty data from areas adjacent to the treatment areas would show whether there had been distance halo effects, i.e. safety benefits in areas where policing had not increased.

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Appendix A: Summary of stationary and visible methods for enforcing speed limits

The majority of studies have examined the effects of stationary and visible methods of physical policing on speeding violations and accidents. Table A1 summarises the results of the studies conducted to investigate the effects on speeding violations and mean speeds. Table A2 summarises the studies in which the effects of enforcement on accident rates have been investigated. It should be noted that, in some studies, other methods of enforcement have been used in combination with the stationary methods. However, the stationary method of policing comprised the majority of the enforcement effort and assessing the effectiveness of the other methods independently of the stationary enforcement is not possible on the basis of these studies. It should also be noted that some of the studies have evaluated enforcement programmes designed to target violations generally, not only speeding. However, speed enforcement has been a major part of these programmes and it is not possible on the basis of these studies to estimate the accident reductions due to the enforcement of different types of driving violations separately.

Table A1 Effects on speed violations

Study	*Road/area type*	*Condition*	*Percentage change in proportion of drivers exceeding speed limit*	*Changes in mean speeds*
De Waard & Rooijers (1994) Netherlands	Motorway	Treatment	-3 to -30	+0.6km/h to -5.2km/h
		Control	+12 to +14	+0.5km/h
Sisiopiku & Patel (1999)USA	70mph highway	Treatment compared with control	–	-4.8km/h to -8.0km/h
Leggett (1988) Australia	3 110km/h rural highways	Treatment	–	-3.6km/h
		Control	–	-0.5km/h
Hool *et al.* (1983) USA	55mph 2-lane highway and 55mph 4-lane interstate	Treatment groups compared with control groups	-3.3 and -2.6	-1.8mph and -1.6mph
Brackett & Beecher (1980) USA	55mph roads	Treatment compared with control	-9	-1.8%
Vaa (1997) Norway	60km/h and 80km/h roads through rural and urban areas	Treatment groups compared with control groups	-12 to -34	–
Salusjarvi & Makinen (1988)[a]	60km/h and 80km/h roads	–	-7 to -25	–
Hauer, Ahlin & Bowser (1982) Canada	60km/h semi-rural 2-lane roads	Treatment compared with control	–	-14.4km/h to -15.9km/h
Holland & Conner (1996) UK	40mph urban road	Treatment	-56 to -64	Not given
Stuster (1995)	2 residential communities	Treatment	-10 to -19	–
		Control	-3	–
Munden (1966) UK	30mph urban roads	Treatment	-35	–
		Control	+10	–
Roop & Brackett (1980) USA	Rural roads	Treatment	-15	-1.8km/h
Edwards & Brackett (1978) USA	Rural roads	Treatment	–	-4.8km/h
Aberg (1983)[a]	Unknown	–	No effect	No effect
Ekstrom, Kritz & Stromgren (1966)[a]	Unknown	–	-13	–

[a] = *Information about these studies was not obtained from the original report but from other references which did not specify the exact enforcement methods used (studies that have been classified as those using mainly stationary enforcement methods may have used stationary methods only).*

Table A2 Effects on accidents

Study	*Area*	*Percentage change in all accidents*	*Percentage change in fatal accidents*	*Percentage change in serious accidents*	*Percentage change in slight accidents*
Leggett (1988)[a] Australia	3 110km/h highways	-17	-28	-62	+50
Brackett & Beecher (1980)[a] USA	55mph roads	-11.5	-15	–	–
Munden (1966)[a] UK	30mph urban roads	-24	-21		-25
Hakkert *et al.* (2001)[a] Israel	700km of urban roads	–	+10 to -48		-
Hauer & Cooper (1977)[b] Canada	Road in Metropolitan Toronto	-3	–	–	–
Sali (1983)[a] USA	City wide enforcement in Boise (Idaho)	-17	–	–	–
Carr *et al.* (1980)[b] USA	City wide enforcement in Kansas	No effect	No effect	No effect	No effect
Fuller (2002)[a] Ireland	One police divisional area in Ireland	–	No effect	Casualties reduced by 18%	Casualties reduced by 9%
Stuster (1995)[b] USA	2 residential communities	-1.1 to -10.3 (note that a control area = +3.4)			
Roop & Brackett (1980)[a] USA	Rural roads	-16 to -18	-6		–
O'Brien (1980)[a]	Rural roads	–	-27		–
Newstead, Cameron & Leggett (2001)[a] Australia	All urban areas in Queensland	-15 to -21	-26 to -60	-4.1 to -20.6	–
	All rural areas in Queensland	-4.8 to +5.1	-34 to +133.5	-4.1 to -7.8	–
Aberg (1983)[c]	Unknown	-11 to -19	–	–	–
Engdahl & Nilsson (1983)[c]	Unknown	+11	–	–	–
Salusjarvi & Makinen (1988)[c]	Unknown	+2 to -11	–	–	–

[a] = *Net change in accidents (i.e. in relation to control sites).*
[b] = *Simple before/after change in accidents (i.e. no control site comparison).*
[c] = *Study cited from a secondary source – not known whether there was a control site.*

Appendix B: Studies of time and distance halo effects

Table B1 Time and distance halo effects

Study/Country	*Area*	*Enforcement details*	*Time halo effect*	*Distance halo effect*
Hool, Maghsoodloo, Veren & Brown (1983) USA	2-lane highway 4-lane interstate	Visible stationary	–	3-5 miles
Sisiopiku and Patel (1999) USA	2- lane highway	Visible stationary for 6 days	1 hour	–
Cooper (1975) USA	Urban junctions	Visible stationary	No halo effect	–
Holland & Conner (1996) UK	Urban	Visible stationary enforcement for one week	2 weeks	–
Edwards & Brackett (1978) USA	Rural	4 weeks of low intensity random enforcement	–	22km (14 miles)
Brackett & Beecher (1980) USA	Rural	18 months of low intensity random enforcement	–	22km (14 miles)
Hauer, Ahlin & Bowser (1982) Canada	Rural	Visible stationary enforcement for 5 days Visible stationary enforcement for 2 days separated by 3 days	6 days 3 days	2.4 km Effects of enforcement reduced by half for every 900 metres after enforcement site
Vaa (1997)	Rural & urban	6 weeks of enforcement. Several enforcement techniques used	2-8 weeks No time halo effect between 0600-0900hrs	–
Engdahl & Nilsson (1983) Sweden	Unknown	Several enforcement techniques used	14 days	–

Appendix C: Studies of speed cameras

Table C1 A selection of studies evaluating the impact of speed cameras

Study	*Country*	*Percentage change in speeding violations/reductions in mean speed*	*Percentage change in injury accidents*	*Percentage change in casualties*
Swali (1993)	England (London)	-5mph	-19 (All injury accidents)	-29 (fatal + serious) -20 (all injuries)
Leithead (1997)	England (London)	–	-36 (fatal + serious) -14 (all injury accidents)	–
London Accident Analysis Unit (1997)	England (London)	–	-56 (fatal) -8 (serious) -12 (fatal + serious) -8 (slight) -9 (all injury accidents)	-71 (fatal) -27 (serious) -30 (fatal + serious) -8 (slight) -12 (all injury accidents)
Gains, Heydecker, Shrewsbury & Robertson (2004)	England	-32 / -2.4mph[a] -71 / -5.3mph[b] -21 / -1.6mph[c]	-35 (all injury accidents)[a] 42 (all injury accidents)[b] -23 (all injury accidents)[c]	-40 (fatal + serious)[a] -51 (fatal + serious)[b] -28 (fatal + serious)[c]
Hess (2004)	England	–	-45 (all injury accidents)	–
DfT (2003b)	England	-56 / -3.7mph[a] -67 / -4.5mph[b] -37 / -3.4mph[c]	-6 (all injury accidents)[a] -5 (all injury accidents)[b] -9 (all injury accidents)[c]	-35 (fatal + serious)[a] -65 (fatal + serious)[b] -29 (fatal + serious)[c]
Mountain, Hirst, & Maher (2004)	UK	-35 / -4.4mph	-11 (fatal + serious) -25 (all injury accidents)	–
Gorell & Sexton (2004)	England (London)	–	-20.6 (fatal + serious) -12.4 (all injury accidents)	–

[a] = *All camera sites.*
[b] = *fixed camera sites.*
[c] = *mobile camera sites.*
Note that all other statistics presented relate to fixed base speed cameras.

Appendix D: Studies of drink-driving enforcement

Table D1 Effects of drink-driving policing (study summaries)

Study	*Percent change in violations*	*Percentage change in accidents*
Ross (1977)[b] UK	–	All serious or fatal accidents: -28% All serious or fatal accidents during drinking hours: -35% All serious or fatal accidents during non-drinking hours: -2%
Cameron *et al.* (1981)[a] Australia	–	Fatal night time accidents at weekends: -54% Serious night time injury accidents (no differences between different nights of the week): -25% Casualties from single vehicle accidents: -18% Casualties from multi vehicle accidents: -10%
Cameron & Strang (1982)[a] Australia	–	Serious night time accidents: -24%
Amick & Marshall (1983)[b] USA	–	Night time injury accidents: -4.6% (0% to +4.5% at control sites)
Arthurson (1985)[c] Australia	–	Fatal night time accidents: -21%
Federal Office for Road Safety (1986)[a] Australia	–	Fatal accidents: -42% Injury accidents: -29%
Voas & Hause (1987)[b] USA	-43%	Night time weekend accidents: -15% (-8% to +10% at control sites) Night time weekday accidents: -10% (-2% to +8% at control sites)
Kearnes *et al.* (1987)[a] Australia	–	All fatal accidents: -20%All night time week end accidents: -40%

Appendix E: Studies of red light cameras

Table E1 Studies of effects of red light cameras on violations (Retting *et al.*, 2003)

Study	*Country*	*Study sites*	*Percentage change*
Chin (1989)	Singapore	23 camera sites	-42
		20 non-camera sites	-27
		14 control sites	+17
Thompson *et al.* (1989)	Great Britain	Camera site 1	-22
		Camera site 2	+13
Arup (1992)	Australia	3 camera sites	-78
		3 non-camera sites	-67
Oei *et al.* (1997)	Netherlands	4 camera sites	-56
Retting *et al.* (1999a)	USA	5 camera sites	-44
		2 non-camera sites	-34
		2 control sites	+5
Retting *et al.* (1999b)	USA	9 camera sites	-40
		3 non-camera sites	-50
		2 control sites	-4

Table E2 Estimated percentage change in accidents due to red light cameras (Retting *et al.*, 2003)

						Right-angle accidents		*Rear-end accidents*	
Study	*Country*	*Treatment sites*	*Comparison sites*	*Total accidents*	*Injury accidents*	*Total*	*Injury*	*Total*	*Injury*
South et al. (1988)	Australia	46 camera sites	46 non-camera sites	–	-7	–	-32	–	-31
Office of Road Safety (1991)	Australia	15 camera sites	All other signalised junctions in area	-8	-23	-38	-54	+14	+25
Mann *et al.* (1994)	Australia	8 camera sites	14 non camera sites	+6	-20	+8	-26	+12	-1
Queensland Transport (1995)	Australia	79 camera sites	All other signalised junctions in area	-48	-46	–	–	–	–
Andrassen (1995)	Australia	41 camera sites	All other signalised junctions in area	+7	–	-13	–	+20	–
Hillier *et al.* (1993)	Australia	16 camera sites	16 non-camera sites	-8	-26	+29	–	+108	–
Ng *et al.* (1997)	Singapore	42 camera sites	42 non-camera sites	–	-9	–	-10	–	+6
Retting & Kyeychenko (2002)	USA	125 signalised junctions where 11 junctions were equipped with cameras	Non-signalised junctions in same area & in 3 other cities	-7	-29	-32	-68	+3	–

Abstract

Traffic laws attempt to improve driving standards by defining as illegal those types of behaviour which are held to be unduly risky, such as drink-driving or driving too fast. These laws are only effective if they are obeyed, but drivers frequently violate traffic laws without being caught. The likelihood of an offender being caught depends on the level of enforcement of these laws by human policing and increasingly by automatic equipment such as speed cameras. This report presents the results of a review of the relevant technical literature that was undertaken by TRL on behalf of Transport for London (TfL) to investigate 'How Methods and Levels of Policing Affect Road Casualty Rates'. The main aims of the review were: (a) to evaluate the findings from existing literature in order to determine whether increasing the level of traffic policing is likely to reduce the number of casualties in road accidents and (b) to summarise the main pieces of work and draw conclusions, including any quantitative relationships between the level of enforcement and the numbers of accidents and casualties. Overall, the literature showed that increased enforcement can lead to significant improvements in road safety. However, determining the precise relationships between levels of policing and casualty rates is problematic on the basis of the available literature. Detailed results are presented along with a brief proposal for a future research project to investigate the influence of levels of traffic policing on accidents and casualty rates.

Related publications

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PPR027 *Performance of safety cameras in London: final report* by R Gorell and B Sexton. 2004 (price £20, code 1X)

PR58 *Speed, speed limits and accidents* by D J Finch, P Kompfner, C R Lockwood and G Maycock. 1994 (price £25, code E)

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