There is a substantial amount of evidence from experimental studies to indicate that a variety of individual skills are impaired at blood alcohol concentrations (BACs) well below 0.05%. Epidemiological studies indicate that the risk of a crash increases sharply for drivers with BACs below 0.05%. The correlation between drunk driving and the risk of traffic accidents has been established on the individual as well as the aggregate level. The BAC level legally permitted is a public policy decision by legislators, while scientists can present experimental and epidemiological evidence indicating the BAC level at which psychomotor skills deteriorate and accident probabilities increase. There is considerable epidemiological evidence to support the fact that the risk of alcohol-impaired drivers being involved in traffic crashes rises with increasing BAC’s. By contrast, the evidence on the BAC at which a driver should be regarded as committing an offence has been the subject of much debate and various legislative decisions. Historically, laws specify BAC levels which are a compromise figure intended to reflect both the point at which a driver becomes significantly more likely to be involved in an accident than a comparative driver with a zero BAC and that which is politically acceptable, but falls within the BAC region of increased accident liability. Therefore, the legislation in most countries has not kept pace with scientific progress. This study suggests that if saving lives on the road is an important issue, then, passing laws that incorporate scientific and epidemiological studies, is necessary.

Every year about half a million people are killed and 35 million injured in road traffic accidents worldwide. U.S. experts predict that traffic accidents will soon become the world’s third leading cause of death, following heart disease and strokes. Harvard University based experts also predict that the number of deaths caused by traffic accidents will rise fifty percent from present levels by the year 2020 if we fail to improve our current safety performance. As early as 1904, a study published in the Journal of Inebriety reported that a large segment of automobile drivers involved in fatal crashes had been intoxicated by drink. Since then, operating a motor vehicle while under the influence of alcohol has become and remains a major cause of traffic deaths. Alcohol has been implicated as a major contributor in a large proportion of driving related accidents, fatalities and injuries worldwide and it is observed that there is a 23%-66% incidence of alcohol among individuals injured in crashes. Impaired driving continues to be a subject of considerable concern in the world. Using sophisticated mathematical modelling, Evans estimated that eliminating alcohol would reduce overall traffic fatalities by about 47%. Legal measures have provided the foundation of modern efforts to reduce drink driving and the associated collisions, injuries and fatalities. The key efforts to reduce the alcohol related crash problem in recent years has been the adoption of laws, which make it an offence to drive with a blood alcohol level beyond a certain limit. Following the international movement toward the establishment of per se limits (a blood alcohol concentration [BAC] that is considered to be illegal, regardless of evidence of impaired behaviour) and the Scandinavian-type laws modified the traditional criminal-law-based concepts successfully by introducing clinical blood alcohol concentration (BACs) as evidence. The per se laws greatly facilitate the apprehension and prosecution of drunk drivers by providing an objective and simple means of detecting alcohol impairment. The use of punishable BAC limits has long been considered the most effective countermeasure to driver behaviour under influence of alcohol.

The level at which the legal limit allowed by the per se laws has depended on a variety of legal and political factors rather than effects on actual driving behaviour and epidemiological investigations of collision risk. Scientific data provide clear evidence that important driving skills are impaired at very low BACs. It falls to society as a whole, and policy makers in particular, to assess the costs of and the remedies for alcohol impaired driving.

*This research was supported by the Japan Society for the Promotion of Science (JSPS) postdoctoral fellowship for young scientists programme.*
New knowledge, new strategies need to be developed within the political and cultural framework of each country, which are more appropriate for the real traffic related problems confronted by the modern world. This study suggests that if saving lives on the road is an important issue, then, passing laws that incorporate scientific and epidemiological studies is necessary. Therefore, alcohol related traffic legislation might be reinforced with a lower legal limit, where human driving capabilities are really impaired. The major purpose of this research is to summarise evidence on the impact of introducing and lowering the legal per se blood alcohol limit on traffic safety.

3) Alcohol related traffic death rates (international comparison).

The major new development in traffic safety is the finding of a reduction in the percentage of drinking drivers using the roads during the time when alcohol-crash risk is the highest, that is, night time hours or weekends. A direct measure of the effectiveness of many programs would be the BAC distribution for drivers on the road. It would be most reliably obtained by breath alcohol tests obtained in roadside surveys of a random selection of drivers at properly selected locations and times. The utility of these natural experiments involving drinking and driving laws is enhanced by the quality of the data that can be used to index the dependent variable. Although drunk driving is very costly to measure directly through a roadside survey, it is widely recognized as a strong methodology to mirror prevalent drunk driving in any society.

A literature survey performed, beginning with an inquiry directed to the National Clearing House on Alcohol and Drug Abuse (NCADI), which searched its computer-based files for materials on the subject under review. Some items came to our attention through our general reading in the areas of alcohol and traffic safety research and through informal inquiries of colleagues and conferences and during routine business. Data was also obtained from the WHO database on injury prevention and control. It is no exaggeration to conclude that a lower legal limit has a deterrent effect than a higher legal limit. An international comparison helps put these rates in perspective as follows:

1) Road side survey results (international comparison);
2) Public opinion (US, Norway, Australia and Japan); and
public might have learned about the new *per se* blood alcohol laws through the media, through direct experience (being arrested), and subsequently, by word of mouth from individuals who initially learned about the law through one of the two primary channels.

Evaluations of drunk driving interventions often look only at fatal crashes. There are two reasons to do this. First, having a much greater involvement of alcohol, fatal crash rates are probably more sensitive indicators of drunk driving. Second, measurement of alcohol involvement is generally better in fatal crashes. The best available data on drunk driving is road fatality data. They endorse the use of fatality data by suggesting that fatalities and serious injuries have low dark figures because the need to treat injuries and to process cadavers brings virtually all cases to the attention of health and hospital authorities with well-established statistical systems. In addition, alcohol related fatality data are collected by a number of reliable sources such as police accident reports, death certificates and emergency medical services reports.

Based on extensive research over several decades, we now have overwhelming evidence showing that even BACs as low as 0.05% impair driving-related skills. One line of evidence grows out of laboratory research with dosed subjects. Confirming evidence comes from field research that compares the BACs of crash-involved with non-crash-involved drivers to determine the relative risk of crash involvement. Both experimental and epidemiological evidence suggests that a BAC limit of 0.10% is too high. A variety of behaviours and cognitive functions begin to show evidence of impairment at BACs as low as 0.04%. In addition to this experimental evidence, the best epidemiological information currently available on BAC and the risk of a driver crashing shows a clear increase in the slope of the risk curve at BACs of about 0.05%. Hence there is a clear and substantial scientific basis for setting the *per se* BAC limit at 0.05%. A national comparison of drivers in single vehicle fatal crashes with drivers not in fatal crashes but stopped at road side surveys indicated that for each 0.02% increase in blood alcohol level nearly doubles the risk of fatal crash involvement. In all age and sex groupings, the fatal crash risk at a blood alcohol level of 0.05mg% to 0.09mg% was at least nine times greater than that at zero blood alcohol. These findings are consistent with the findings from epidemiological crash data, which have been analysed using contemporary statistical methods.
pared 5,985 drivers involved in accidents during 1962–63 with a control group of 7,590 drivers during the same period. The control group was randomly sampled at 2,000 places at times of day and days of week, representative of accidents occurring over the previous three years. This remains a landmark in its field despite the passage of a quarter century and the accumulation of several more recent studies.

Moreover, Borkenstein et al. Grand Rapid study had a significant impact on public policies in North America, Australia, New Zealand, Japan and Europe. Since then the use of deterrence techniques in the prevention of alcohol related traffic problems has been gaining increasing importance. Deterrence administered by law enforcement agencies, has been the principal method to reduce alcohol impaired driving. Legislation has moved from prohibiting ‘intoxicated’ drivers to specifying blood alcohol concentration (BAC) limits for drivers. While originally, such legislation specified limits as high as 0.10%, recently countries have reduced the level to as low

<table>
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<th>Country</th>
<th>BAC Limit Change</th>
<th>Study Details</th>
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<tr>
<td>UK</td>
<td>introduction of 80mg%</td>
<td>Ross (1973)</td>
<td>Time series analysis</td>
</tr>
<tr>
<td>Canada</td>
<td>introduction of 80mg%</td>
<td>Chambers et al. (1974)</td>
<td>Positive impact on traffic safety and which appeared to decrease over time</td>
</tr>
<tr>
<td>Netherlands</td>
<td>introduction of 50mg%</td>
<td>Noordzij (1977)</td>
<td>Pre-post comparison</td>
</tr>
<tr>
<td>Australia</td>
<td>Queensland lowering the BAC limit from 80mg% to 50mg%</td>
<td>Smith (1986)</td>
<td>Time series analysis</td>
</tr>
<tr>
<td>Canada</td>
<td>Ontario lowering the BAC limit to 50mg%</td>
<td>Vingilis et al. (1988)</td>
<td>Time series analysis</td>
</tr>
<tr>
<td>US</td>
<td>introduction of 100mg% BAC limit</td>
<td>Zador et al. (1989)</td>
<td>Time series analysis</td>
</tr>
<tr>
<td>Australia</td>
<td>Capital Territory lowering the BAC limit from 80mg% to 50mg%</td>
<td>Brooks and Zall (1993)</td>
<td>Pre-post comparison</td>
</tr>
<tr>
<td>South-Australia</td>
<td>lowering the BAC limit from 80mg% to 50mg%</td>
<td>Kioden and McLean (1994)</td>
<td>Positive long term impact on traffic safety found</td>
</tr>
<tr>
<td>US</td>
<td>lowering the BAC limit from 100mg% to 80mg% in five states</td>
<td>Hingson et al. (1996)</td>
<td>Pre-post comparison</td>
</tr>
<tr>
<td>Japan</td>
<td>lowering the BAC limit to 50mg%</td>
<td>Desapriya and Iwase (1996)</td>
<td>Positive long term impact on traffic safety found</td>
</tr>
<tr>
<td>Sweden</td>
<td>lowering the BAC limit from 50mg% to 20mg%</td>
<td>Nostrom (1997)</td>
<td>Time series analysis</td>
</tr>
<tr>
<td>Australia</td>
<td>New South Wales – Queensland – lowering the BAC limit from 80mg% to 50mg%</td>
<td>Henstridge et al. (1997)</td>
<td>Time series analysis</td>
</tr>
<tr>
<td>France</td>
<td>lowering the BAC limit from 80mg% to 50mg%</td>
<td>Mercier-Guyon (1998)</td>
<td>Pre-post comparison</td>
</tr>
<tr>
<td>US</td>
<td>lowering the BAC limit from 100mg% to 80mg% in 11 states</td>
<td>Apsler et al. (1999)</td>
<td>Multiple time series analysis</td>
</tr>
<tr>
<td>US</td>
<td>lowering the BAC limit from 100mg% to 80mg% in North Carolina</td>
<td>Foss et al. (1999)</td>
<td>Multiple time series analysis</td>
</tr>
<tr>
<td>US</td>
<td>lowering the BAC limit from 100mg% to 80mg%</td>
<td>Voas et al. (2000)</td>
<td>Weighted least-squares regression</td>
</tr>
<tr>
<td>Denmark</td>
<td>lowering the BAC limit from 80mg% to 50mg%</td>
<td>Bernhoft (2000)</td>
<td>Pre-post comparison</td>
</tr>
<tr>
<td>Austria</td>
<td>lowering the BAC limit from 80mg% to 50mg%</td>
<td>Bartl and Esberger (2000)</td>
<td>Pre-post comparison</td>
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</table>

(Source: Desapriya and Iwase, 2000)
as 0.02%. The BAC level legally permitted is a public policy decision by legislators, while scientists can present experimental and epidemiological evidence indicating the BAC level at which psychomotor skills deteriorate and accident probabilities increase. Virtually all drivers are substantially impaired at 0.05% BAC.

Straightforward and powerful reasons exist for lowering the legal limit of blood alcohol concentration (BAC) from 0.10 to 0.05. In 1964, Borkenstein et al. showed drivers who had been drinking were more likely to be involved in a crash than sober drivers, and that beginning with low BACs, the greater the level of intoxication, the higher the probability of crash. Other investigators have replicated and refined Borkenstein et al.’s findings. More recently, Zador et al., and Zador extended this line of research by showing that driver BAC is associated with the probability of being responsible for a crash in which they were involved. The strong relationship between BAC level, probability of crash involvement, and increased impairment, has led a growing number of countries to introduce and reduce the BAC \textit{per se} laws.

Beneficial effects on alcohol-related collision, injuries and fatalities have been observed in most jurisdictions in which introduction and reduction of the \textit{per se} legal blood alcohol limit have been evaluated. Generally, studies employing the most rigorous methodology have found significant beneficial effects. Some variable findings emerge which may be related to methodological differences between studies, as well as to differences in the way the law has been applied and the specific social and historical context. In some cases, it appears that beneficial effects may decline over time, but lasting reductions in alcohol-related collisions and fatalities have been observed.

It is hypothesised that implementing the \textit{per se} blood alcohol limit legislation has a synergistic effect on the other components of the anti-drunk driving system, namely the enforcement, adjudication, judicial, licensing and public information and education components. The international experience suggests that combating drunk driving is most effective when all of the components are at play and which emphasised the system approach to address this social problem. Implementing the \textit{per se} laws and the publicity surrounding them serves to remind the public about the dangers of drunk driving, and may catalyse the enforcement, judicial and licensing communities to refocus their efforts and draw renewed attention to the importance of removing drunk drivers from the roads.

Previous research suggests conditions under which the introduction or change in a \textit{per se} law will maximize its effect. In considering the ideal indications for the use of \textit{per se} law, prevention of traffic offences is best achieved under certain conditions through the mechanism of general deterrence. It is observed that the law works best when enforcement is strict, extensive and prompt from the time of the law’s inception throughout the years, as has been practically demonstrated in Japan, Scandinavian countries, Australia and some states of the US. In conclusion, most jurisdictions in which a legal limit has been introduced or lowered, shows that it results in lower levels of drinking and driving and hence safer roads. This finding counters previous predictions and suggests that introducing and lowering BAC limits has a generalized deterrent effect and that it reinforces an anti-drink-driving message.

Previous evaluation studies utilized either qualitative or quantitative analysis and researchers are very concerned about the changes in public perceptions and attitudes towards drinking and driving resulting from an enactment of new policies on drunk driving. These changes comprise the key element in the logical links of the deterrence model and long-term effects of deterrence policies. Researchers usually have performed qualitative analysis with a survey method to assess the changes in public perception and attitudes. While it is an indirect and strong way of measuring the effectiveness of a new policy, qualitative analysis further permits examination of the appropriateness of assumptions underlying the deterrence model. In addition, qualitative analysis also has been considered appropriate to assess the long-term effects of deterrence policies. Andeans has suggested that the law can function both as a cause and effect of moral values. The passage of a “tough” drunk driving law may indicate that moral commitment to control is already widespread in the community.

Andeans, and Snortum and Berger suggest that the law also serves an education and moralizing function “that fosters a change in moral outlook and promotes habitual law-abiding behaviour”. A reduction in road fatalities attributable to attitude changes would be long-term and might not follow new legislation immediately. To explore this possibility, Snortum and Berger surveyed drivers in the United States in 1983 and 1986 with a range of attitudinal, knowledge and behavioural self report
questions. They found increasing restraint and control by drivers over the three-year period, as well as a reduction in alcohol-related road fatalities over the period. They concluded that even if tightening up drinking and driving legislation over this time did not cause these changes, it at least acted as a catalyst. Loxley et al. found that evidence of restraint and control on the part of drinkers who were driving suggests that drinking and driving legislation has served similar education and moralizing functions in Australia as in the US, because their data suggest that many Australian drivers (legal blood alcohol level is 0.05%) attempt to comply with drinking and driving legislation. In a comparative study by Snortum et al. in 1986, 88% of a Norwegian sample (legal blood alcohol level is 0.05%) and 55% of an American sample (legal blood alcohol level is 0.10%) said they should not be drunk and drive. A 1994 survey in Finland (legal blood alcohol level is 0.05%) further showed that 89% of respondents were of the opinion that they must always be sober when driving.

Borschos in 2000 noted that after introduction of a reduced BAC limit in Sweden in 1994, different public opinion polls have shown that the Swedish population is in favour of: (1) restrictive drunken driving legislation and (2) drunken driving is regarded as a serious crime. In addition, survey in Australia demonstrated a significant long term change in attitudes and reported behaviour amongst drivers; a shift towards “general prevention” of drunk driving, in which drink driving is considered the wrong thing to do; and substantial public opposition to any degree of drunk driving. The success of most nations’ national campaigns may be related to changing social norms and attitudes towards drinking and driving.

<table>
<thead>
<tr>
<th>Country</th>
<th>BAC Limit</th>
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<tbody>
<tr>
<td>United States</td>
<td>0.10%</td>
</tr>
<tr>
<td>France</td>
<td>0.05%</td>
</tr>
<tr>
<td>Canada</td>
<td>0.08% (0.05% in provinces)</td>
</tr>
<tr>
<td>Spain</td>
<td>0.08%</td>
</tr>
<tr>
<td>Japan</td>
<td>0.05%</td>
</tr>
</tbody>
</table>

As can be seen in Table 2, all of the countries studied had a BAC level lower than that established in most of the United States (0.10%). Both experimental and epi-
demiological evidence suggests that a BAC limit of 0.10% is too high. A variety of behaviours and cognitive functions begin to show evidence of impairment at BACs as low as 0.04%. In addition to this experimental evidence, the best epidemiological information currently available on BAC and the risk of a driver crashing shows a clear increase in the slope of the risk curve at BACs of about 0.08%. Hence there is a clear and substantial scientific basis for setting the *per se* BAC limit at 0.08% (or lower). The lowest illegal BAC level is in Sweden (0.02%). The majority of countries have established 0.05% as the illegal BAC, with the remaining countries maintaining an illegal level of 0.08% and 0.10%. The trend has been downward in recent years, with nine European countries having reduced the illegal BAC level within the past five years or with new lower limits about to be implemented. These recent reductions in illegal BAC levels have resulted in some pre-post evaluations of the effects of the change. Belgium lowered its limit to 0.05% in December of 1994, reporting a 14% reduction in fatalities in the following year. The legal limit in France, the country with the highest per capita alcohol consumption in the world, the reduction in the legal limit to 0.05% in December of 1995 resulted in a fall of 4% in the number of fatalities. Perhaps the strongest evidence for this effect comes from a study by Voas and Tippetts who analysed the effects of the 0.08% laws using data from all 50 states in the USA, where BAC limit is highest in the world, over a 16 year period. The results suggest that these laws were associated with 8% reductions in the involvement of both high BAC and lower BAC drivers in fatal crashes. But passage of new 0.08% laws has been slow, despite consistent evidence that these laws are effective. Research by NHTSA, the Boston University, School of Public Health, and the California Department of Motor Vehicles have shown impaired driving reduction clearly attributed to reduced *per se* BAC limit as well as the potential for saving additional lives when all states adopt lower BAC laws. Currently, 19 states plus the District of Columbia and Puerto Rico have enacted such laws. Usually, states have enacted these laws over strong opposition from the hospitality industry that believes the legislation will significantly reduce alcohol sales and not significantly affect the number of alcohol-related fatalities.

<table>
<thead>
<tr>
<th>Legal Blood Alcohol Concentration Limits</th>
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<tbody>
<tr>
<td>Czech Republic, Slovak Republic, Hungary, Saudi Arabia, Turkey, Bulgaria</td>
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<tr>
<td>Poland, Sweden, Russia</td>
</tr>
<tr>
<td>Finland, Belgium, Greece, Holland, Norway, France, Denmark, Portugal, Australia, Yugoslavia, Japan, Great Britain, Austria</td>
</tr>
<tr>
<td>South Africa, Ireland, Canada, Germany, Luxemburg, New Zealand, Spain, Sri Lanka, Switzerland</td>
</tr>
<tr>
<td>USA – all states except the following have 1.0 BAC law: Alabama, California, Florida, Georgia, Hawaii, Illinois, Kansas, Maine, Massachusetts, N. Hampshire, N. Mexico, N. Carolina, Oregon, Utah, Vermont, Virginia, Indiana, Georgia, Arizona, Nebraska, Maryland, Arkansas, Puerto Rico, Kentucky, Rhode Island, Washington and District of Columbia</td>
</tr>
<tr>
<td>Channel Island, Cyprus, Malta</td>
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</tbody>
</table>

Source: Desapriya and Iwase, 1996. Supplementary information is added.

One in 10 road deaths are alcohol-related in the United Kingdom, where the BAC limit is 0.05%. In the Netherlands, the legal limit is 0.05% and 1 in 12 deaths are alcohol related. In Japan the legal limit is 0.05% and 1 in 20 traffic deaths are alcohol-related. In 1995, France lowered legal BAC limit from 0.8% to 0.5%. In most of the United States the legal limit is 0.10% (see Table 2 – re. exception i.e., where 0.08% legal limit is applicable), 41% of road crash fatalities are classed as alcohol-related. One in 6 road deaths are alcohol-related in France, (according to the assessment during 1988-1993 period) where the BAC limit is 0.08%. (In 1995, France lowered legal BAC limit from 0.8% to 0.5%).
Much of the progress that has been made in impaired driving in the last decade or more has been facilitated by lessons learned from different countries. For example, the international community drew valuable lessons regarding deterrence from analysing the results of the British Road Safety Act of 1967. Similarly, the international community has learned about alcohol policy and serious enforcement and penalties from Japan and Scandinavian countries. The Australian experience with random breath testing has influenced international enforcement efforts. These lessons show us that a strong legal foundation severity, certainty and celerity are necessary for a permanent social change in drinking driving habits. Otherwise, any reduction in accident rates brought about by the per se laws will most likely be transitory.

The trend toward lower legal limits reflects the international scientific consensus that there is no safe limit for alcohol consumption in relation to driving skills, and therefore a blood alcohol concentration of 0.05% is the maximum compatible with public safety. This means that, in most of the countries the prescribed legal alcohol limit for drivers is higher than what the scientific evidence suggests. Because of the complexities involved, it is difficult to compare one country with another to discover the effects of higher or lower legal limits. It is noted that epidemiological and scientific research findings might be taken into consideration when enacting legal BAC limit laws to achieve maximum benefit and objectives of the per se laws. It has shown that alcohol-related traffic safety has been an important factor to be achieved by utilizing and taking into consideration scientific results that show “human impairment” could be affected by a small dose of alcohol intake. This perspective has not been taken into consideration by most of the countries under investigation.

Only a few countries have fully incorporated scientific evidence into their legal BAC limit legislation and these countries have experienced lower alcohol-related traffic problems compared to other countries. It shows that the amount of drunken driving and related problems vary, for example, from a low level in certain countries to high levels in other countries. A lower level of alcohol-related traffic problems has been observed in countries where lower legal limits are in effect. In contrast, it is interesting to show that a higher level of problems have existed in countries where a higher legal limit is in effect. It should not be forgotten that enforcement of laws must also have played an important role in the achievement of lower legal limit legislation in the countries under consideration. The variation is correlated with the variables such as a lower legal limit combined with other promising alcohol policy related strategies and extensive enforcement.

References:


54. Desapriya, E. B. R. Lowering the Legal BAC limit should be encouraged in the USA as international evidence shows it saves lives and resources. A paper presented at the International Conference on Alcohol Drugs and Traffic Safety – Annecy France. (1997).


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