Accident risk factors of young drivers

and targeted countermeasures

By:

George Yannis, PhD – corresponding author
Assistant Professor,
Department of Transportation Planning and Engineering,
National Technical University of Athens,
5, Iroon Polytechniou str, 15773 Zografou, Greece,
tel.: +30 210 7721326, fax: +30 210 7721454,
e-mail: geyannis@central.ntua.gr

John Golias, Prof.
Professor,
Department of Transportation Planning and Engineering,
National Technical University of Athens,
5, Iroon Polytechniou str, 15773 Zografou, Greece,
tel.: +30 210 7721276, fax: +30 210 7721454,
e-mail: igolias@central.ntua.gr

Ioanna Spyropoulou, PhD
Research Associate,
Department of Transportation Planning and Engineering,
National Technical University of Athens,
5, Iroon Polytechniou str, 15773 Zografou, Greece,
tel.: +30 210 7722889, fax: +30 210 7721454,
e-mail: iospyrop@central.ntua.gr

Eleonora Papadimitriou, MSc
Research Assistant
Department of Transportation Planning and Engineering,
National Technical University of Athens,
5, Iroon Polytechniou str, 15773 Zografou, Greece,
tel.: +30 210 7721380, fax: +30 210 7721454,
e-mail: nopapadi@central.ntua.gr

Abstract: This paper reports on an investigation of the accident risk factors of young drivers in Greece, who are considered to be a vulnerable road user group. Risk rates of young drivers are calculated per various driver, vehicle and road environment characteristics. The estimated risk rates allow for the identification of specific risk factors for young drivers. Results demonstrate that male drivers, inexperienced drivers and motorcyclists are more prone to accidents. Furthermore, accident risk is higher when driving at night. A number of targeted road safety measures are suggested based on the above results, as well as on a qualitative cost-benefit analysis.

Key-words: road safety, road accidents, vulnerable road users, young drivers, road safety measures

1. Introduction

Increase of mobility may have enhanced our everyday life, but has also been followed by a number of adverse effects the most important of which is the increase of accident rates. Research studies on accident rates have identified specific road user groups that exhibit high risk rates, and are considered to be vulnerable user groups. Young drivers comprise a vulnerable user group (OECD, 2005). Furthermore, road accidents comprise the primary cause of death for young people in western countries.

The actual causes for the increased risk rates of young drivers arise both from the immaturity of their youth and inexperience errors. For drivers that are both

novice and young, the effects of inexperience greatly exceed those of age for the first few years of driving (McKnight and McKnight 2003). Young drivers also tend to violate traffic rules more frequently than other drivers (Reason et al 1991, Aberg and Rimmo 1998), which is related to the 'sensation seeking' behaviour of this specific driver group (Jonah 1997). This behaviour is encountered in experienced young drivers rather than inexperienced ones (Rimmo and Aberg, 1999). Furthermore, young and novice drivers (Pelz and Schumann 1971) are prone to make driver decision errors. Novice drivers that are involved in complex traffic situations are the least probable to judge the situation appropriately and respond in the required manner because of their limited perception of the situation (Fuller 1988, McGwin and Brow 1999). Another attribute that leads in decision errors for novice drivers is the overrating of their driving abilities (Edwards 2001), which usually decreases with their involvement into an accident (Bliersbach and Dellen 1980). All the above primary factors lead in high risk rates of young drivers under specific situations.

The aim of this research is to identify the risk factors of young drivers as these can be identified from the analysis of risk rates and to propose suitable countermeasures. The second section of the paper describes specific aspects of the methodology used and is mainly focused at the presentation of the nationwide driver mobility study from which exposure data was calculated. The third section of the paper investigates the relation between driver age and driver experience. The risk factors of young drivers are presented in the fourth section. Next, road safety measures targeting at the reduction of the risk factors of young drivers that

have been applied are discussed, and the ones that are suit Greek driver needs are suggested for implementation.

2. Methodology

As noted in the previous section risk factors were identified from the analysis of the accident risk rates of young drivers, in relation to these of older drivers. The measure of accident risk used in this study was expressed as the number of drivers killed per vehicle-kilometres in 2004.

The road safety data (i.e. number of drivers killed) was extracted from the National road accident database of Greece. However, no available data on Greek drivers risk exposure expressed in vehicle-kilometres was available. In general, qualitative methods for studying travel behaviour include interviews, focus groups studies and participant observer techniques. To determine the exposure of Greek drivers, a nationwide Computer Assisted Telephone Interviewing (CATI) survey was carried out. A Simple Random Sampling (SRS) technique was used to collect the necessary information, and the only quota applied in the sampling process concerned the national coverage of all area types, including large metropolitan areas, urban areas and rural areas. Participants were randomly picked out from the national telephone register of Greece, within the defined quota (one participant per household was interviewed).

The survey target population was active drivers of passenger cars and two-wheelers (mopeds and motorcycles) aged above 16 years (18 years for passenger

car drivers). Active drivers were defined as those who are driving licence holders, have been active drivers in the past six months and have driven their vehicle on the previous day of the interview.

Respondents were initially asked on their personal characteristics (age, gender, nationality, driving experience etc.) and the characteristics of their vehicle (vehicle type, vehicle age, cubic capacity etc.). Then, they were asked to report the distance travelled by this vehicle on the previous day of the interview, and its breakdown in different road environments (road type, area type, daylight or night etc.). This information allowed for the calculation of the total vehicle-kilometres travelled in Greece in 2004 (using the total number of registered drivers in Greece), classified according to several variables, as described above.

The CATI survey was conducted in Greece during the period May-June 2004, which can be representative of the yearly patterns as all kinds of trips (work-related, recreational, long distance etc) could be observed. Furthermore, this period presents only marginally better weather conditions (slightly higher average temperature and slightly lower rainfall levels) compared to the average yearly weather conditions and therefore no significant difference in the estimated mobility is expected.

3. Driver age versus driver experience

When investigating the risk of young drivers two distinct classifications can be taken into account. One is driver age and the other is driver experience. These

two distinct categories may correspond to different driver behaviours, but they may also overlap. Figure 1 illustrates the relationship between driver age and experience as calculated from the survey sample.

***** *Please insert Figure1 here* ******

Figure1. Relationship between driver age and driver experience

As expected, driver experience increases with driver age in an almost linear way and the plot of the X-Y pairs indicates correlation between the two parameters. This correlation was further tested using the bivariate Pearson mean product correlation. Despite the contradicting cases that can be observed from the data, driver age and experience are highly correlated (at 95% confidence level) with a correlation coefficient equal to 0,842.

However, there are cases which demonstrate the opposite. In particular, a number of older drivers (>60 years old) who have only a few years of experience is observed. This however does not necessarily denote that these drivers should be classified as novice drivers. The question imposed at the survey participants was "when was your driving licence issued?" rather than "how many years have you been driving?". Greek legislation requires drivers over 65 years old to renew their driving licence by sitting the driving licence exams. Hence, it is presumed that most of the older drivers above 60 years of age with only a few years of driving experience had had their licence renewed and answered the issue date of their renewed licence rather than that of their initial one. This assumption can be

sufficiently confirmed by the fact that most of these drivers reported owning a vehicle for more years than their driving experience.

Moreover, there is still a number of older drivers that are novice, and do not fall within the above described category. These are drivers who obtained their driving licence at a later age than the usual one. Further analysis of the data showed a tendency of female drivers obtaining their driving licence at a greater age than males.

4. Risk rates of young drivers

4.1 General

In this study drivers risk rates are investigated in relation to driver age rather than driver experience. In order to investigate the specific elements of young drivers, certain driver age groups were initially defined. These were drivers aged between: 16-17 years old (including only moped drivers), 18-24 years old, 25-34 years old, 35-54 years old, 55-64 years old and over 64 years old. Young drivers are usually defined as those between 16 and 24 years old, according to the international literature (OECD, 2006). However, this age group is further divided into two groups, as people aged between 16 and 17 years old are only allowed to ride mopeds (and not any other type of vehicle) in Greece. Full driving licence (passenger car or motorcycle) can only be obtained after 18 years of age. Age group 35-54 years old comprises of more-or-less middle-aged and experienced drivers, whereas the last age group (65 year of age and older) comprises of elderly drivers. The other two groups 25-34 and 55-64 years comprise in-

between age groups from young to middle-aged and from middle-aged to elderly drivers. However the first driver group (16-17 years old) was omitted from the analysis because of the small sample and insufficient accident data. Figure 2, illustrates accident rates of drivers in relation to driver age group.

***** Please insert Figure2 here ******

Figure2. Risk rates for the different driver age groups

The data clearly demonstrates that young drivers are a vulnerable road user group as their risk rates are significantly higher in relation to the other examined groups. Moreover, the risk rates of drivers aged 18-20 years old is twice than that of drivers aged 21-24. This can be attributed to the fact that the first driver group includes more drivers who are both young and rather inexperienced. Elderly drivers also comprise a high risk driver group, with their average risk rate being 16.9. Finally, middle-aged drivers comprise the safest driver group with their risk rate being below the average.

The present study focuses on the risk rates of young drivers and for this reason, these should be compared with those of other age groups. Age group 25-34 is an intermediate group between young and middle-aged drivers which also consists of drivers that could be considered as young. Similarly, age group 55-64 is also an intermediate group between middle-aged and elderly and may contain elderly drivers. Hence, it was decided to compare the risk rates of young drivers with those of age group 35-54, which does not contain any young or elderly drivers.

4.2 Driver characteristics

Risk rates of young drivers are first examined in relation to specific driver characteristics such as driver gender and driver experience. Table 1 illustrates risk rates of the different driver age groups in relation to driver gender.

Table 1. Risk rates (drivers killed/10^9veh-kms) per driver age group and driver gender

***** Please insert Table1 here ******

Male drivers are more prone to accidents than female drivers, irrespectively of their age, a finding which is also confirmed by international literature. In addition, the relative difference between male and female drivers decreases with driver age, and is greater for age group 18-20 years old, where male risk rates are 12,8 times greater than the female ones. In the second driver age group (21-24) the respective ratio is equal to 8,0 and in the third age group (35-54) is equal to 4,2. The data indicates that the driver group with the higher risk rates is young males.

Next, risk rates in relation to driver age and driver experience are investigated. For this reason, driver experience was also classified into different groups: less than 1 year, 1-2 years, 3-5 years, 6-10 years and more than 10 years of driving experience. In general, experienced drivers are considered to be those that have over 6 years of driving experience. Hence, novice drivers were divided into three

different groups. Table 2 illustrates the risk rates of the three driver age groups in relation to driver experience.

Table 2. Risk rates (fatalities/10^9veh-kms) per driver age group and driver experience

***** Please insert Table2 here ******

One would expect that risk rates decrease with driver experience. The calculated rates indicates that having one year of driving experience is significant for young drivers in relation to road safety, as risk rates decrease around 20% and 70% for age groups 18-20 and 21-24 years old. For middle-aged drivers, risk rates decrease significantly following 2 years of driving experience, after which risk rates still decrease with increasing experience but in a smoother way.

4.3 Vehicle characteristics

In this section, accident risk rates of young drivers are calculated in relation to vehicle characteristics. First the relation between vehicle type and road safety is examined. In Greece, the vast majority of drivers use mopeds, motorcycles and passenger cars, with their respective percentages being 5.6%, 8.9% and 85.5% (Yannis *et al.*, 2007). Risk rates of drivers of the three driver age groups in relation to these three different vehicle types are presented in Table3.

Table3. Risk rates (drivers killed/10^9veh-kms) per driver age group and driver vehicle type

***** *Please insert Table3 here* ******

Risk rates decrease with driver age with for motorcycle riders and passenger car drivers. A different pattern is observed for moped riders. Risk rates of moped riders decrease with driver age and experience only within the young riders group. In addition, young moped riders (18-20 years) exhibit lower risk rates than middle-aged ones. Furthermore, the group of young moped riders exhibits lower risk rates than young passenger car drivers. This means that young drivers are safer on mopeds than they when driving passenger cars in Greece. Motorcycle riders demonstrate extremely high risk rates in relation to moped riders and passenger car drivers. Hence, the least safe driver group is young and inexperience motorcycle riders.

Next the influence of vehicle engine size on road safety is investigated, and the results are presented in Table 4. For this parameter, the two young driver age groups (18-20 and 21-24 years old) are joined into one – namely, 18-24 years old because in specific categories the sample was proved to be insufficient.

Table4. Risk rates (drivers killed/10^9veh-kms) per driver age group and vehicle engine size (cc)

***** *Please insert Table4 here* ******

No clear pattern can be identified for the risk of young drivers in relation to vehicle engine size. Riders of small (50-115cc) and large (270-730cc) motorcycles seem to exhibit high risk rates. A similar pattern is identified for

middle-aged (35-54) riders. A significant difference is that for middle-aged riders the size of a motorcycle does not seem to affect risk rates greatly, with the exception of motorcycles over 730cc. No clear pattern can be identified between the risk rates of young drivers and the vehicle engine size. Engine size, however, seems to affect more the risk rates of middle-aged drivers than those of young drivers, as risk rates increase with increasing engine size.

4.4 Road environment characteristics

In this section, the influence of the different road networks and areas on road safety is investigated. The types of road networks that were investigated are networks inside and outside of residential areas, and the respective risk rates for the different driver age groups are presented in Table 5.

Table5. Risk rates (fatalities/10^9veh-kms) per driver age group and road type

***** *Please insert Table5 here* ******

No clear pattern of the influence of the different road networks can be established. In particular, for drivers aged 18-20 years it is safer to drive outside residential areas, whereas for drivers aged 21-24 and 35-54 years it is safer to drive inside residential areas. The main difference between residential and non-residential areas is that outside residential areas vehicles drive at higher speeds, and the environment is hence perceived to be less safe. On the other hand, inside residential areas speeds are lower, however the traffic situations are more complex (e.g. more junctions). One possible justification of the above findings is

that drivers aged 18-20 years tend to drive more carefully due to the lack of experience, especially in more complex road environments, and hence exhibit lower risk rates outside than inside residential areas.

Next the risk rates at daytime and night-time are investigated. There are two main differences between these periods. One involves light conditions and the other the type of trips. Daytime driving usually involves work related or shopping trips and whereas night-time driving usually involves leisure and entertainment trips. In addition, night-time driving also involves drink-and-drive which imposes high accident risks. Table6 illustrates risk rates during the different times of day.

Table6. Risk rates (fatalities/10^9veh-kms) per driver age group and time of day

***** Please insert Table6 here ******

Night-time driving is much riskier than daytime-driving for all driver age groups. The relative risk difference between night-time and daytime driving increases with the increase of driver age. Nevertheless, risk rates of young drivers at night are particularly high, emphasising the need for countermeasures to reduce this type of accidents.

Last, risk rates are investigated in relation to the day of the week, i.e. weekday and weekend, and are presented in Table7.

Table7. Risk rates (fatalities/10^9veh-kms) per driver age group and day of week

***** ***** Please insert Table7 here ******

Weekday trips mainly consist of work related trips, whereas weekends mostly include trips of leisure and entertainment. Driving during the weekend is less safe for drivers aged 18-20 and 35-54 years old, it is however safer for drivers aged 21-24 years old. No clear assumption could be extracted from these results.

5. Description of targeted countermeasures

The design of countermeasures aiming at the reduction of the risk rates of young drivers has two dimensions. First, a general overview of the various proposed, applied and evaluated measures worldwide is made. Second, the specific measures that could also apply for Greece based on the estimated risk rates of young drivers are chosen.

5.1 Overview of implemented measures internationally

A category of measures that has been applied in several countries under different variations is the graduated licensing schemes. Under these schemes the full driving licence is obtained after having passed through several part-licence phases. The aim of these schemes is increase driving experience under lower risk conditions, so that the driver develops more complex driving abilities and does not estimate the potential driving risks. Furthermore, the driver is not allowed to obtain a full licence if he commits traffic rule violations. There are several variations of the graduated licensing schemes which mainly involved the applied restrictions at the intermediate licence stages. The restrictions involve the

number of co-passengers (Vollrath *et al.*, 2002), the level of blood alcohol concentration (BAC) (Twisk, 1996), the presence of a supervisor (Land Transport NZ, 2006; Gregersen *et al.*, 2000), night-time driving (Preusser *et al.*, 1984), driving on highways, vehicle engine size. In addition, to graduated licence schemes, schemes suggesting courses specific courses for young drivers have also been implemented. In addition, training of young drivers with the use of a driver simulator has also been proposed as a measure to reduce accident rates of this particular driver group (Bressendorf *et al.*, 1995).

Driver voluntary courses for raising driver awareness of the potential driving hazards and risks or courses on driver behaviour provided at schools have also been implemented. The assessment of this measure indicated an improvement of road safety. Several studies (Dielman *et al.*, 1989; Elikcson *et al.*, 1993; Gregersen, 1996; Perry *et al.*, 1996) have indicated that such courses can improve road safety but only in the long-term. In addition, public campaigns raising the issue of road safety may also contribute to the reduction of road accidents and several such campaigns have been designed, their impact however cannot be assessed.

A measure that is anticipated to improve road safety is setting motives for young drivers to adopt safer driving styles. An example is refunding insurance money if the driver has not been involved in a road accident. The implementation of this measure in Norway by a specific insurance company had a positive impact on road safety (Vaaje, 1991). in addition, provision of alternative transport means which are considered to be safer (e.g. buses) for specific trip types that may

involve high accident rates (Friday and Saturday night trips) may also contribute to the reduction of the accident rates of young drivers.

A rather new category of measures targeting at the reduction of accident rates are intelligent transport systems, and two such systems that have the potential to improve road safety for young drivers are alco-lock (Beck *et al.*, 1999; ICADTS 2001; Bjerre 2005; ETSC, 2005; Mathijssen, 2005) and intelligent speed adaptation (Biding and Lind, 2002; Jamson, 2006).

5.2 Adopted road safety measures for Greek drivers

On the basis of the estimated risk rates, a set of measures was selected considering the following attributes: the international experience (as summarised in the previous section), the characteristics and particularities of the Greek drivers and the specific high-risk factors that were identified in the analysis. Figure 3 shows how each risk factor was associated with a particular measure, resulting in a targeted set of measures.

***** Please insert Figure 3 here ******

5.2.1 Graduated licensing scheme

Driver inexperience is contributing factor on the increased risk rates of young drivers. The calculated risk rates presented in Table2 indicated that a year of driving experience reduces risk rates significantly. Hence, the implementation of graduated licensing schemes in Greece is proposed. In addition, driving at night (Table 6), during the weekend (drivers aged 18-20) (Table 7) and in non-

residential areas (Table 5) imposes high risk rates for young drivers. Hence, the proposed scheme consists of the following elements:

- Administer of a temporary/intermediate one year driving licence

- Prohibit driving at night or during the weekend

- Driver re-examination after one year of obtaining the intermediate driving licence

- Suspension of driving licence if the driver causes a road accident or commits a severe violation of the highway-code

This measure is expected to reduce the mobility of young drivers significantly, and hence its implementation will only be successful if it is combined with the provision of alternative transport means for specific types of trips (night and weekend).

Taking into account the reduction of the number of road accidents (1%-5% during the first year of experience, 36% night-time accidents, 7%-9% due to the graduated licence scheme), as these have been identified by a number of studies, as well as the low implementation cost which mainly consists of the costs for the re-examination and the enforcement costs, the proposed measure is judged to be quite efficient.

5.2.2 Restrictions on vehicle engine size

Risk rates of young drivers increase with increased engine size mainly for two-wheelers but also for passenger cars (although small engine size vehicles also

exhibit high risk rates) (Table 4). This is mainly a consequence of the higher speeds that the drivers obtain when driving such vehicles. Reducing driver speeds can be achieved either directly with the instalment of speed limiting devices such as the intelligent speed adaptation or by applying restrictions on the maximum allowable engine size. The first option would be more effective, but cannot be applied at the moment in Greek. Hence, restrictions on vehicle engine size are proposed for young drivers.

The actual benefit of this measure cannot be estimated, however it is well accepted that reduction in driving speeds results in reduction of accident rates. The costs of the implementation of this measure mainly involve enforcement costs, which are expected to be significantly less than the potential benefits.

5.2.3 Provision of alternative transport means

This measure aims at reducing driving at nights and during the weekends, as the risk rates of young drivers were observed to be rather high during these periods. The provision of alternative transport means should be implemented in combination with the graduated licensing schemes in order to be more effective. Its cost involves the extension of the operation hours of public transport including buses and the metro system. In Athens, the tram and specific bus routes already operate at Friday and Saturday nights. The impact of their operation on road safety has not been evaluated.

5.2.4 Other secondary countermeasures

There is a number of other supplementary measures that can be applied in Greece and could reduce risk rates of young drivers. These include campaigns for raising driver awareness, classes on driving behaviour and road safety at schools and refunding insurance costs if young drivers do not get involved in a road accident.

Campaigns for raising driver awareness on road safety issues have already been used in Greece as measures towards safer driving behaviour. Two main strategies can be identified. The first involves the employment of a popular celebrity (singer, actor, athlete etc.) and it aims at young people and the second the projection of the consequences of an accident. Both types of campaign do manage to be 'noticed' by drivers, their effect however has not been established.

Driving behaviour and road safety classes at schools is a measure that has also been implemented in Greece, for certain periods of time, but not at a nationwide level for a considerable amount of time.

Insurance companies in Greece encompass a scheme according to which insurance costs rise with accident involvement. However, a refund of all insurance costs has not so far and will be impossible to expect to be applied. This measure however, could be subsidised by appropriate public bodies or the government, and under this adaptation its implementation is more probable.

6. Discussion

Young drivers comprise a road user group that exhibits high risk rates due to youth immaturity and driving inexperience, and special attention should be given to the design of targeted road safety measures.

The findings of this study emphasise the significance of driving experience, as one year of driving experienced reduced risk rates dramatically, especially for drivers aged between 21-24 years old. Male drivers tend to be involved into accidents more than female drivers, and this tendency decreases with driver age. Two-wheelers' riders comprise another high risk user group as their risk rates were significantly higher than those of passenger car drivers. Risk rates are somewhat influenced by vehicle engine size, especially for motorcyclists. Driving at night and during the weekend were also identified to be risk driving conditions.

The improvement of road safety by reducing risk rates under these particular circumstances has been discussed, and road safety measures that could be applied to Greek conditions were presented. These measures include the introduction of a graduated licensing scheme with restrictions on night and weekend driving, prohibiting young drivers driving vehicles of high engine size and provision of safer alternative transport means for travelling at night and during the weekends. Other supplementary measures were also proposed including raising public awareness campaigns, organising classes at school to discuss about driving behaviour and road safety and refunding insurance money to young drivers who are not involved in road accidents.

This study attempts to investigate risk factors of Greek young drivers and proposes suitable countermeasures for reducing accident risk of this particular driver group. Estimating the risk of particular driver groups and proposing road safety measures is not sufficient on its own. This should always be followed by the monitoring of their implementation and the assessment of their impact, in order to be able to provide structured and effective solutions towards reducing accident risk.

7. References

Aberg, L. and Rimmo, P-A. (1998) 'Dimensions of aberrant driver behaviour', *Ergonomics,* **41**(1), pp. 39 – 56.

Beck, K. H., Rauch, W. J. and Baker, E. A. (1999) 'Effects of alcohol ignition inter-lock license restrictions on multiple alcohol offenders: A randomized trial in Maryland', *American Journal of Public Health*, **89**(11), pp. 1696 – 1700.

Biding, T. and Lind, G. (2002) Intelligent Speed Adaptation (ISA), Results of large-scale trials in Borlänge, Lidköping, Lund and Umeå during the period 1999 – 2000, Vägverket, Publication 2002:89 E.

Bjerre, B. (2005) 'Primary and secondary prevention of drink driving by the use of alcolock device and program: Swedish experiences', *Accident Analysis and Prevention,* **37**, pp. 1145 – 1152.

Bliersbach, G. and Dellen, R., 1980, Interaction conflicts and interaction patterns in traffic situations, *International Review of Applied Psychology*, **29**, 475 – 489.

Bressensdorf, G. V., Heilig, B., Heinrich, H. C., Kappler, W. D. and Weinand, M. (1995) 'Eignung von Pkw-fahrsimulatoren für fahrausbildung und fahrerlaubnisprüfung', *Mensch und Sicherheit*, M50, Bremerhaven: Wirtschaftsverlag.

Dileman, T. E., Shope, J. T., Leech, S. L. and Butchart, A. T. (1989) 'Differential effectiveness of an elementary school based alcohol misuse prevention program', *Journal of School Health*, **59**, pp. 255-63.

Edwards, M. (2001) 'Standards for novice driver education and licensing', in: Driver Education at the Crossroads, Proceedings from the Committee on Operator Education and Regulation, Report E-C024.

Ellickson, P. L., Bell, R. M. and McGuigan, K. (1993) 'Preventing adolescent drug use: Long-term results of a junior high program', *American Journal of Public Health*, **83**, pp 856-61.

ETSC (2005) In-car enforcement technologies today, ETSC Report (ISBN 9076024200).

Fuller, R., 1988, Psychological aspects of learning to drive. In: *Road user behaviour: Theory and research,* edited by T. Rothengatter and R. de Bruin, (Wolfeboro, NewHampshire: Van Gorcum), pp. 527 – 537.

Gregersen, N. and Bjurulf, P. (1996) 'Young Novice drivers: Towards a Model of Their Accident Involvement', *Accident Analysis and Prevention*, **28**(2), pp. 229-241.

Gregersen, N.P., Berg, H.Y., Engström, I., Nolén, S., Nyberg, A. and Rimmö P.A. (2000) 'Sixteen years age limit for learner drivers in Sweden—an evaluation of safety effects', *Accident Analysis and Prevention*, **32**(1), pp. 25-35.

McGwin, G. J. and Brown, D. B. 1999 Characteristics of crashes among young, middle-aged, and older drivers. *Accident Analysis and Prevention,* **31**, 181 – 198.

ICADTS working group on alcohol interlocks (2001) Alcohol ignition inter-lock devices I: Position paper, ICADTS (ISBN 90-802908-4-x).

Jamson, S. (2006) 'Would those who need ISA, use it? Investigating the relationship between drivers' speed choice and their use of a voluntary ISA system', *Transportation Research,* **9F**, pp. 195 – 206.

Jonah, B. A. (1997) 'Sensation seeking and risking driving: a review and synthesis of literature', *Accident Analysis and Prevention,* **29**(5), pp. 651 – 665.

McKnight, A. J. and McKnight, A. S., 2003, Young novice drivers: careless or clueless? *Accident Analysis and Prevention,* **35**, 921 – 925.

Land Transport NZ (2006) http://www.landtransport.govt.nz/licensing/

Mathijssen, M. P. M. (2005) 'Drink driving policy and road safety in the Netherlands: a retrospective analysis', *Transportation Research*, **41E**, pp. 395 – 408.

OECD (2006) Young drivers – the road to safety, OECD, ECMT Report.

Pelz, D. and Schuman, S., (1971) 'Are Young Drivers Really More Dangerous After Controlling for Exposure and Experience?', *Journal of Safety Research*, **3**, pp. 68 – 79.

Perry, C. L., Williams,C. L., Mortenson, S. V., Toomey, T. L., Komro, K. A., Anstime, P. S., McGovern, P. G., Finnegan, J. R., Forster, J. L., Wagenaar, A. C. and Wolfson, M. (1996) 'Outcomes of a community-wide alcohol use prevention program during early adolescence: Project Northland', *American Journal of Public Health*, **86**(7), pp. 956–65.

Preusser, D. F., Williams, A. F., Zador, P. L. and Blomberg, R. D. (1984) 'The effect of curfew laws on motor vehicle crashes', *Law and Policy*, **6**, pp 115-28.

Rimmo, P-A. and Aberg, L. (1999) 'On the distinction between violations and errors: sensation seeking associations', *Transportation Research,* **2F**, pp. 151 – 166.

Reason, J., Manstead, A., Stradling, S., Parker, D. and Baxter, J., 1991, The social and cognitive determinants of aberrant driving behaviour. TRRL Report CR253.

Twisk, D. A. M. (1995) 'Young driver accidents in Europe, magnitude and nature', *Proceedings of the 1st annual international symposium of the Youth Enhancement Society*, Los Angeles.

Twisk, D. A. M. (1996) 'Bedingungen der Fahrerlaubnis für Fahranfänger/Fahranfängerinnen und ihr Beitrag zur Verkehrssicherheit im Rahmen der psychologischen, sozialen und kulturellen Entwicklung von Jugendlichen', Leidschendam: SWOV Institute for Road Safety Research.

Vaaje, T. (1991) 'Rewarding in insurance: Return of part of premium after a claim-free period', *Proceedings of OECD/ECMT Symposium on enforcement and rewarding: Strategies and effects*, Copenhagen DK.

Vollrath, M., Meilinger, T. and Kruger, H. P. (2002) 'How the presence of passengers influences the risk of a collision with another vehicle', *Accident Analysis and Prevention*, **34**(5), pp. 649-54.

Yannis, G., Golias, J., Spyropoulou, I. and Papadimitriou, E. (2006) 'Mobility patterns of motorcycle and moped riders in Greece', *Proceedings of the 86th Transportation Research Board Annual Meeting*¸ Washington D.C.

Table 1. Risk rates (drivers killed/10^9veh-kms) per driver age group and driver gender

	18-20	21-24	35-54
Male	85,3	44,2	9,6
Female	6,6	5,6	2,3
Average	65,0	32,8	7,8

Table 2. Risk rates (fatalities/10^9veh-kms) per driver age group and driver experience

	18-20	21-24	35-54
< 1	25,5	46,1	26,8
1-2	20,4	13,7	34,5
3-5		14,8	6,7
6-10		0,0	6,4
>10			4,6
Average	63,4	31,2	7,8

Table3. Risk rates (drivers killed/10^9veh-kms) per driver age group and driver vehicle type

	16-17	18-20	21-24	35-54
Moped	54,7	31,0	20,8	44,4
Motorcycle		313,0	162,7	47,6
Passenger car		41,5	20,7	5,8
Average		65,0	32,7	7,8

Table4. Risk rates (drivers killed/10^9veh-kms) per driver age group and vehicle engine size (cc)

	18-24	35-54
Two-wheers		
<49	26,6	45,1
50-115	184,2	55,7
116-269	92,7	44,5
270-730	670,8	41,4
>730		197,7
Average	103,3	56,3
Passenger cars		
<1100	24,3	17,8
1101-1300	13,0	4,9
1301-1600	31,8	5,8
>1600	22,0	3,7
Average	24,7	5,8

Table5. Risk rates (fatalities/10^9veh-kms) per driver age group and road type

	18-20	21-24	35-54
Residential area	76,6	28,3	6,2
Non-residential area	50,4	38,5	9,3
Average	65,0	32,8	7,8

Table6. Risk rates (fatalities/10^9veh-kms) per driver age group and time of day

	18-20	21-24	35-54
Day	40,4	15,3	4,5
Night	108,0	93,0	27,9
Average	65,0	32,8	7,8

Table7. Risk rates (fatalities/10^9veh-kms) per driver age group and day of week

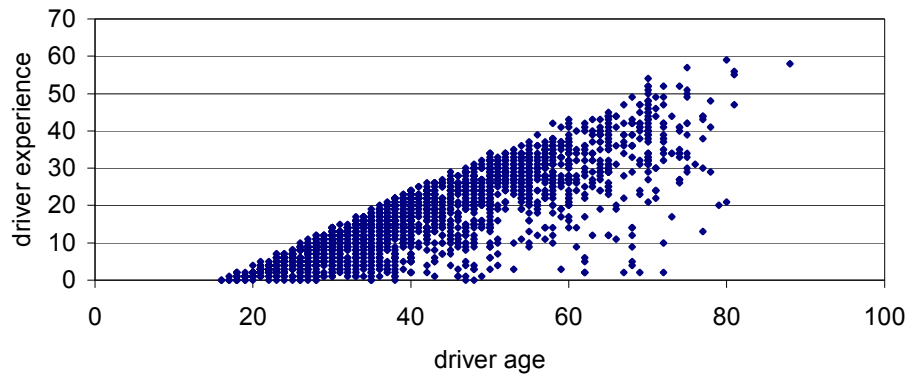|	18-20	21-24	35-54
Weekday	59,4	34,5	6,9
Weekend	73,6	28,6	10,3
Average	65,0	32,8	7,8

Figure1. Relationship between driver age and driver experience

Figure2. Risk rates for the different driver age groups

Risk factors	Proposed measures

Risk factors

- Young drivers
- Inexperienced drivers
- Male drivers
- Night
- Weekend
- Non-resiential area
- High vehicle engine size

Proposed measures

Graduated licensing scheme
(intermediate one year driving licence)
- Prohibit driving at night
- Prohibit driving during the weekend
- Prohibit driving in non-residential areas

Provision of alternative transport means at night

Restrictions on vehicle engine size

Road safety classes at schools

Campaigns for raising driver awareness
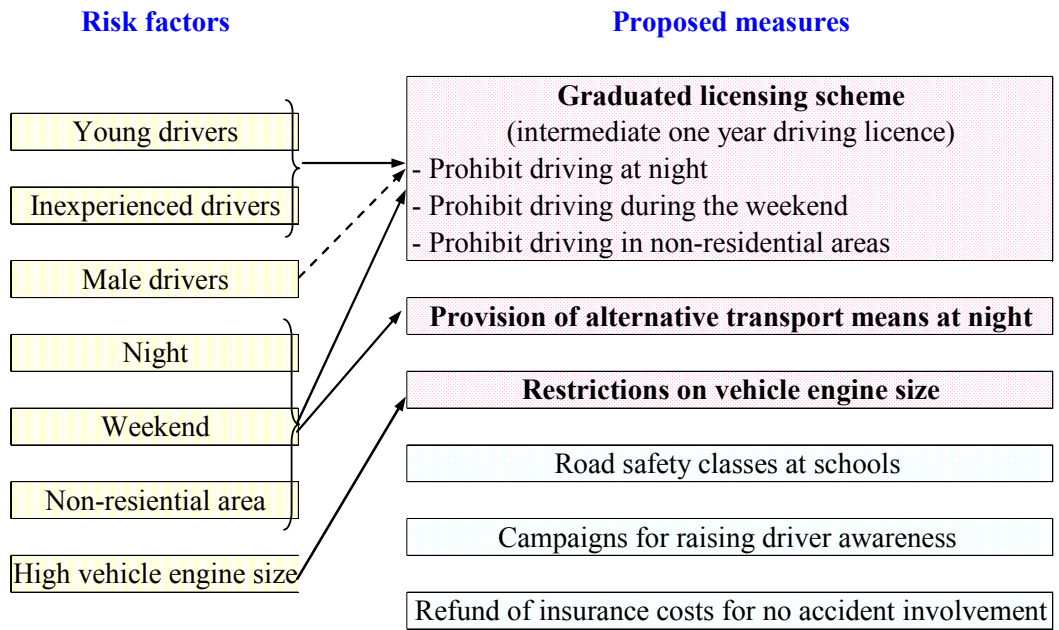
Refund of insurance costs for no accident involvement

Figure3. Risk factors of young drivers and targeted measures