How far from Zero?

Benchmarking of road safety performance in the Nordic countries



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The European Transport Safety Council

The European Transport Safety Council (ETSC) is an international non-governmental organisation which was formed in 1993 in response to the persistent and unacceptably high European road casualty toll and public concern about individual transport tragedies. ETSC provides an impartial source of advice on transport safety matters to the European institutions and to national governments and organisations concerned with safety throughout Europe.

ETSC brings together experts of international reputation and representatives of a wide range of national and international organisations with transport safety interests to exchange experience and knowledge and to identify and promote research-based contributions to transport safety.

Executive summary

This report provides an overview of five Nordic countries' (Denmark, Finland, Iceland, Norway and Sweden) performance in various areas of road safety. It builds upon the indicators developed within the PIN Programme, but introduces also some new indicators. Two types of benchmark are used: one is the average performance of Nordic countries, and the other is the average EU-27 countries' performance. The aim of the report is to identify strengths and weaknesses in road safety performance in particular Nordic countries and suggest target areas of policy interventions in the near future.

In terms of road safety, the Nordic countries are among the safest countries not only in Europe, but also in the world. But the gap between Nordic countries and the rest of Europe is shrinking, as the improvements have slowed down in the last decade. But it can be partly due to the fact that it is difficult to maintain the same pace of reduction in countries with good safety records, which have already exploited most of the potential of highly effective road safety measures. For all countries, speeding and driving while under the influence of alcohol remain key areas of policy intervention. Powered two-wheeler safety emerges as another area for attention. The safety of elderly road users will also need to be further addressed in the future.

Sweden is the best performing Nordic country, but its rate of improvement is the lowest among the large Nordic countries. On the other hand, Denmark has been improving its national road safety record fastest. Thus the gap between the safest Nordic country and the least safe has been shrinking.

The overview benchmarks the performance of all Nordic country in the particular areas of road safety considered in this report and provides aggregate performance ratings. This is intended to help in identifying areas for future policy intervention. Recommendations summarise these findings in the form of advice on the areas which could well be the subject of future policies.

Introduction

Nordic countries (Denmark, Finland, Iceland, Norway and Sweden) have come a long way in improving road safety and they have nowadays among the safest road traffic systems in the world. Sweden has indeed been depicted as the world road safety champion several times and gave birth to Vision Zero, the concept of a road system without serious health losses. But there is no place for complacency, as still 1,400 people are killed and around 16,000 people are seriously injured each year on roads in Nordic countries. Therefore continuing efforts towards road safety improvements are needed.

The current approaches towards road safety improvement have been inspired by numerous management theories and take an engineering and behavioural view of the road safety system. They arise from the belief expressed by Robert Kaplan as "One can't manage what one can't measure" in a reformulation of an earlier statement by Lord Kelvin, which can be simplified as "If you cannot measure it, you cannot improve it". The values of various indicators have therefore been used to benchmark different properties of the road safety system and its performance.

In the methodology developed for the European Road Safety Observatory, these various indicators relate to different levels of the so-called road safety pyramid, a hierarchical representation of relationships between causes and outcomes. Thus by benchmarking on lower levels of the pyramid, one can shed light on performance on the top of the pyramid. The road safety pyramid was introduced in the consultation document on the Road Safety Strategy 2010 of New Zealand[1] and later adjusted by Koornstra and Hakkert, who were highlighting the role of so called Road Safety Performance Indicators[2].

Applying the managerial approach to road safety requires setting up a comprehensive evaluation framework, in which not only outcomes and the main leading causation factors are assessed, but which also covers other relevant issues. As an example of such a framework, the example of so-called process and performance benchmarking could be considered (Fig.1). This representation offers a broader perspective and allows for the inclusion of road safety problems among other relevant societal problems. That way, policymakers get a useful tool for prioritising their actions. At present, the major obstacle to broader employment of the benchmarking approach in road safety at the cross-national level is the limited availability of appropriate indicators characterising organisational and strategic features of the road safety management process.

Indicators in the area of accident outcomes have been traditionally used by road safety specialists. These can be either direct indicators such as number of casualties, risk indicators such as the road death rate, or indirect indicators of social costs. Later, intermediate outcomes as the estimated results of measures and actions applied under defined programmes of actions were added. They provide a link between policy actions and outcomes and allow the evaluation of the effectiveness of policies (impact evaluation).

[1] LTSA (2000).

[2] Koornstra et al.(2005) and Hakkert et al. (2007).

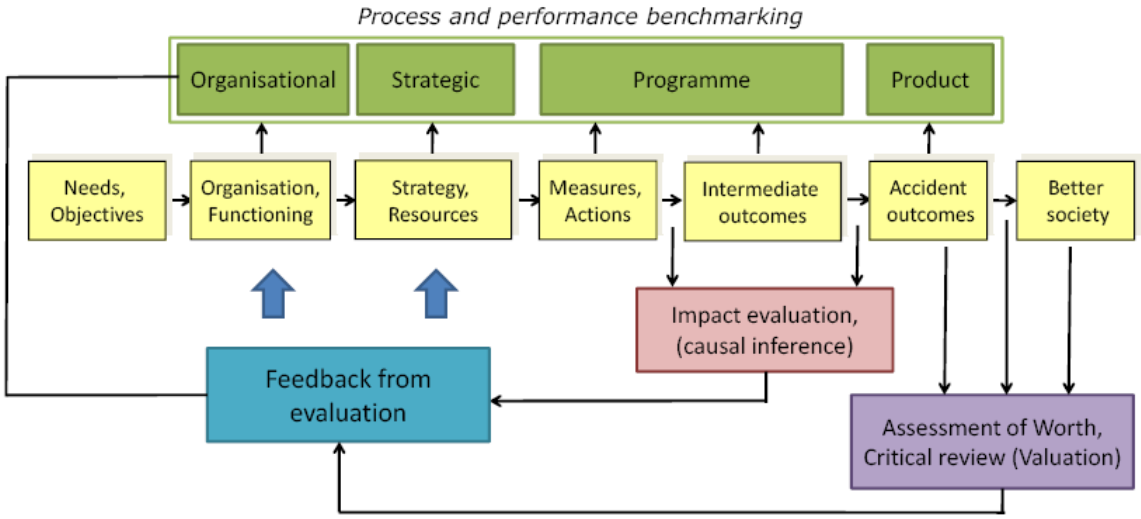


Fig.1: Process and performance benchmarking applied to road safety management[3].

Indicators developed under the ETSC's PIN Programme relate to both kinds of benchmarking and aim to provide new insights into the extent of various road safety problems. By analysing and understanding them, influence on outcomes is sought. And here lies the added value of benchmarking applied in the PIN Programme and in this report.

[3] Eksler (2009).

1 Road Safety outcomes

1,400 people died on roads in the five Nordic countries in 2008 while a further 16,000 were seriously injured in vehicle collisions the same year. On the basis of the average monetary valuation of prevention of these injuries used in Norway, namely 3million EUR per road death and 0.9million EUR per serious injury[4], the monetary valuation of prevention of the road deaths and serious injuries that occurred in Nordic countries in single year 2008 could be as high as 18.6 billion EUR. This is one indicator of the social costs that top the road safety pyramid.

Road injuries are indeed often a forgotten part of road safety picture. With more than 11 seriously injured per one killed road user and the above valuations, they represent 75% of the estimated value of preventing killed and seriously injured road casualties in the Nordic countries. In Europe as a whole, only 7 seriously injured road victims were recorded per one death last year. This may be partly because consequences of injuries are mitigated to a greater extent in Nordic countries, thanks to the higher level of vehicle and infrastructure passive safety so that fewer injuries are fatal. At the same time, the level of reporting of serious injuries may be higher in the Nordic countries than on average across Europe. Last but not least, great differences exist in the type of serious injury and the consequences they bring.

1.1 Road deaths

On average four people die on Nordic roads each day, while some 44 others are seriously injured in road traffic. During the past decade, 15,900 people were killed on roads, the population of an average Nordic town. The road toll thus remains considerable in the Nordic countries, despite a continuous decrease[5].

The number of road deaths fell by 21% over the past ten years. Iceland achieved the highest reduction of 43% followed by Sweden and Denmark (22%), Norway (20%) and Finland (19%). With the exception of Iceland, the reduction in road deaths was significantly lower in Nordic countries than in the EU, which saw a 34% drop in road deaths over the past decade (Fig.2).

Only in Denmark has the pace of reduction in the number of road deaths since 1998 in Nordic countries, as estimated from the numbers in each of the intervening years, matched the EU average of 3.6%. On average, as shown in Fig.3, road deaths have been reduced by 3.7% yearly in Denmark, by 3.1% in Norway, by 1.8% in Finland, by 1.3% in Sweden and hardly reduced in Iceland (notwithstanding its position in Fig.2). A relatively poor performance of Nordic countries compared to the EU as a whole is confirmed here.

[4] Statens vegvesen (2006).
Note that the values attributed could be lower in other Nordic countries (e.g. in Sweden 2.2/0.4mio EUR per fatal/serious injury).

[5] Absolute level of road safety is addressed in Chapter 2.

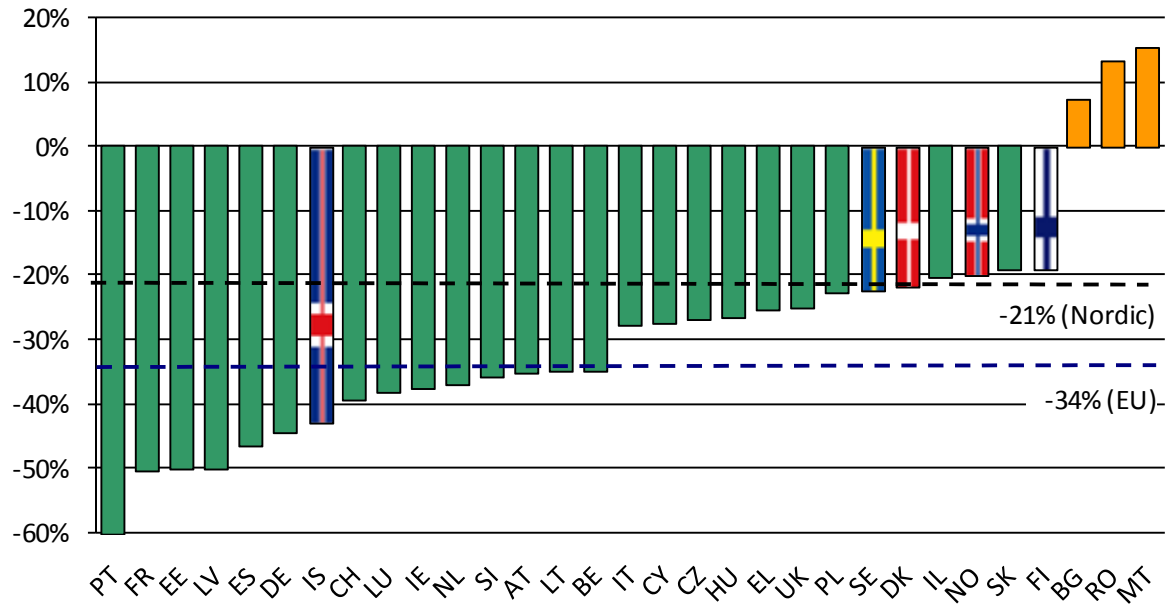


Fig.2: Percentage change in road deaths between 1998[6] and 2008.

Iceland and Denmark are the countries whose positions in Fig.3 differ considerably from those in Fig.2. Iceland is among the worst performing countries in Fig.3, because the exceptionally low numbers of road deaths that gave it its good position in Fig.2 were achieved only in the last two years. Similarly, Denmark's better position in this second ranking results from its relatively good performance in the period 2003-2006.

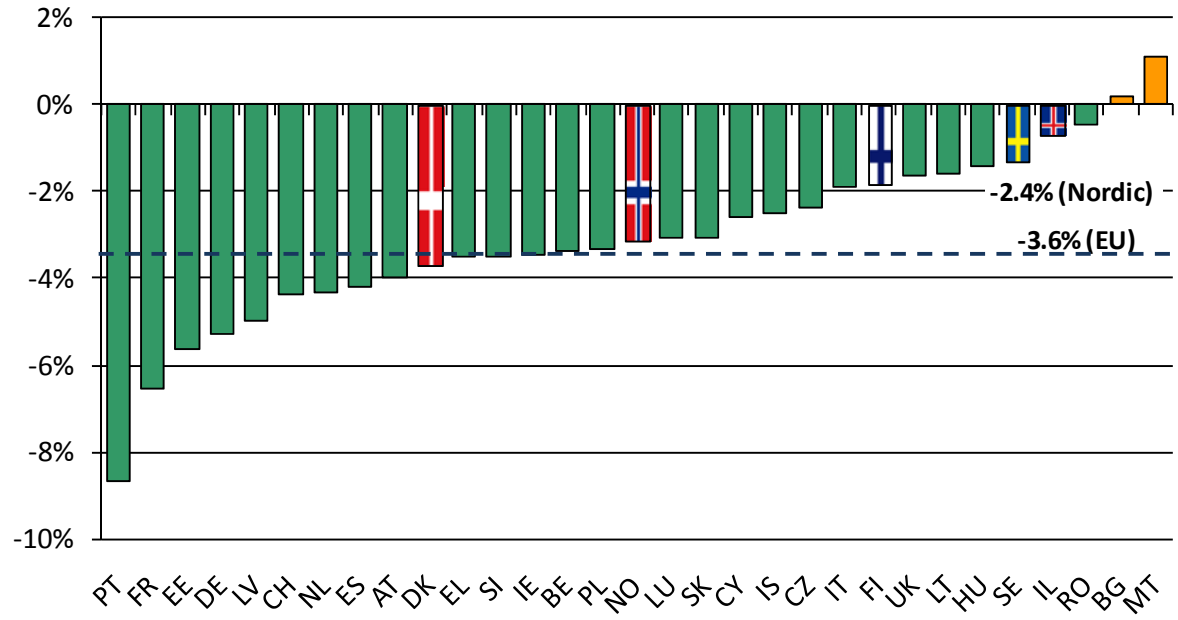


Fig.3: Estimated average annual percentage change in road deaths over the period 1998-2008[5].

[6] Baseline 1997-1999 applied.

At the current pace of an average annual reduction of 2.4%, the Nordic countries would reduce deaths by 99% only after 2200. Even the best performing Nordic country in the past decade, Denmark with a 3.7% annual average reduction in road deaths would not reduce the number of deaths by 99% earlier than 120 years from now. To reach such a reduction by 2050, a year to year reduction of more than 10% would be needed (Fig.4). There is thus still a long way to go.

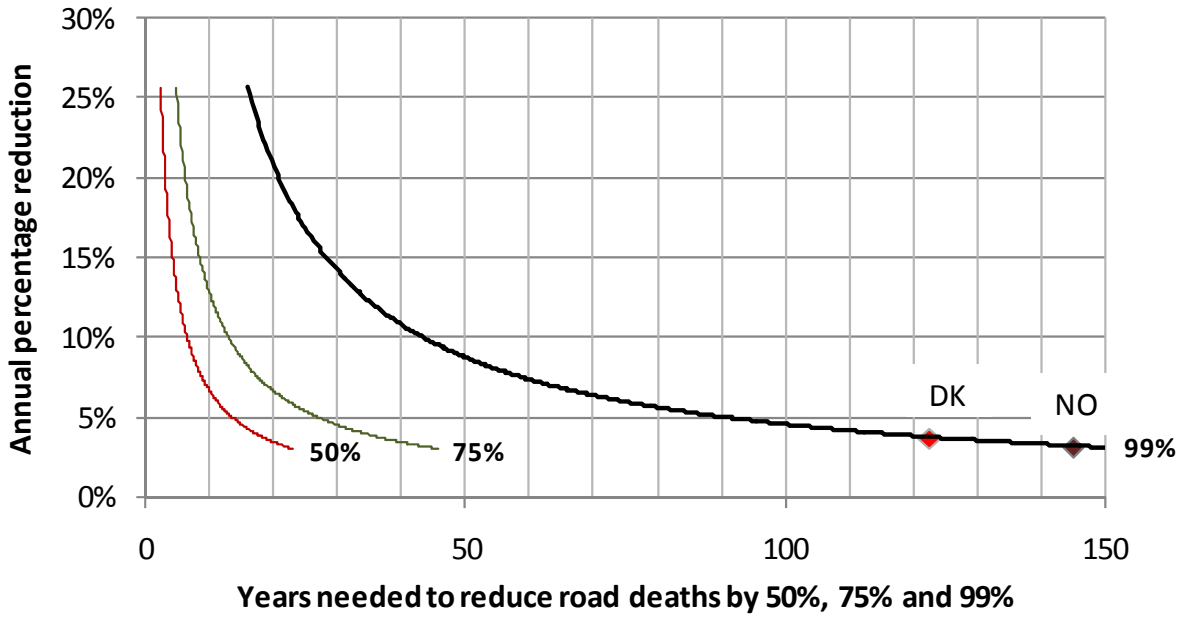


Fig.4: Annual percentage reduction and corresponding time length necessary to reduce road deaths by 50%, 75% 99%.

However, the Vision Zero is not a numerical target and its ultimate goal should be its pursuit with great effort. Vision Zero – that is basically the idea of thinking in terms of reducing the number of road deaths and serious injuries to something that is tiny or zero – is an approach replicated in many parts of the world and which has paved the way to substantial improvements so far (e.g. 21% fewer deaths in Sweden in 2008 than in 1998).

1.2 Serious injuries

Road deaths are only the tip of the iceberg of the burden of road crashes. Injured road users represent an increasing concern of public authorities, given the burden they impose on national health systems. Long-lasting injuries often leading to disability are a great problem. While the number of fatal injuries has been monitored with a high accuracy for decades, questions of definition and the level of underreporting and thus inaccuracy remain important issues for other types of injury. Given the differences in definitions and various reporting practices, it is barely possible to compare the situation in different countries. A limited comparison is possible for serious injuries.

Around 16,000 persons were seriously injured in road crashes in Nordic countries in the single year of 2008. Furthermore, while road deaths have been reduced by an annual average rate of 2.4%, the pace of reduction for serious injuries during the same period (1998-2008) has been lower at 1.3% only. A small part of this difference could stem from

more and more fatal injuries being transformed into serious ones, but this may well be more than offset by serious injuries being transformed into slight ones.

But attention should be paid in the interpretation of these numbers to the fact that reporting practices are changing over time. For example in Finland, official figures from Statistics Finland do not separate slight and severe injuries; furthermore an improved method for data collection on road injuries was adopted in 2003, and this led to a slight increase in the number of injuries recorded thereafter. The Swedish reporting system has also undergone changes in 2003, possibly having similar consequences. For the definition of injuries, please refer to Annex B.

Serious injuries have been falling steadily in all the Nordic countries since 1998. The pace of the reduction was most pronounced in Iceland, followed by Norway and Denmark, while the number was hardly changing in Finland and Sweden (Fig.5).

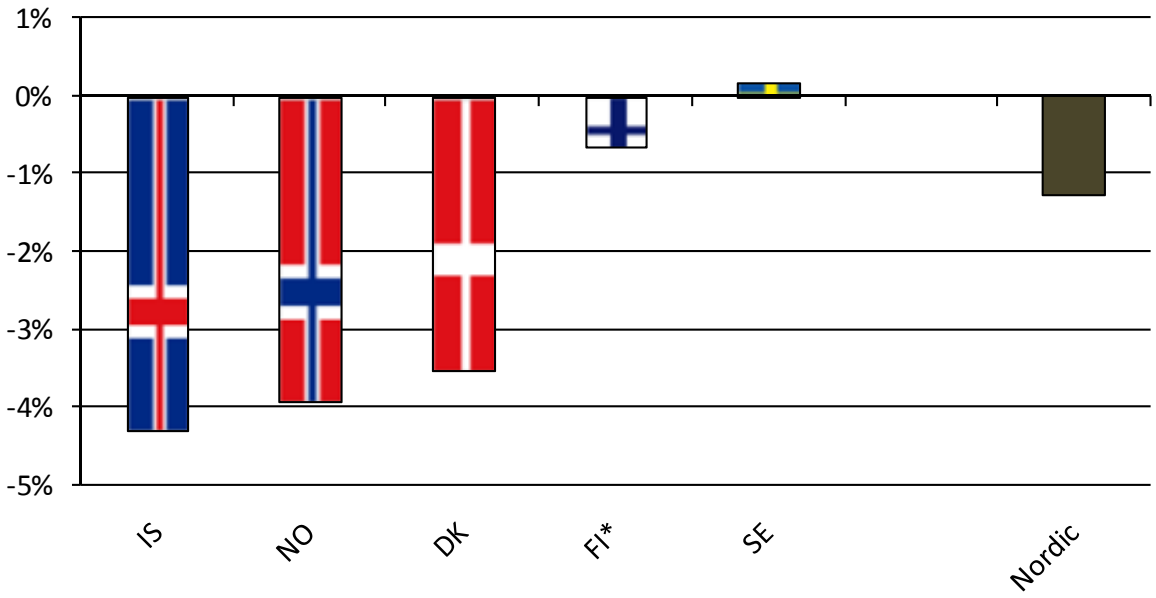


Fig.5: Estimated average annual percentage change in serious injuries (1998-2008)[7].

All Nordic countries have been less successful in reducing serious and fatal injuries than EU member states as visible in Fig.6 showing the estimated average year-to-year reduction in road deaths in the past decade plotted against the estimated average year-to-year reduction in serious injuries.

There is clearly a strong correlation between the two indicators, with Iceland standing apart. While for Sweden one might have expected a reduction in serious injuries, the one recorded in Norway perhaps exceeds expectations. The clearly outlying position of Iceland may be due to low numbers of deaths and injuries being subject to substantial random fluctuation.

[7] For Finland, severe and slight injuries were considered.

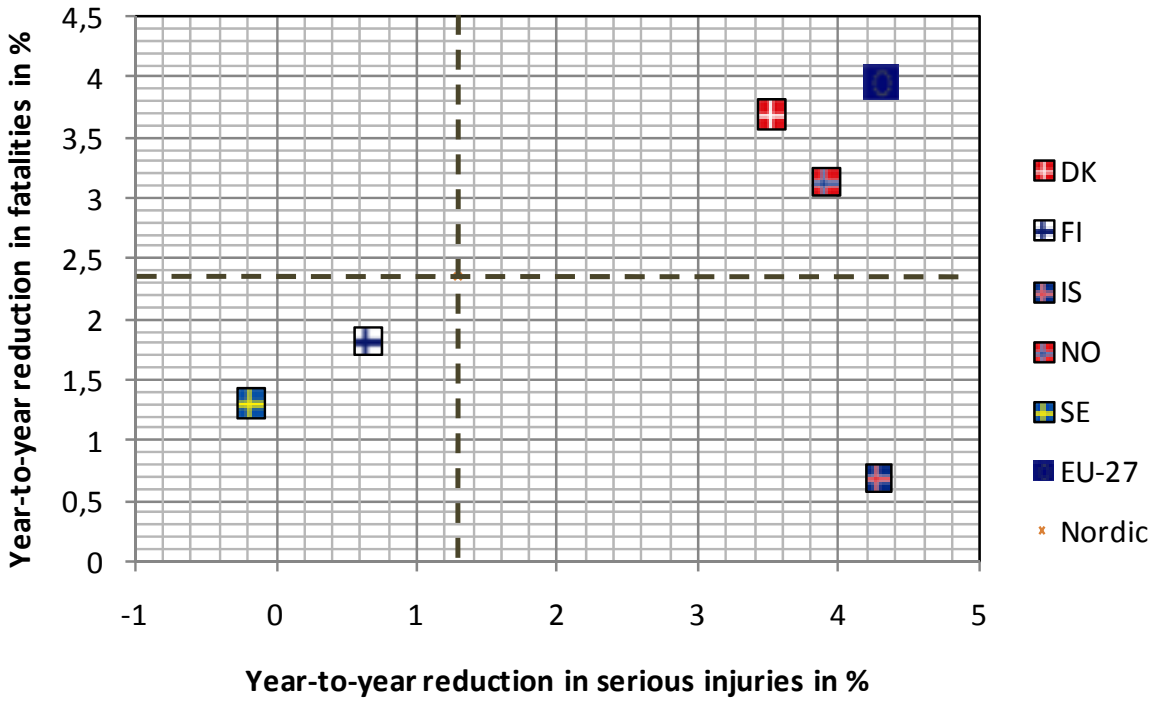


Fig.6: Average year-to-year percentage reduction in the number of road deaths plotted against the average year-to-year percentage reduction in the number of serious injuries (1998-2008).

2 Road safety indicators

In an international context it is common to use a few (different) indicators of road safety (death rates) to compare the general level of road risk of countries. These are the annual road deaths per million population (also referred to as road mortality rate), the annual deaths per million vehicles and deaths per billion motor vehicle-km. Notwithstanding that the mortality rate is the one for which most reliable and comparable data are available, has the advantage of measuring road risk to the population resulting from the number of vehicles and the extent of their use, and has been extensively used so far in the framework of the PIN Programme, this report is trying to present a wider picture making use of more than one index. All these three indicators are expressed by the ratios between the annual number of persons killed in road traffic (as numerator) and their exposure to traffic risk (as denominator). While the road mortality is expressed by road deaths per million population and is a measure of public health, the two other rates use as exposure the number of registered vehicles and the number of vehicle kilometres travelled respectively and can be viewed as measures of the quality of road transport system. The table below gives an overview of the estimates for each of the above mentioned indicators in five Nordic countries.

	Country	Deaths per million population	Deaths per million vehicles	Deaths per billion vehicle-km
	Denmark	68	76	13.6
	Finland	67	67	11.4
	Iceland	63	64	7.8
	Norway	52	64	7.8
	Sweden	48	57	8.3
	Nordic	57.2	64.7	9.9

Tab.1: General road safety indicators for Nordic countries over the period 2006-2008.

The level of road risk measured by the mortality rate in Nordic countries is lower than in the EU-27 countries. Over the years 2006 to 2008, 57 people were killed on roads per million inhabitants in Nordic countries, compared to 84 people per million inhabitants in EU-27. Thus the level of road risk in Nordic countries is one third lower than in the EU. Given the lack of traffic exposure data, it has been impossible to estimate the other two indicators for the EU (Tab.1).

Thus the deaths per million population differs by a third between the two groups of countries. Sweden, with 48 road deaths per million population, is together with the Netherlands the country with the lowest road mortality after Malta. Among the Nordic countries, Norway follows with 52, Iceland with 63, Finland with 67 and Denmark with 68 road deaths per million population in 2006-2008 (Fig.7).

To compare the levels of road risk of countries, more than one road safety indicator could be used. This can be accomplished by visually plotting different road safety indicators, here deaths per million population against deaths per billion motor vehicle-km.

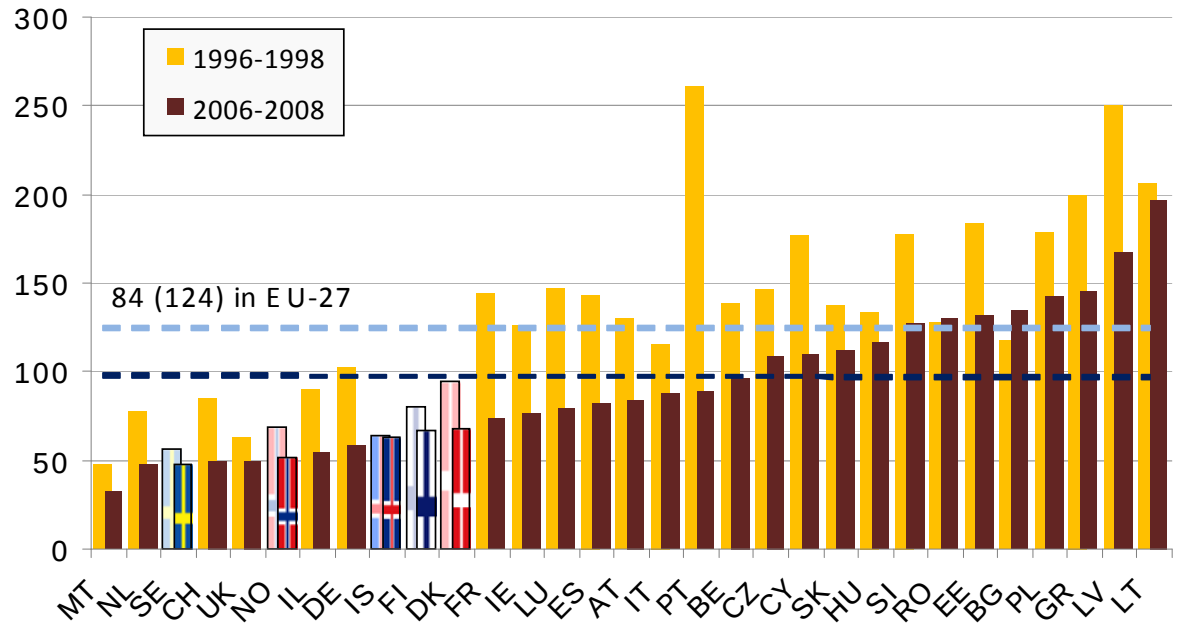


Fig.7: Road mortality over the period 1996-1998 compared to road mortality over the period 2006-2008.

If the former indicator could be viewed as an index for the personal safety (an indicator more familiar to the health sector), the latter indicator is more suitable to express the safety level of the transport system. Thus a balanced overview of the national road safety situation could be provided by making use of both of them and combining their values. This exercise is performed in Fig.8.

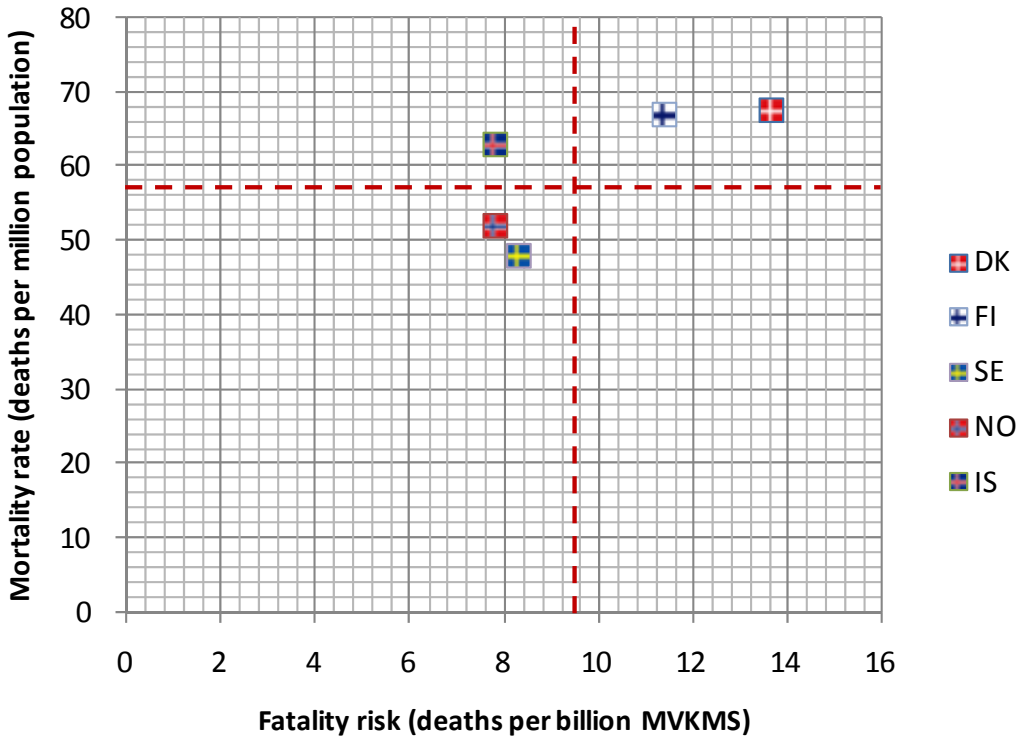


Fig.8: Deaths per million population plotted against deaths per billion motor vehicle-km in Nordic countries (2006-2008).

It appears that Sweden and Norway are the Nordic countries with the best safety records being the only ones with both indicators lower than average. The Nordic average is plotted at 57 deaths per million population for the mortality rate and 9.86 deaths per billion vehicle kilometre driven. By contrast, Denmark and Finland present risks rates above the Nordic averages.

There has been a general downward trend in each of the three previously defined indicators of risk since 1998 (1997-1999). This is presented in Fig.9 which shows the relative developments of deaths per billion vehicle-km in Nordic countries over the past decade. Three year moving averages are plotted here to obtain smoothed curves of the trends. Iceland and Sweden saw an initial rise which was later reversed, with Iceland seeing an unusually large drop in last three years, which cannot be attributed solely to the drop in fatalities in 2008 driven mostly by the economic downturn. For Norway, Finland and Sweden, a slowdown in the positive downward trend can be observed since 2005. In Denmark, an increase could be observed from 2005.

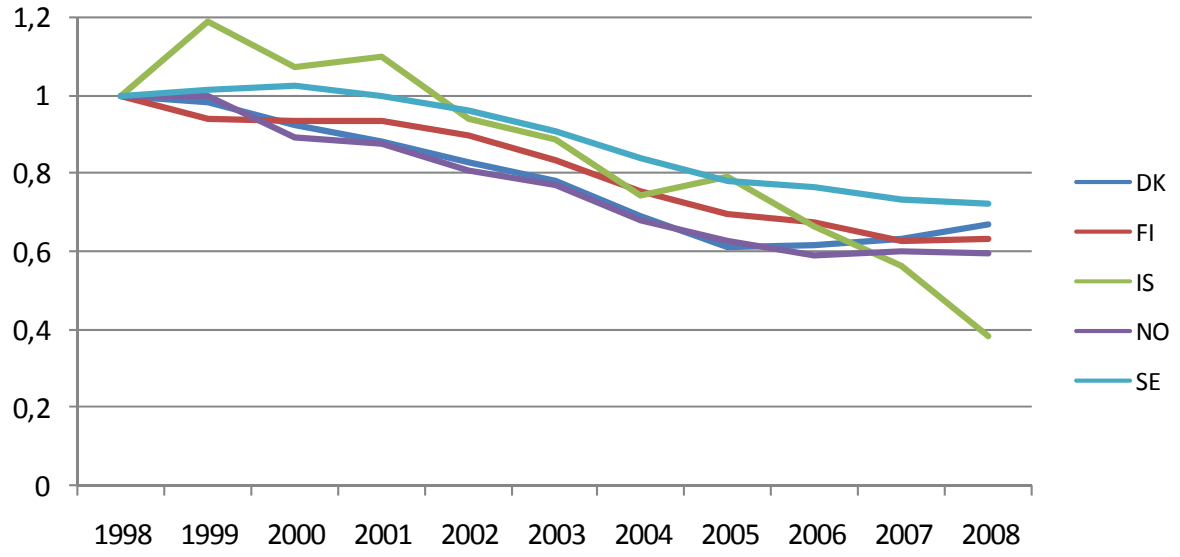


Fig.9: Relative development in deaths per billion vehicle-km in five Nordic countries since 1998.

It is also possible to compare the development of the three risk indicators over time. The average annual reduction over the past decade is estimated in Tab.3. The values for deaths per million vehicles and per billion vehicle-km are broadly similar and differ from the one for deaths per million population, reflecting the increase in motorisation and distance driven in the past decade. On average, annual deaths per million population have been decreasing by 3.6% per year in Nordic countries compared to 4.4% for deaths per billion vehicle-km (Tab.2).

At 3.6% per year, the reduction in deaths per million population has been slightly smaller in the Nordic countries, that the corresponding reduction of 3.9% achieved in the EU-27. The EU average is not available for the two other death rates.

Country	Deaths per million	Deaths per million	Deaths per billion

	population	vehicles	vehicle-km
Denmark	-3.9 %	-4.6 %	-5.1 %
Finland	-3.0 %	-3.6 %	-4.5 %
Iceland	3.8 %	-4.7 %	-5.5 %
Norway	-2.9 %	-5.1 %	-5.6 %
Sweden	-0.3 %	-2.7 %	-3.0 %
Nordic	-3.6 %	-3.9 %	-4.4 %

Tab.2: Estimated average annual percentage change in the risk indicators over the past decade.

3 Behaviour indicators

Road user behaviour and compliance with traffic law are prerequisites for achieving a safe road system. These properties could be described by a large number of indicators, but only a few of these have been standardised so far and allow for a causal link between them and road safety outcomes. There are three established major behavioural risk factors in road traffic and these are speed, alcohol and non-use of protective systems. All these have a great impact on road safety performance at national level. For example, Delorme and Lassarre[8] noted that the three major risk factors (speed, alcohol, belt-wearing) together with urbanisation explain 80 to 90% of the gap in road risk levels between France and Great Britain.

All the three risk factors have been long since recognised by authorities, which have tried to regulate them by passing legislation and enforcing it. The success in their effort is then mirrored by performance indicators related to these risk factors. Nordic countries belong to those with highest compliance with law in general, perhaps a result of a marginal incidence of corruption and a high participation of civil society in public life. But risky behaviour is difficult to erase for all road users groups and still persists on the roads.

3.1 Speeding

Speed is involved in all vehicle collisions and in about a third of fatal collisions it is a key contributing factor. Respecting the posted speed limits would bring significant safety benefits in terms of collisions and consequent death and injury avoided. For example in Sweden, an estimated 34% of road deaths could be prevented if all drivers kept to the speed limits[9]. But the level and effects of speed also depend on road design, which also influences what is an appropriate speed limit and how likely drivers are to comply with it.

3.1.1 Urban roads

Speed is a core issue in the probability of death of vulnerable road users involved in collisions. A small change in speed has a great impact on the probability of sustaining fatal or serious injury. Latest available data shows that mean speed on urban roads measured under uncongested conditions with 50 km/h speed limit was between 48km/h in Sweden and 52 km/h in Denmark. Around half of drivers of motor vehicles were above the legal limit in Norway and Sweden, while their proportion was as high as 61% in Denmark (Tab.3). Worse performance of Denmark may be partly due to a relatively high share of 30km/h urban roads and a lower number of speed cameras.

Evidence of the development of speed variables over the past decade is limited to Sweden, where no important changes in mean speed could be identified in the period 1996-2004.

[8] Delorme and Lassarre (2005).

[9] Elvik (TOI Report 930/2007).

	NO (2006)	SE (2003)	DK (2008)
Mean speed (km/h)	47.9	47.5	52.0
Percentage above the limit	46.4	52.8	61.0

Tab.3: Mean speed and proportion of motor vehicles above the speed limit under uncongested conditions on roads with a limit of 50km/h in urban areas.

3.1.2 Roads outside urban areas

Speeding on roads outside urban areas is a widespread phenomenon in Nordic countries. Under uncongested conditions, at least 50% of all cars are above the legal speed limit according to latest available data. This proportion is highest in Denmark where some 72% drivers speed and the mean speed under uncongested conditions on 80 km/h rural roads is almost 85 km/h. In Norway, on the same types of roads, the mean speed recorded was 78 km/h in 2006 with only 45% of cars above the limit (Tab.4). A percentage lower than that could be found only in Finland on 100 km/h roads (with some 40% above the limit). Speed data for Iceland come from a single road, Reykjavik No.1 ring road. Speed may have decreased on Swedish rural roads since 2004, due to the gradual introduction of automated speed cameras and other interventions.

Rural roads	NO (2006)	DK (2008)	IS (2008)	FI (2008)		SE (2004)		
Speed limit (km/h)	80	80	90	80	100	70	90	110
Mean speed (km/h)	78.1	84.8	93	82.0	99.0	68.4	88.9	111.4
Percentage above the limit	44.8	71.8	*	63.7	40.3	55.1	50.2	59.6

* 85th percentile speed was 103km/h.

Tab.4: Mean speed and proportion of motor vehicles above the speed limit in uncongested conditions on rural roads.

While motorways are the safest roads by design, still some 5% of all road deaths occur on them each year. Distraction, lack of concentration and tiredness are among the triggering factors for these collisions, but it is the speed which most strongly determines their outcomes. Mean speed on uncongested motorway is within the legal limit by the largest margin in Finland with a 120 km/h speed limit, followed by Danish 130 km/h motorways. In these two cases, the compliance with the speed limit on motorways seems to be relatively high. But on Danish 110 km/h motorways, the mean speed is well above the legal limit at 117 km/h. This suggests that that drivers' choice of speed on Danish motorways may have rather little to do with the speed limit applied.

Motorways	NO (2006)	SE (2004)	FI (2007)	DK (2008)	
Speed limit (km/h)	100	110	120	110	130
Mean speed (km/h)	99.7	109.8	111.0	117.1	122.3
Percentage above the limit	51.5	64.1	N/A	N/A	N/A

Tab.5: Mean speed and proportion of motor vehicles above the speed limit in uncongested conditions on motorways.

The development in mean speed of passenger cars on rural roads in Nordic countries is depicted in Fig.10. For most countries, no specific development in mean speed can be identified. But in Denmark, the speed has been increasing steadily from 2005 on motorways,

and from 2007 on rural roads, after a decrease in early 2000s. The general motorway speed limit was increased from 110 to 130 km/h in Denmark, and since this time, the mean speed has increased on all roads outside urban areas. This could be a result of a so-called spillover effect. Higher speed driving on motorways induces speed adaptation (higher speed) on connecting interurban roads. Increasing speed on roads outside urban areas is indeed the major issue in Denmark, where it may well be behind the increase in road deaths between 2006 and 2007. In 2008, deaths did not rise further, perhaps as a consequence of consolidation in mean speed and decrease in road travel.

It may be surprising that the mean speed of light vehicles has been almost the same on Swedish and Finnish motorways, despite different speed limits. Also, it is remarkable that the speed on 110 km/h motorways in Denmark is far higher than on Finnish motorways with 120 km/h speed limit.

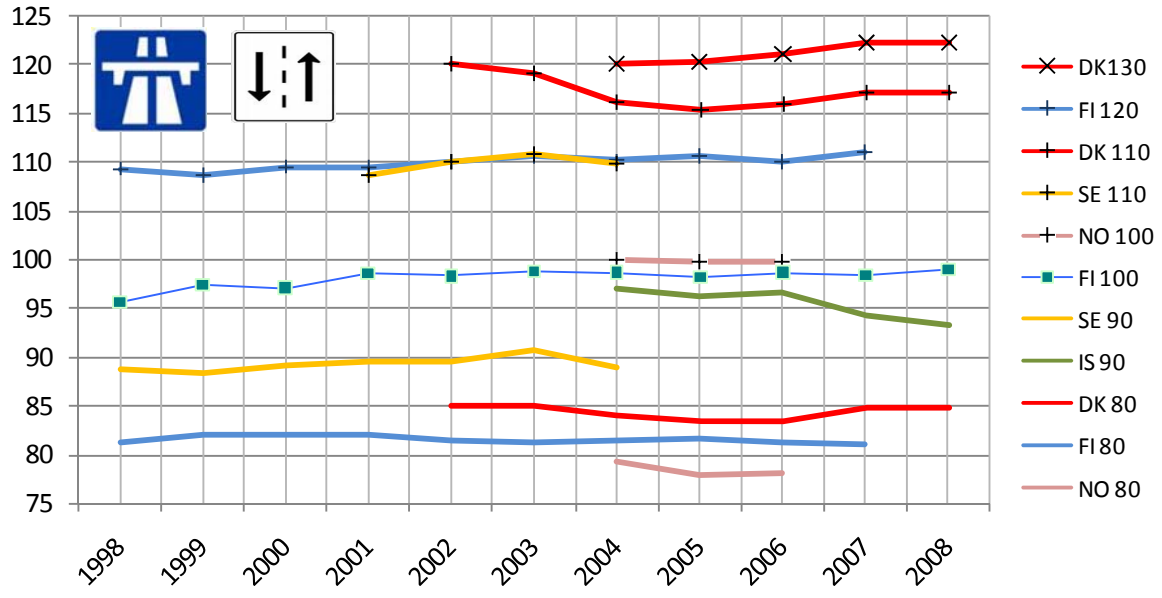


Fig.10: Development in mean speed of light vehicles on motorways and rural roads 1998-2008.

To conclude, speeding is a major issue in Denmark, where the mean speed is considerably higher than on comparable roads of other Nordic countries. Iceland has made an improvement by reducing the mean speed on its Ring road No.1 in Reykjavik from 97 km/h in 2006 to 93 km/h in 2008. Limited availability of recent data in Sweden and Norway prevents a more comprehensive comparison.

Automated speed enforcement is in place in all Nordic countries, but to different extents, as illustrated in Tab.6 in which the number of fixed speed cameras is presented. Most speed cameras were in place in Sweden in 2008 and 50,779 tickets were issued on the same year. A somewhat lower number of automated cameras was in operation in Finland and much lower number in Norway, while in Denmark the enforcement using stationary cameras is a relatively new practice and it is not yet be of a same intensity as in the other Nordic countries. Norway has introduced speed cameras with section control in summer 2009.

Country	SE	FI	DK	NO	IS
Fixed speeding cameras	980	850	4	365	NA

Tab.6: Number of fixed speeding cameras in Nordic countries in 2008[10].

3.2 Use of protective systems

Protective systems, traditional passive safety devices, mitigate the consequences of road crashes on the human body and thus help to avoid serious and fatal injuries. The use of a seat belt reduces the probability of fatal injury in a crash by more than 50%, similarly the use of helmets by users of two-wheeled vehicles has a huge life-saving potential. While this potential has been largely realised in Nordic countries, gaps still exist, not only due to persistence among non-users across all categories, but especially due to low use in specific groups of road users.

3.2.1 Seat belts

This year marks the 50th anniversary of the most important lifesaving device in automotive safety: the 3-point seat belt. Patented in 1959, the three-point safety belt has saved more than one million lives worldwide and was introduced in the Volvo Amazon (120) and PV 544 in the Nordic markets. Volvo thus became the first car maker in the world to equip its cars with 3-point safety belts as standard. Following its invention, free use of its patent was immediately given to all manufacturers and today the safety belt is a natural feature in virtually all trucks and cars. This was perhaps the single most important contribution of a manufacturer to road safety improvement in history.

While the use of seat belt was relatively low at the very beginning, the usage rates rose sharply when e laws were passed making use mandatory. For example, it tripled (from 23 to 77%) between 1975 and 1976 when the law was passed in Denmark. Nowadays, over 92% of front seat car occupants and over 81% rear seat passenger of cars and vans wear a seat belt in Nordic countries. The rest of Europe follows, mainly with lower rates. Among Nordic countries, Sweden has registered a rate of over 95% for front seats since 2007, followed by Norway (93% in 2008). Finland and Denmark follow with a 90% rate. The use of seat belts in rear seats is typically 10-15% lower. Sweden has the highest seat belt wearing rate among Nordic countries for both front and rear seats.

Similar numbers of tickets for the non use of seat belt were issued in Sweden and Denmark in year 2008 (36,091 and 39,907 respectively).

While the use rates in road traffic may seem satisfactorily high, the usage rates in fatal crashes are far lower, partly due to higher risk of non-users, but also due to lower use at night. We can estimate the usage rate among killed car occupants, the number of people whose life has been saved by wearing a belt and the further life-saving potential of wearing of belts by those who are not yet wearing them.

[10] 2009 in Denmark, where 10 fixed pylons have been set up and 4 cameras are switched between the pylons. Since January and until the end of July 11,410 tickets have been issued as the result of surveillance by the speed cameras.

Seat belts have saved over 600 lives of car occupants in Nordic countries in 2008 alone, most of them in Sweden (230) and Finland (150) and somewhat fewer in Norway (140) and Denmark (90). An estimated 100 further deaths of car occupants could have been prevented in Nordic countries in 2008, had all car occupants involved in collisions been belted. Therefore, there is still a large life-saving potential in Nordic countries despite relatively high wearing rates in road traffic[11].

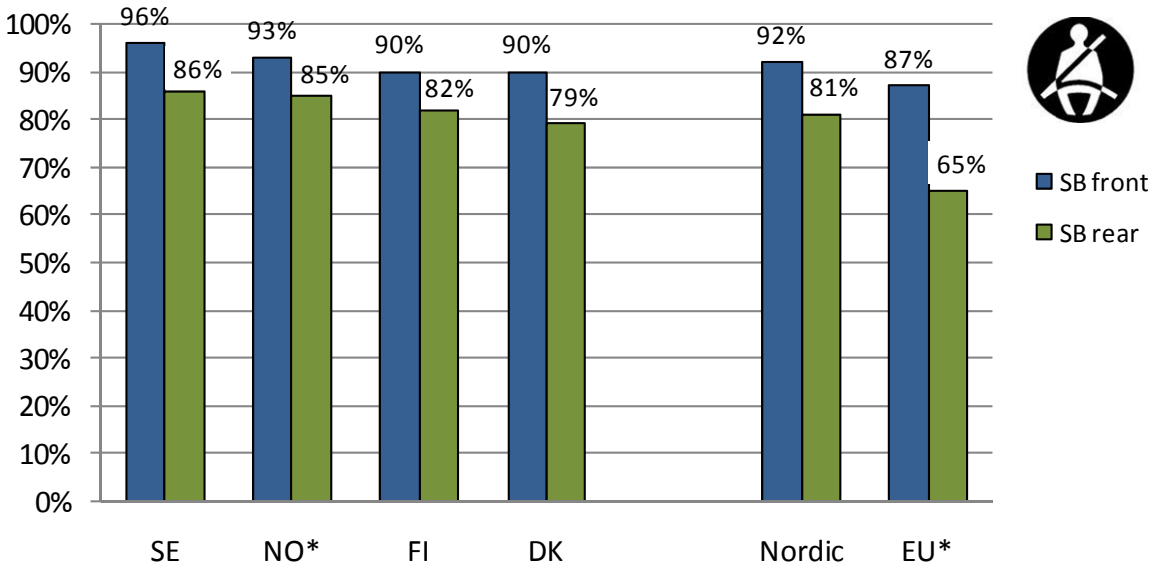


Fig.11: Daytime seat belt wearing rates in front and rear seats of passenger cars and vans[12].

Daytime seat belt wearing rates on front seats have increased most in Denmark over the past decade (by at least 12%), followed by Sweden (7%). Smaller improvements have been recorded in Finland and Norway (Tab.7). Over the past ten years 38% non-users of belts on front seats of passenger converted into users in Nordic countries.

Country	DK	FI	SE	NO	Nordic
Period	2000-2008	1998-2008	1996-2008	1998-2008	1998-2008
Absolute change*	12%	2%	7%	3%	5%
Conversion rate **	55%	16%	64%	30%	38%

* the number of percentage points by which the wearing rate has increased.
** the percentage reduction in the non-use of belts.

Tab.7: Changes in use of seat belts in front seats of passenger cars up to 2008.

Daytime seat belt wearing rates on rear seats have also increased most in Denmark, from 64% in 1998 to 79% in 2008, meaning that 42% of non-users have converted into users over the past five years. A substantial improvement has also been registered in Finland (10% increase and conversion rate of 36%), but this was over a longer period (10 years).

[11] Methodology available in Hakkert and Gitelman (Eds.) (2007) and in the first PIN Report (2007).
[12] Vis and Eksler (Eds.) (2008).

The use of belts is worryingly low among truck drivers in Nordic countries. For example, on Swedish roads, only four out of ten truck drivers use the belt. The consequences of not using the belt are well documented in Volvo Trucks' own accident research. For example, of 15 truck driver fatalities on Swedish roads over the past three years, only one driver was wearing a safety belt[13]. Rates for HGV drivers are low also in other EU countries (in Germany only 51% of truck drivers were belted in 2005), and this requires special attention by the authorities, given the fact that they are recorded by professional drivers who could be expected to set an example.

Country	DK	FI	SE	NO	Nordic
Period	2003-2008	1998-2008	1996-2008	1998-2005	1998-2008
Absolute change	15%	10%	2%	3%	7%
Conversion rate	42%	36%	7%	17%	27%

Tab.8: Changes in use of seat belts in rear seats of passenger cars up to 2008.

3.2.2 Helmets

There has been a long discussion about the actual health benefits of wearing a helmet by pedal cyclists, as their use may result in less riding and less attentive driving of passing cars. But the data on their effectiveness in crashes is persuasive. Helmets protect the most vulnerable part of the body and thus mitigate the injuries sustained in collisions on and falls from pedal cycles.

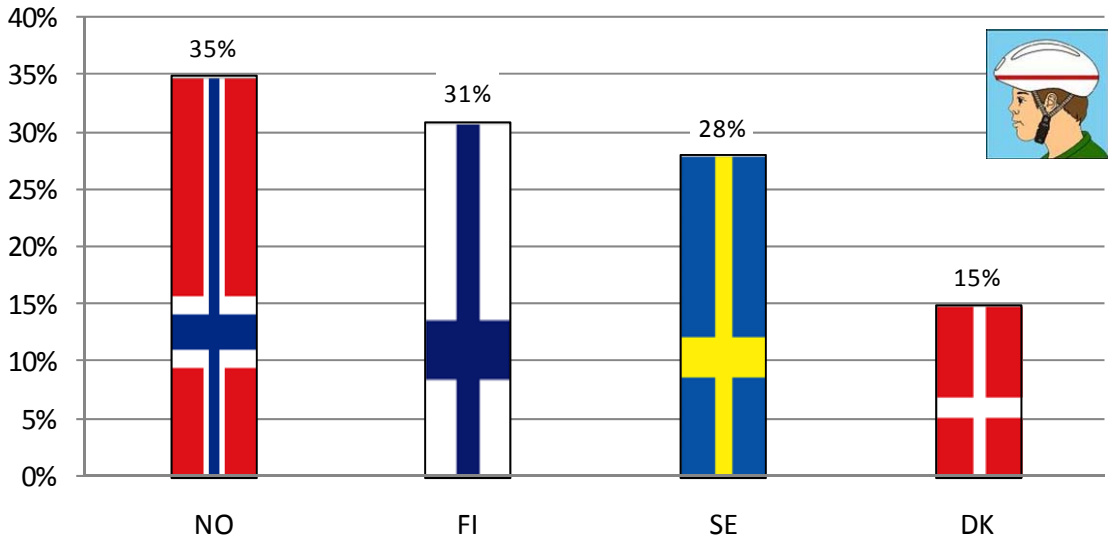


Fig.12: Daytime wearing rate of helmets among pedal cyclists.

Over one third of pedal cyclists in Norway wear a helmet, while about 30% do so in Finland and Sweden. In Denmark, the Nordic Mecca of cycling, only 15% of cyclists do so (Fig.12). Without data on the amount of cycling in Nordic countries, the average helmet wearing rate for all four countries cannot be estimated.

[13] Volvo (2009).

The use of helmets among powered two-wheeler (PTW) riders is less well documented in Nordic countries. While the usage rate is virtually 100% in Norway, the Swedish riders wear the helmet in only about 90 and 95% of moped and motorcycle journeys respectively. Because the wearing of a helmet is so important in reducing head injuries to users of PTWs, the apparent lack of monitoring of helmet use where this is appreciably less than 100% calls for urgent attention.

3.3 Driving under the influence of alcohol

Driving under the influence of alcohol is a well-recognised risk factor. While probably only 1-2% of journeys are associated with alcohol impairment, in the EU as a whole the indications are that of the order of 10 times this percentage of road deaths are associated with alcohol impairment of an active driver involved in the accident. There are nowadays countries in Europe such as France that claim alcohol to be the single biggest killer on national roads. While the problem is well-recognised, it appears to be relatively resistant to current policy interventions.

The data from the latest European-wide Police enforcement campaign carried under the umbrella of TISPOL in July 2009 shows that Norway, Finland and Sweden are the countries with the lowest proportion of drivers driving with the blood alcohol above the legal limit in Europe, with less than 0.5% found positive in random checks. In Denmark, however, the share was as high as 3.1%. The legal BAC is 0.2g/l in Norway and Sweden and 0.5g/l in Finland, Denmark and Iceland.

If the percentage of driving with BAC above the legal limit were 1% and the proportion of fatally injured drivers who are over the legal limit were 15%, this would imply that the average risk of being killed in an accident for drivers over the legal limit is 17.6 times that of those driving below the legal limit.

National statistics in Nordic countries include data on drink driving deaths, defined as any death occurring as a result of road accident in which any active participant was found with blood alcohol level above zero. This definition is well in line with the one recommended by SafetyNet project building the European Road Safety Observatory[14]. According to these data, 26% of road deaths in Nordic countries are associated with alcohol impairment of at least one active participant, with the proportion varying from 22% in Norway to 28% in Denmark (Fig.13), but it is not known to what extent these percentages are comparable, because the procedures for identifying deaths as alcohol-related according to the above definition differ between countries.

[14] Sørensen et al. (2008).

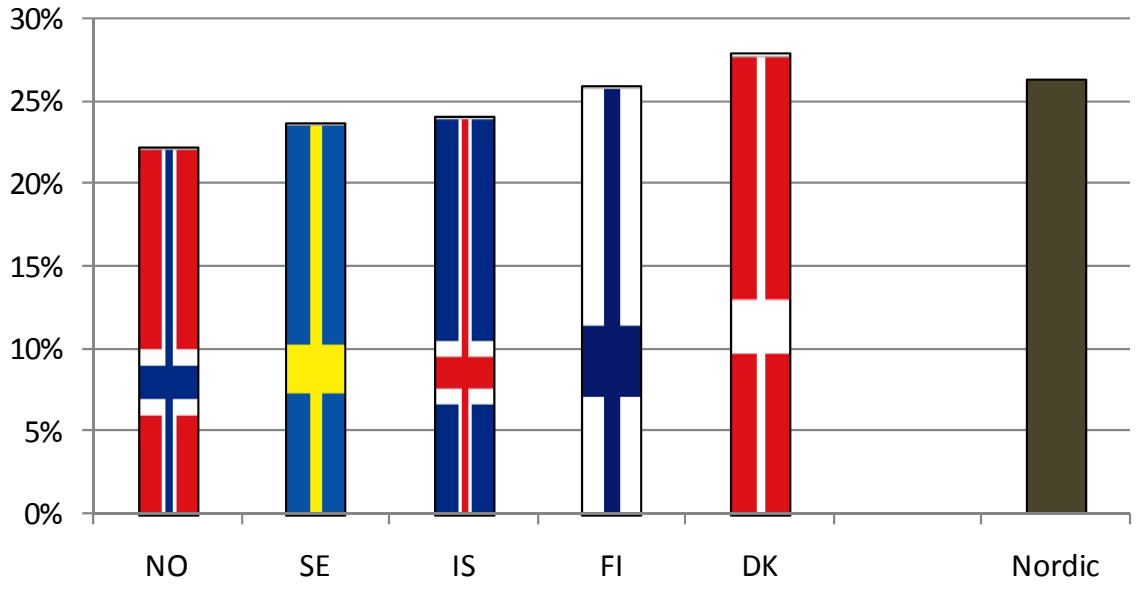


Fig.13: Proportion of alcohol-related deaths among all road deaths in Nordic countries (2006-2008)[15].

Alcohol-related road deaths have not been falling as quickly as other road deaths in Nordic countries, and their share among all road deaths has increased over the past decade. While ten years ago, 23% of road deaths were associated with alcohol impairment, this proportion was 26% in 2008. So while in Nordic countries the proportion of alcohol related deaths has been increasing by between 1% and 2% per year, in the rest of the Europe it was decreasing at a rate of about 3% per year (Fig.14).

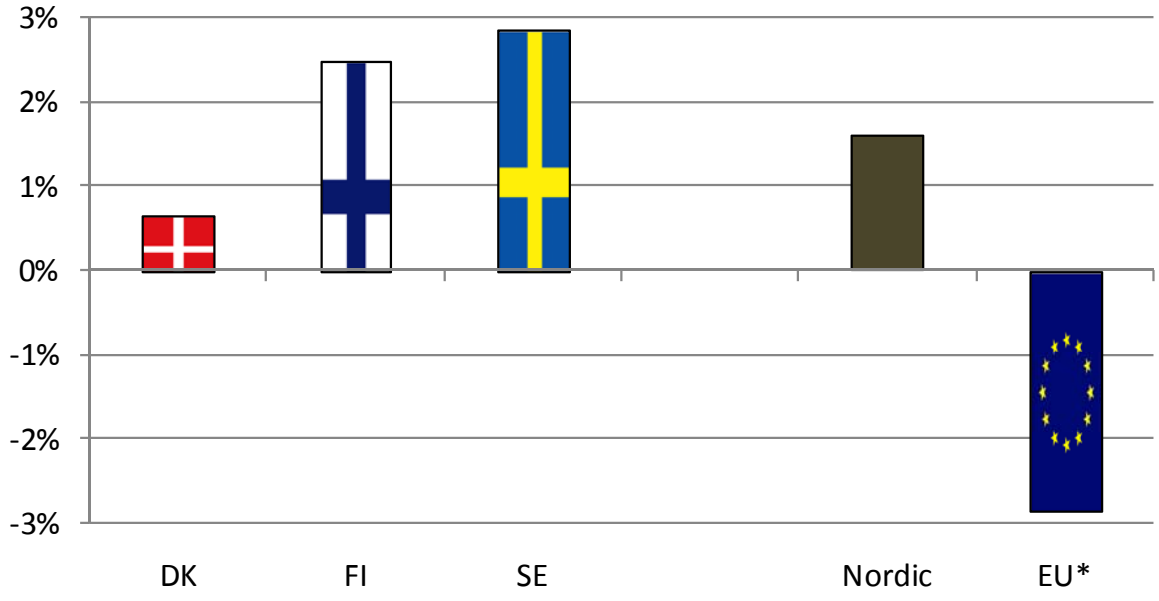


Fig.14: Annual average percentage change in the proportion of road deaths that were alcohol-related (1998-2008)[16].

[15] In Sweden, only collisions involving passenger cars are considered.

As to the development in absolute numbers of drink-driving deaths, they were little changed over the past decade, with a slight increase in Sweden and Finland (2% yearly) and slight decrease in Denmark and Iceland (3% yearly). These trends differ from the trends observed elsewhere in Europe, where the number of alcohol-related deaths has been falling by some 6.5% per year during a similar period (1996-2005).

Enforcement is the best known and most effective tool for reducing driving under the influence. The extent of enforcement by means of so-called random breath tests is summarised in the Tab.9.

Country	DK	SE	NO
Year	2008	2008	2008
Checks	389,000*	2,534,236	1,600,000
Ratio per population	0.07	0.28	0.34

* DK: Number of targeted traffic checks. (Whether and if so how these differ from what are called random tests in Sweden, and whether there are other tests in Denmark which are called random, has not been checked).

Tab.10: Yearly number of random breath test checks and ratio to number of population.

Data on the number of random or targeted alcohol checks for three Nordic countries is presented in Tab.10, showing the highest probability of being checked in Norway, followed by Sweden. In Denmark, less than 400,000 were checked in 2008. The probability of a Danish driver being checked is thus less than 10%, much less than in the other two countries.

[16] 15 EU countries considered for the period 1996-2005 (See PIN Report No.1). Iceland excluded from the comparison due to too small number of relevant deaths and Norway because only a single year's data was available.

4 Other indicators

Several other indicators have been developed and applied in the PIN Programme in the past three years. They aim at assessing particular road safety problems at country level and thus relate to road user groups with unusual risk in road traffic, to specific road types, or to vehicles. The ultimate aim is to cover all the three cornerstones of road system (users, vehicles, roads). By applying the indicators in these areas, the authorities could learn about changes in road safety patterns, helping them to identify targets for interventions. Altogether five indicators have been chosen for this report upon the criteria of reliability and recency.

4.1 Safety of children and elderly people

Some 680 children aged 0 to 14 and almost 3,700 older road users above 65 years old have been killed in road traffic over the past ten years in Nordic countries. Each year, the lives of some 50 families are torn apart by the loss of a child killed in traffic. Road collisions are a major cause of disability among children, which can have a long-lasting impact on their physical and psychological growth.

On average in Nordic countries, the mortality of children from road collisions is about one-seventh of the corresponding mortality for road users aged 15 and above. There are 11 child deaths per million children, compared to 72 deaths per million inhabitants for all other age groups taken together. The ratio between child road mortality and that of the rest of the population varies between 4 in Norway and 8 in Finland and Sweden. Sweden is indeed the country with the lowest child road mortality in the EU-27.

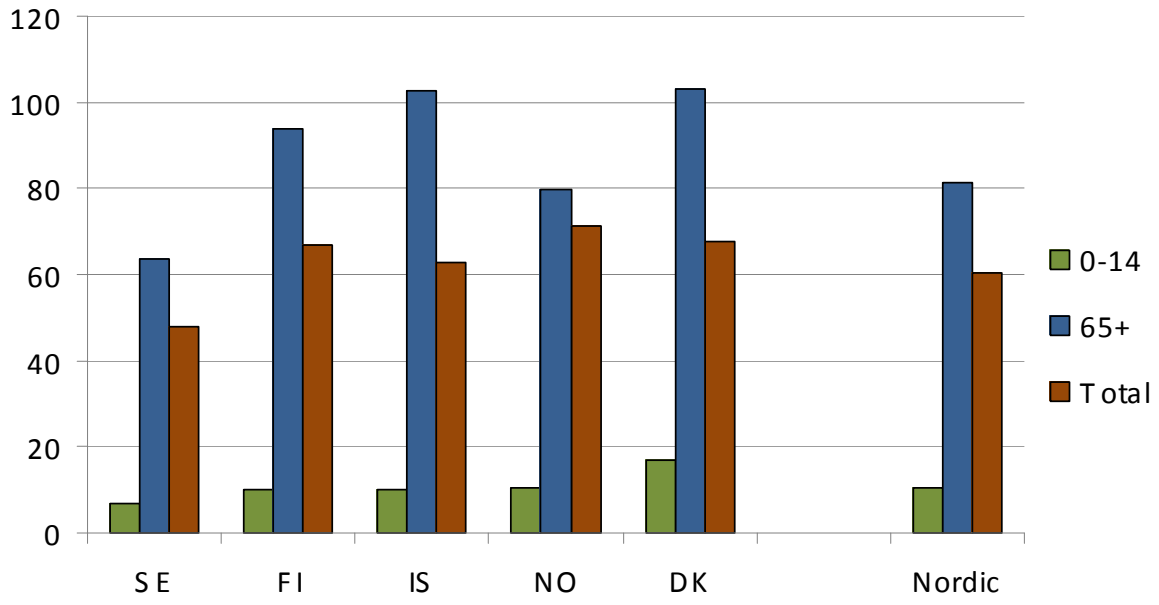


Fig.15: Road mortality of children, older people and the whole population over 2006-2008.

Elderly people are more likely to be killed on the roads compared to their younger counterparts. Their road mortality is on average equal to 81 deaths annually per million

population while the corresponding rate for the rest of the population is 56. The mortality rate for the whole of the population is settled at 60 (Fig.15) Elderly people are relatively safer in Norway, where their mortality exceeds that of the rest of the population by only about 11 deaths annually per million population.

Road safety of children has improved even faster than road safety of the rest of the population over the past decade in all Nordic countries (Fig. 16). In Iceland, Sweden and Finland, the annual average reduction in road mortality among children is clearly more than 4 percentage points (the Nordic countries average) higher than the corresponding reduction for the rest of the population. In Denmark and Norway, it is only some 2 percentage points higher.

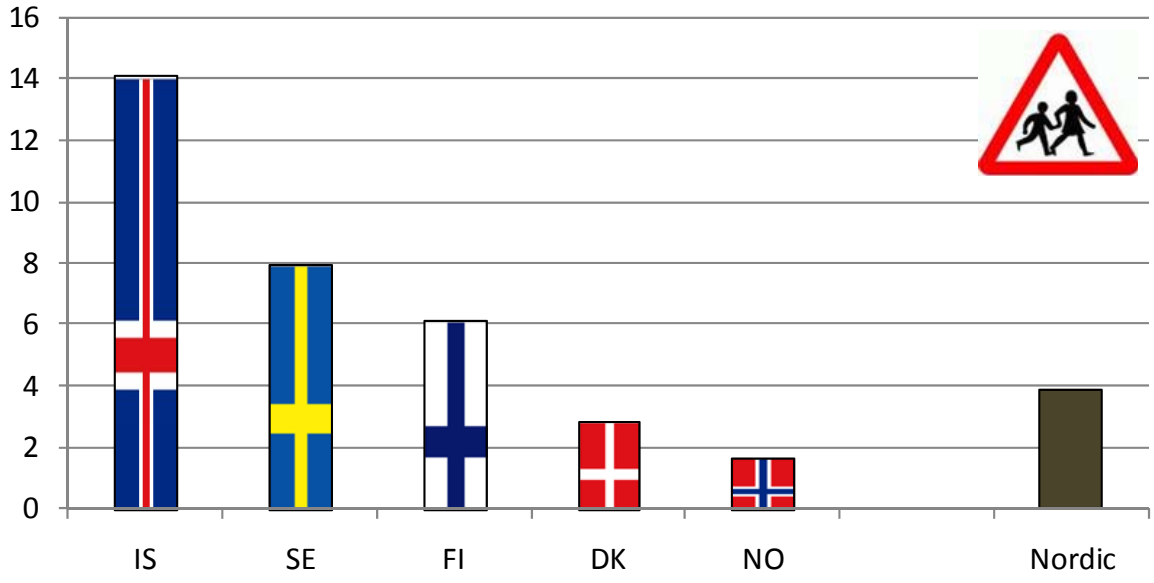


Fig.16: Difference between the average annual reduction in road mortality among children aged 0-14 and the corresponding reduction for the rest of the population (aged 15+) over the period from 1997-1999 to 2008.

On average in the EU-27, the annual average reduction in child mortality over the period 1997-2007 was 7% compared to 4% for all other age groups, i.e. 3 percentage points higher for the child population.

Road safety of elderly people has also improved faster than road safety of the rest of the population over the past decade (Fig.17). In Norway, the annual average yearly reduction in elderly road mortality exceeded by 6% that of younger population, in Finland by 4% and in Sweden and Denmark by 2 percentage points. In Iceland, the opposite is true and the road safety of the population aged 0-64 has improved faster than road safety of elderly population, but one must bear in mind that the annual numbers of road deaths are very low in Iceland.

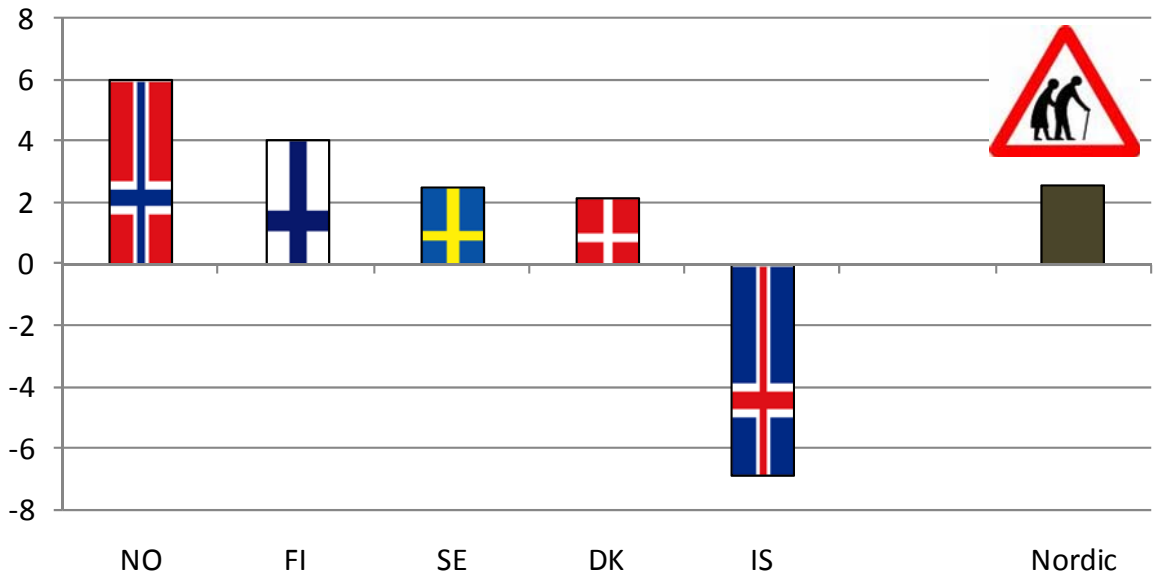


Fig.17: Difference between the average annual reduction in road mortality among elderly population aged above 65 and the corresponding reduction for the rest of the population (aged 0-64) over the period from 1997-1999 to 2008.

On average in the EU-27, the annual average reduction in elderly road mortality over the period 1997-2006 was 3.7% compared to 3.9% for the younger population.

In Fig.18 the recent road mortality for children and elderly people in each of five Nordic countries is plotted horizontally against the average annual reduction over the last decade plotted vertically. The Nordic countries' averages of the two indicators are used to divide the diagram for each group into four quadrants, where for children all countries except Iceland lie either in the upper right quadrant with higher than average mortality after lower than average reduction, or in the lower left quadrant with lower than average mortality after higher than average reduction. The situation is slightly different for the elderly population. For both children and elderly people, Nordic countries appear to be better performing than the EU as a whole, but not to have improved much faster.

Sweden, Norway and Finland have achieved lower than average child road mortality after higher than average reduction. Denmark has higher than average mortality and has achieved lower than average reduction over the past decade. In general, countries with lower than average road mortality now are the ones that have made relatively fast progress over the past decade, thus widening the gap between countries.

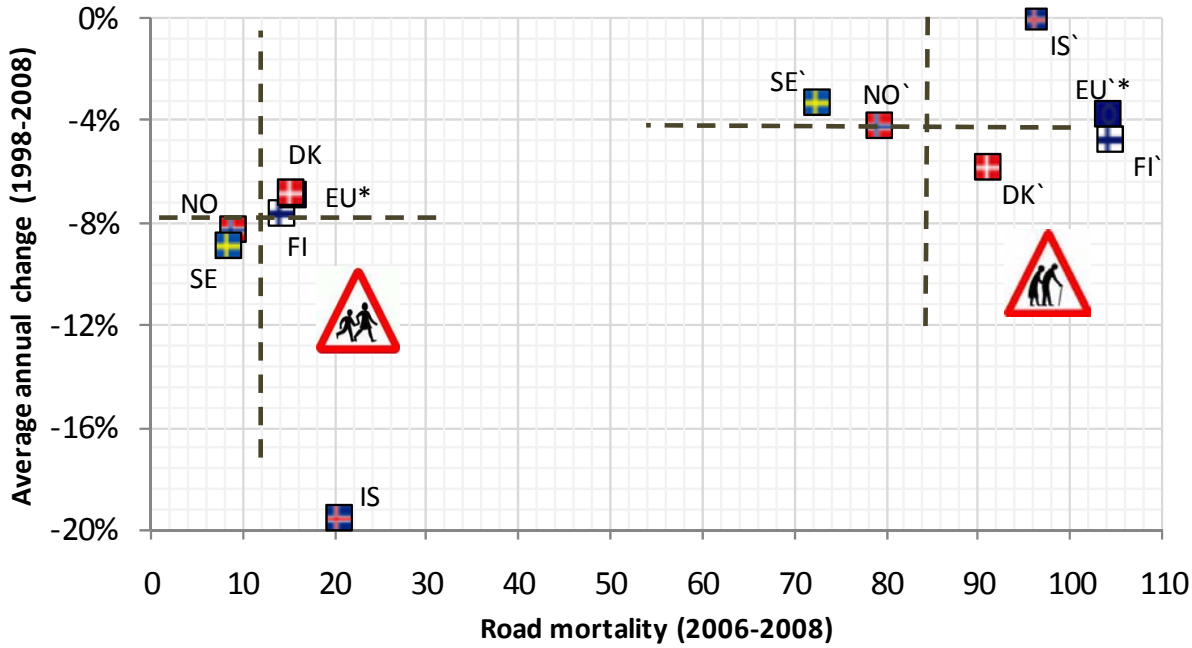


Fig.18: Road mortality of children and elderly people plotted against the annual average percentage change 1998-2008[17].

Denmark has made the fastest progress in reducing road mortality among elderly people in the past decade with 5% annual average reduction, but the rate of deaths per million inhabitants remains above the Nordic countries average.

In general, children over 6 years old have somewhat higher road mortality than children aged 0-6. This is in part because, as part of normal child development, children above 6 are more likely to move around unaccompanied by adults, in particular travelling to and from school. But once they reach the age of 14 and progressively acquire access to motorcycles and cars, their road mortality starts to increase steeply. The distribution of child deaths according to their age points to differences in mobility pattern in Nordic countries. The proportion of young people's road deaths occurring among children under 7 varies between 9% in Finland and 28% in Denmark. Similarly, the proportion of killed young people under 15 years old varies between 29% in Finland and 55% in Denmark. Compared to the EU, there is a lower proportion of deaths in the age group 7-13 in Nordic countries and a higher proportion in the age group 15-16 years (Fig.19).

The European population is undergoing major changes in its demographic structure with the proportion of older people growing at a faster rate. People over 65 years old represent nowadays 16% of total population in Nordic countries (17% in the EU). Because of the decline in birth rates, the increase in life expectancy and the maturing of the baby-boom generation, 25% of the population will be over 65 in 2030 and 30% in 2050. Given the fact that road mortality of elderly people is in Nordic countries 20% higher than mortality for other age groups, the demographic change will have a negative impact on the number of road deaths, if external conditions do not change significantly in the coming years.

[17] EU averages were estimated for slightly different period than 1998-2008.

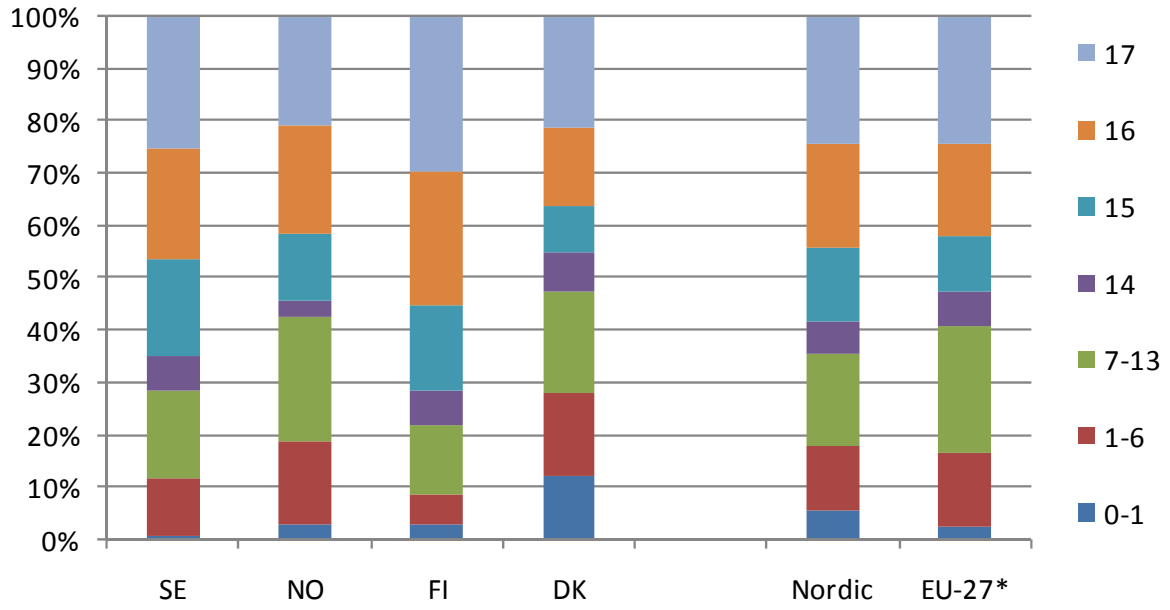


Fig.19: Percentage share of road deaths in age groups among all road deaths under 18 presented in reverse alphabetical order. Average values for 2006, 2007 and 2008.

We could estimate the expected number of deaths based on the population forecast employing the mortality rates determined for the two age groups and assuming that these will remain constant. In order to isolate the effect of population ageing from the change in the total population, we have undertaken a relevant adjustment based on the assumption of linearity between the number of deaths and the size of the population. In Nordic countries, population ageing is likely to contribute to an increase of the number of road deaths as the increase in the share of elderly population having a relatively high road mortality rate will weigh negatively on the overall level of road risk. By 2020, the number of deaths could rise by 4% in Finland and by more than 2% in Denmark and Sweden just because of demographic change[18]. Although these effects are relatively small in the short term (up to 2020), they may become more important in the longer term.

[18] ETSC (2008).

4.2 Divided roads

Divided roads are the safest open roads by design. They are characterised by the presence of a physical barrier, preventing vehicles from colliding head-on. Most typically in Nordic countries their layout is 2+2 lanes, 2 for each direction (typical motorways), but their configuration could also be different: 1+1 or 2+1 lanes. Demark and Sweden have been building 2+1 roads since the 1990s, but while in Sweden a median physical barrier has been systematically installed, this has not been the case in Denmark[19]. There are nowadays over 1,100 kms of divided 2+1 roads in Sweden and they are claimed to bring a major reduction in road deaths occurring on rural roads. They are highly cost-efficient, as they are typically reconstructions of existing roads.

It has been possible to compare safety of motorways in only four Nordic countries as there are no motorways in Iceland. In these countries, over 4,000km of motorways are in operation representing 1% of all paved roads, but carrying 16% of road traffic[20]. Around 80 people die each year on them. As a measure of safety on motorways, the rate of deaths per billion vehicle-km over the last three years for which data are available has been estimated. Counts of road deaths are relatively small and subjected to fluctuation. Motorway users in Denmark and Sweden enjoy a lower level of risk than users in other two Nordic countries and the average for these four countries is half of that for the EU (Fig.20).

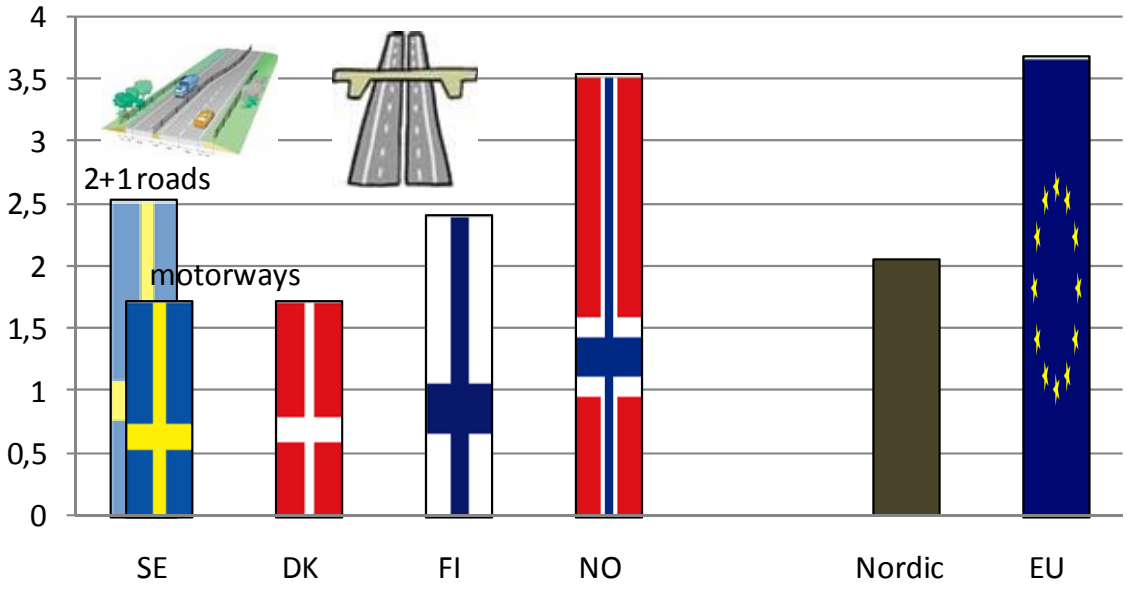


Fig.20: Death rate per billion motor vehicle km driven on motorways in the last three years[21].

In Denmark and Sweden, less than two people are killed on average for every billion vehicle-km. In Finland, the rate of deaths per vehicle-km is below the EU average of 3.7

[19] Herrstedt (2005).

[20] Source of data: IRTAD.

[21] Period 2006-2008 considered for SE and DK, 2005-2007 for Finland, 2004-2005 for Norway, EU in 2006. In Sweden, also 2+1 lanes roads were considered.

deaths per billion vehicle-km[22], but higher than in Sweden and Denmark. The death rate on Norwegian motorways (3.5 deaths per billion vehicle-km) is still below the EU average although it is the highest among Nordic countries, but it is available only for the period 2003-2005. Thus surprising disparities in terms of motorway safety can be found in Nordic countries. The death rates in Sweden and Norway differ by a factor of more than 2. The different speed limits applied on motorways could be the main reason behind these discrepancies.

The death rate on Swedish 2+1 divided roads was 2.6 over the past three years, nearly 50% higher than on Sweden's motorways, but still lower than the risk on EU motorways. The death rate is not available for Denmark, but it was suggested that they are not so safe compared to motorways due to the missing physical barrier.

Motorways in Nordic countries are by far safer than other roads, by a factor of nearly 4 in all countries taken together. For Denmark and Sweden which have among the safest motorways in Europe[23], this is by a factor of over 5, for Finland by a factor of 3. In Norway, the ratio is close to two, suggesting that a relatively less substantial difference in risk levels on motorways and other roads exists in Norway (Fig.21).

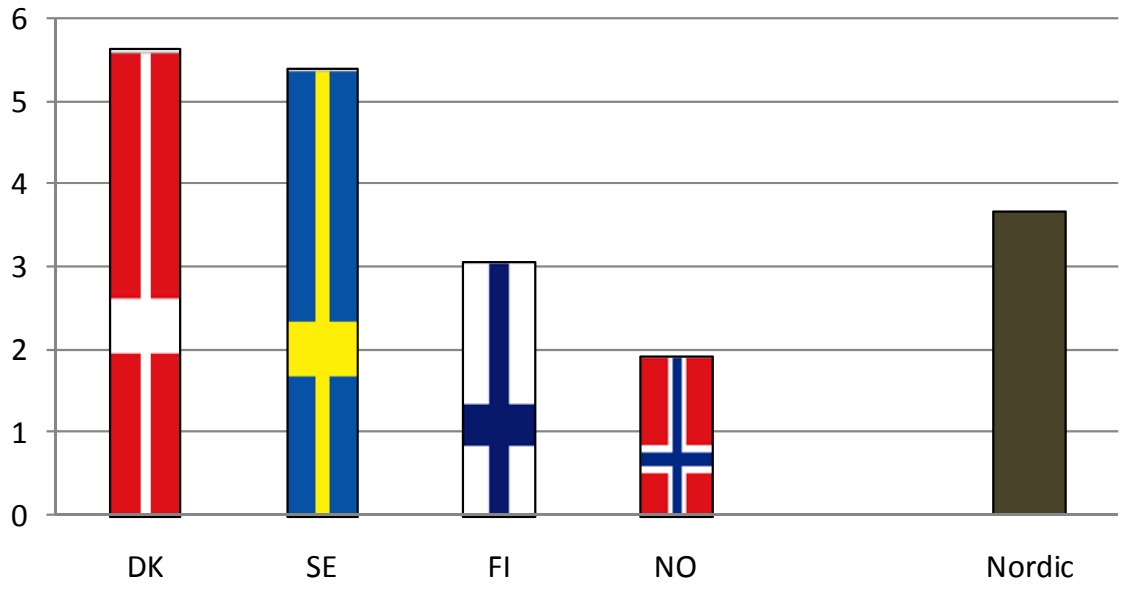


Fig.21: Ratio of death rate per billion vehicle-km on all other roads to death rate on motorways in the Nordic countries.

In the period 1998 to 2008, the highest average yearly reductions in the risk of being killed on motorways were achieved by Finland (Fig.22). In this country, the number of deaths per billion vehicle-km decreased each year on average by 11%. Denmark follows with annual reduction of 9%. In Sweden, the death rate was falling by 5% on motorways and by 3% on 2+1 roads. In all Nordic countries, the reduction has been much more substantial than the reduction achieved by EU countries over the period 1997-2006. This success could possibly be attributed to a gradual introduction of automated speed cameras and further

[22] 15 EU countries considered in 2006 (ETSC, 2007).
[23] ETSC (2006).

improvements in infrastructure passive safety. Nordic countries are indeed exceptions in using speed cameras extensively on their motorway networks.

Death rates have been falling more quickly on motorways than on other roads. In the three countries considered, the average annual reduction has been higher by three percentage points for motorways.

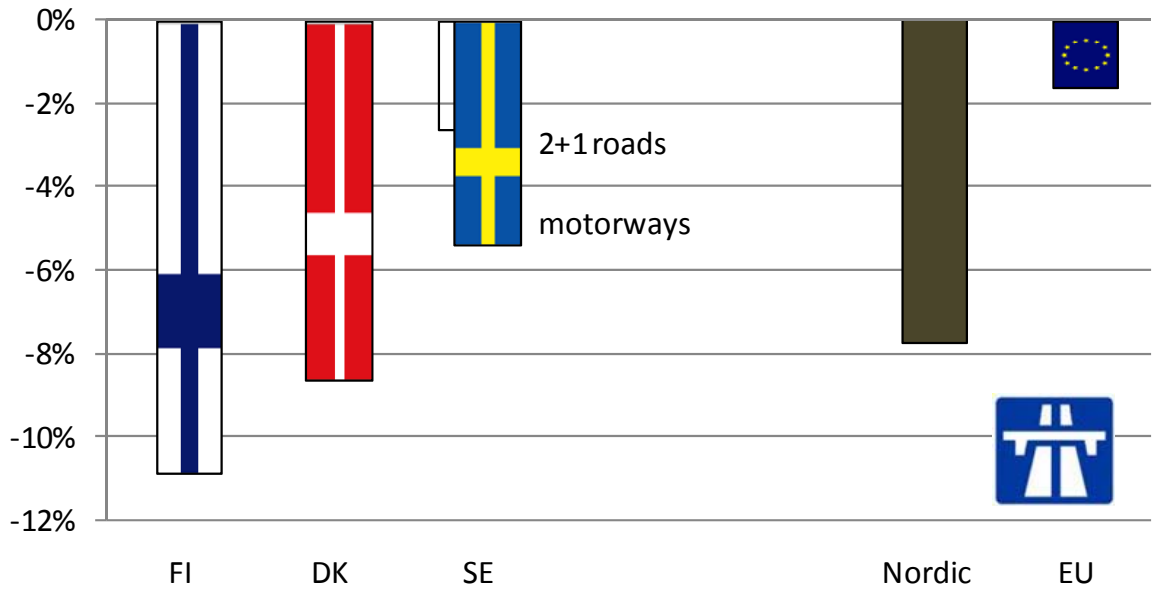


Fig.22: Average annual change in death rate per billion vehicle-km on motorways over the period 1998-2008.

Speed is an important factor of safety on motorways. Changes in the pattern of speeds have a great potential impact on road deaths, but this can be difficult to distinguish from the effects of other changes taking place concurrently with changes in speed. In Denmark the general speed limit on motorways was increased from 110 to 130 km/h in April 2004, after major infrastructure safety upgrades. For around half of the network the drivers are still required to keep to the 110 km/h limit. The speed limit for heavy good vehicles (HGV) was also increased from 70 to 80 km/h to reduce the problem of speed heterogeneity. Police enforcement was intensified and accompanied with awareness campaigns. The number of deaths on Danish motorways has been fluctuating during recent years. There was a slight increase in deaths in 2005, a reduction in 2006 but since 2007 the number is rising again. In the meantime the mean speed on motorways rose between 2005 and 2007.

The analysis of safety on divided roads points to the limitations of analysis based on the use of a single death rate indicator. Road deaths on motorways are relatively rare events and their numbers do not allow more detailed analysis, even when applying sophisticated statistical techniques. Data on serious injuries sustained in motorway collisions are needed to shed more light on actual level and development in risk on motorway in the Nordic countries.

4.3 Powered two-wheeler safety

Powered two-wheeler users are the only road user group for which the number of deaths has been continuously increasing in recent years. Altogether 212 PTW riders were killed on Nordic roads in 2008, representing 15% of all road deaths.

PTW riders in Norway enjoy the lowest level of risk among Nordic countries with 30 deaths per billion kilometres travelled. Finland and Sweden follows with the death rate per billion km of 35 and 40 respectively, but for Denmark the rate is over 70. For all Nordic PTW riders the rate is 45 killed per billion km, some 50% lower than in the EU as a whole (Fig.23).

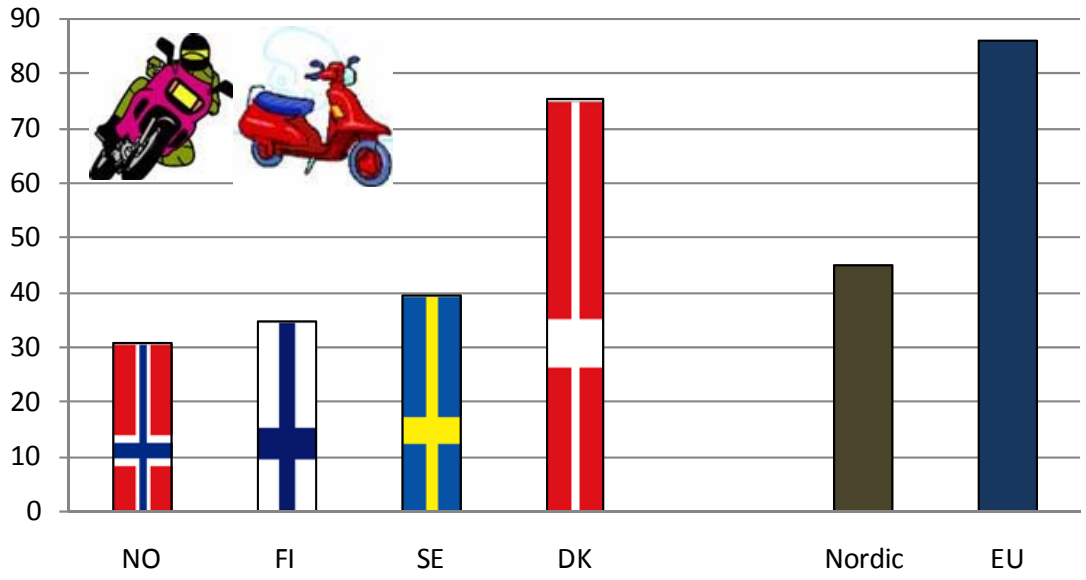


Fig.23: Powered two-wheeler rider deaths per billion km in 2006-2008 (EU in 2006).

For the same distance travelled, the risk of a rider being killed in a road accident is on average 15 times higher than the corresponding risk of a car driver in Nordic countries. The ratio is striking, despite being lower than the ratio of 18 for the EU in 2006 (Fig.24).

Moped riders accounts for one fifth of all PTW deaths, with a high share in Denmark (42%) and lowest share in Norway (13%).

The death rate per billion km driven by motorcyclists (engine volume above 50ccm) is very similar in three countries for which detailed data are available, but the death rates for moped riders differ appreciably, between Sweden and Norway by a factor of 2.9 (Tab.9).

	Engine volume	NO	SE	DK	Nordic
	<50ccm	10.0	43.0	NA	NA
	>50ccm	45.4	44.0	41.0	43.5

Tab.9: Death rate per billion km driven by riders of PTWs.

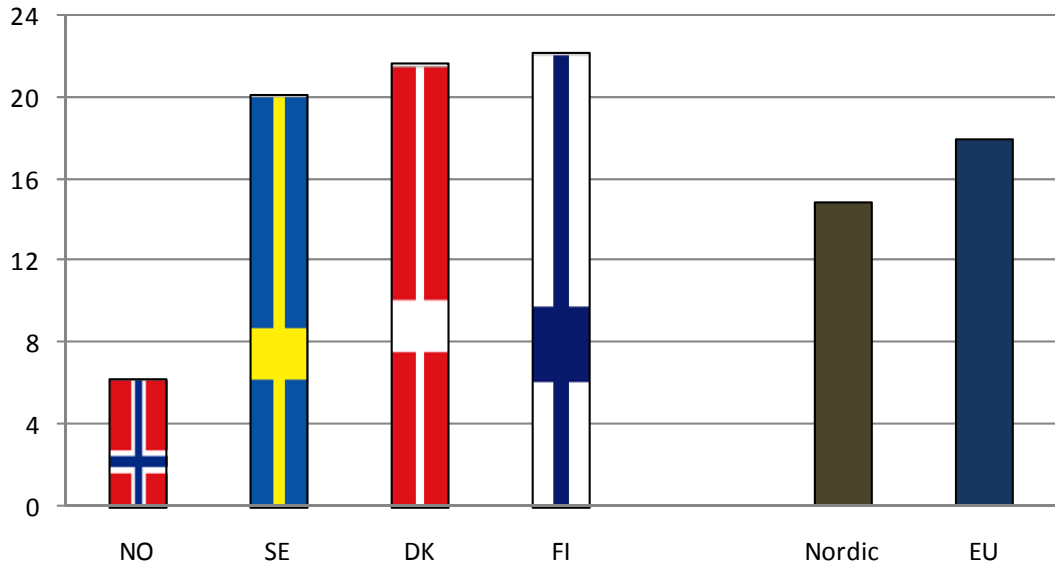


Fig.24: Ratio of death rate per billion km ridden by PTW riders to corresponding rate for car drivers in 2006.

The number of road deaths among PTW riders has been growing on average by more than 2% per year over the past decade (1998-2008). PTW deaths have been falling in only one country - in Norway, while the increase has been most substantial in Finland, where the number of PTW deaths has been increasing by more than 5% each year (Fig.25). Taking Europe as a whole, PTW rider deaths have shown little change between 1997 and 2006, with substantial increases in some countries offset by decreases in others. The distance travelled by PTWs has increased by a third in Nordic countries in ten years and thus the death rate per billion km travelled has been decreasing during the same period by about 5% each year, which is better than for passenger cars, for which an annual reduction of 3% has been recorded.

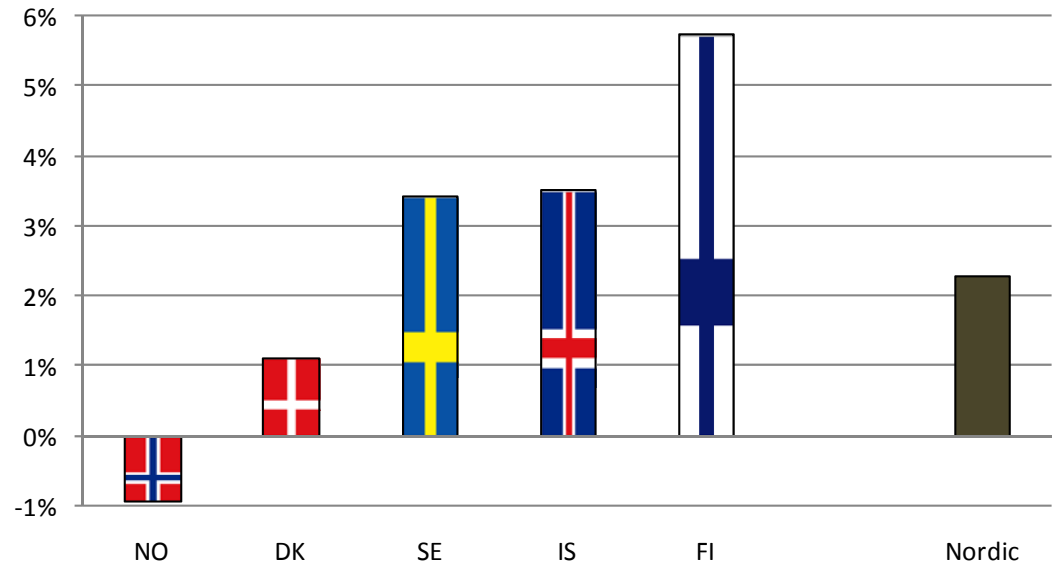


Fig.25: Annual average percentage change in number of PTW deaths over the period 1996-1998 to 2008.

4.4 Safety of capital cities

Capital cities have been regarded as showcases of their countries. They have long since come to take the lead in numerous areas of public life. Capitals generate a good deal of the national wealth and command relatively large resources for improving quality of life for their citizens. They are therefore expected to take a lead in improving road safety at national level. In this chapter, the focus is on the development in safety rather than in the actual level of road risk, which is difficult to compare given the differences among cities in commuting patterns, public transport availability, settlement structure, modal split or proportion of the administrative area that is urbanised.

Nowadays Capital cities in Nordic countries have substantially fewer road deaths than ten years ago. Reykjavik and Oslo have succeeded in bringing down the number of road deaths per million residents to the greater extent. Both of them present average annual reduction of the death rate by more than 9% while on average road mortality in Nordic countries has been cut by 4.4%. In Helsinki, the number of people dying on the roads per million residents has increased slightly (Fig.26).

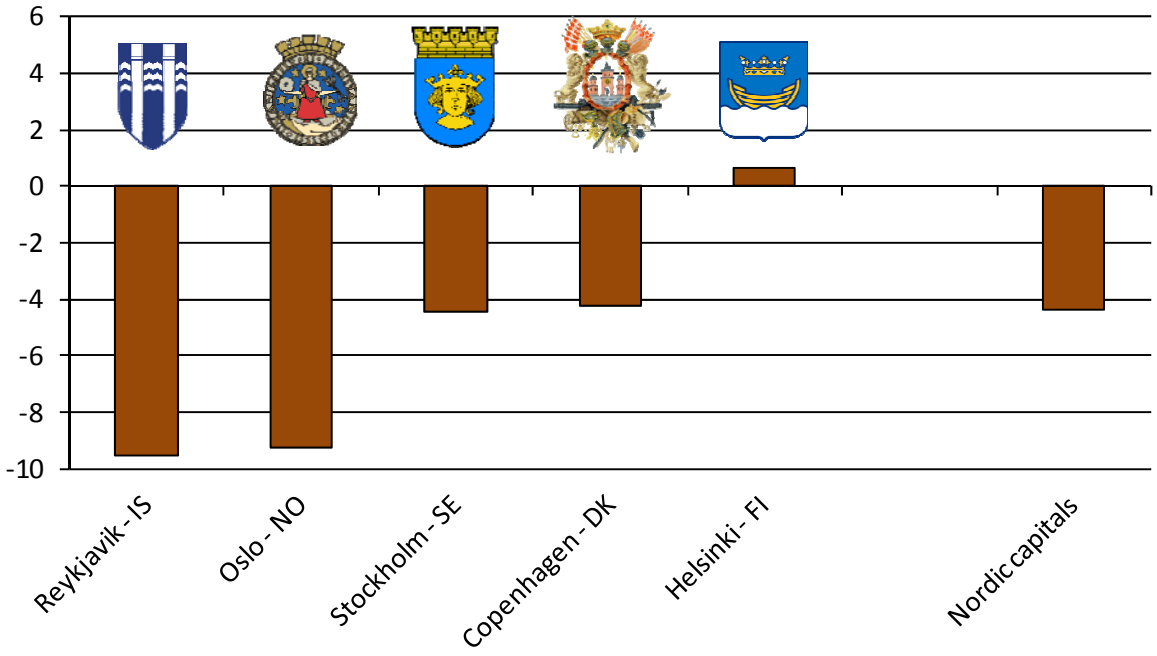


Fig.26: Average annual percentage change in deaths per million residents over the period 1996-2008.

When comparing the road mortality rate of the three most recent years (2006 to 2008) with that in the corresponding period ten years ago (1996 to 1998), the differences among the capitals are further emphasised (Fig.27). Reykjavik, Stockholm and Oslo have managed to halve their mortality rate, an exceptional performance also in comparison with other EU capitals. (Only Lisbon showed a similar reduction over the past decade.) By contrast: improvements are not so noticeable in Copenhagen where its road mortality rate is still above the Nordic average. Helsinki deserves particular attention. Ten years ago it had the lowest road mortality rate of the Nordic capitals, but nowadays with an unchanged rate, Helsinki places itself behind all except Copenhagen (Fig.27).

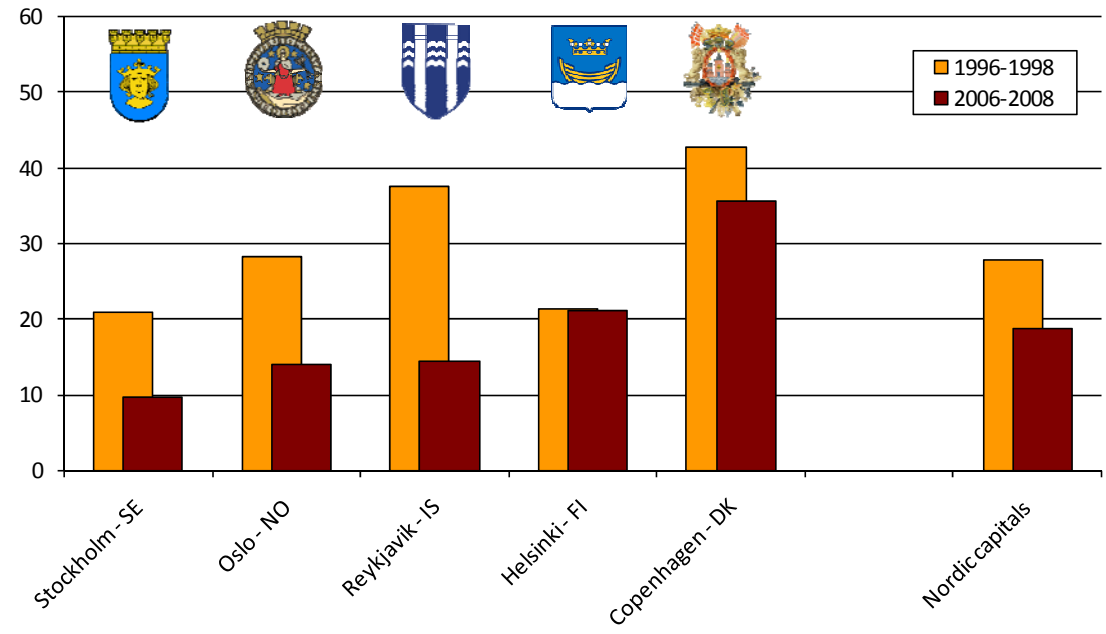


Fig.27: Road death rate per million residents in capital cities in 1996-1998 and 2006-2008.

Reykjavik is not only the Nordic capital where road mortality has been decreasing fastest, but is has also achieved the highest reduction in comparison with the reduction achieved by the rest of the country. The amount by which the annual average percentage reduction in road mortality in the capital exceeds that in the rest of the country in the period 1997-2008 is greatest in Reykjavik at 14 percentage points (Fig.28).

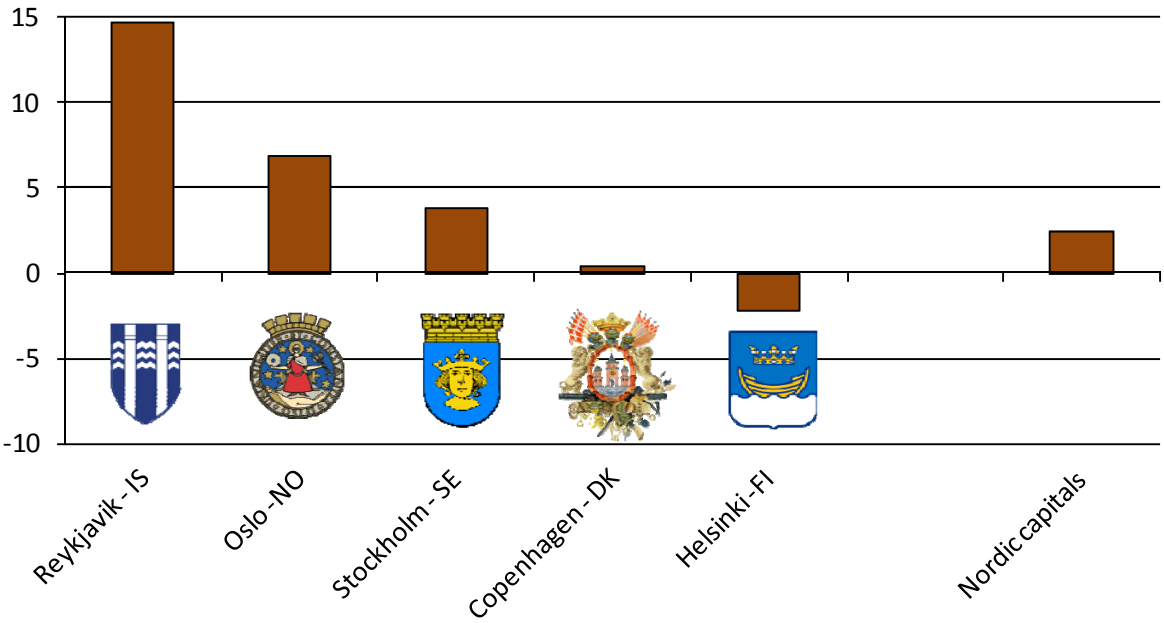


Fig.28: Amount by which the annual average percentage reduction in death rate per million resident population in the capital exceeds that in the rest of the country in the period 1997-2008.

Pedestrians and cyclists are the most common victims of road traffic in capital cities. Their share among road deaths in Nordic capitals is 42% and 18% respectively. In other EU

capitals they represent 44% and 6% of road deaths[24]. The reason for a high share of pedal cyclists among killed road users in Nordic capitals could be a higher use of this environmental friendly mean of transport. The proportion of those killed who are cyclists in Copenhagen and Stockholm is about 8 times that in Helsinki and Oslo, as shown in Fig.29. However it should not be forgotten that numbers under consideration are quite small. To give an idea 5 out of 16 total road deaths registered in Copenhagen in 2008 were cyclists. The share of car users among road users killed in Nordic capitals corresponds to the share registered in other EU capitals (one fourth of all deaths), but the proportion of those killed who are PTW users is substantially lower in Nordic capitals (13 against 20%) probably because of their lower use in the tougher climate.

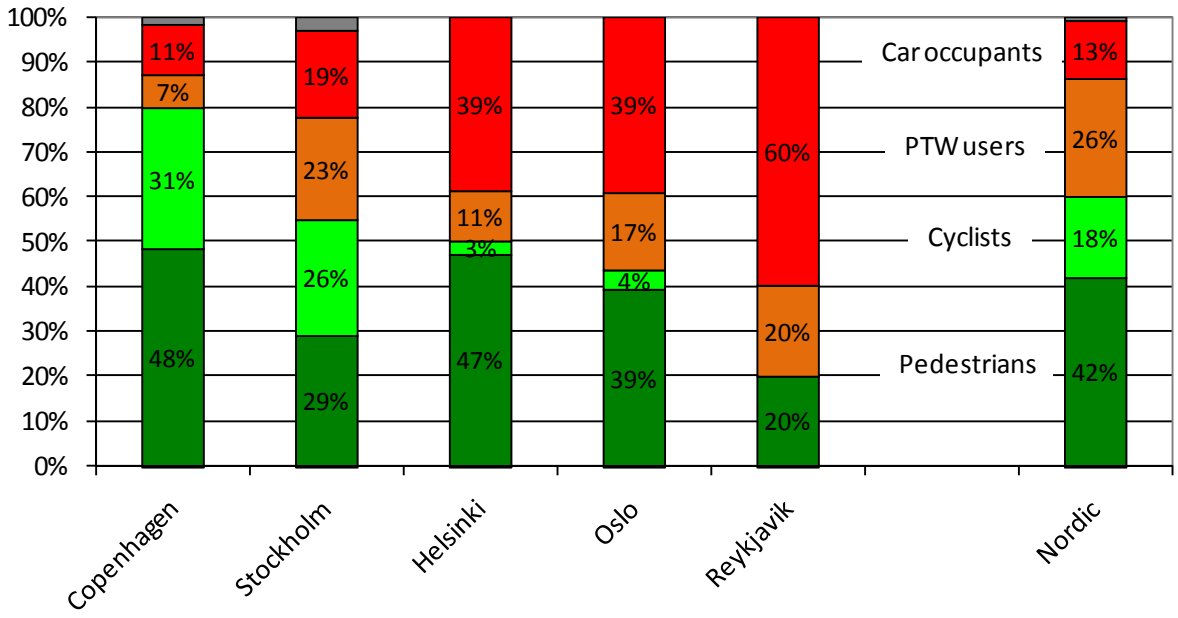


Fig.29: Distribution of road deaths by road user group in the Nordic capitals (2006-2008).

[24] See PIN Flash 11- En route to safer mobility in EU capitals downloadable at http://www.etsc.eu/PIN-publications.php

4.5 Safety of new cars

4.5.1 Car occupant protection

The proportion of cars awarded with the maximum of stars according to EuroNCAP parameters on car occupant protection is particularly high in Norway, Sweden and Finland. These are in the order of 60% or over, thus well above the EU average of 53%. The safest car fleet sold in 2008 was in Sweden. Sweden not only comes out as the country with the highest proportion of cars awarded 5-star, compared to the group of Nordic countries here under consideration[25] but also in comparison with all the rest of Europe[26]. However, Norway is in the lead when looking at 4- and 5-star cars together: 92.5% against Sweden with 91.1%. Denmark has a lower share of 5-star cars, but 88.1% of 4- and 5-star cars taken together. The share of 3-star cars in Nordic countries is particularly low compared to the EU average of 7% (Fig.30).

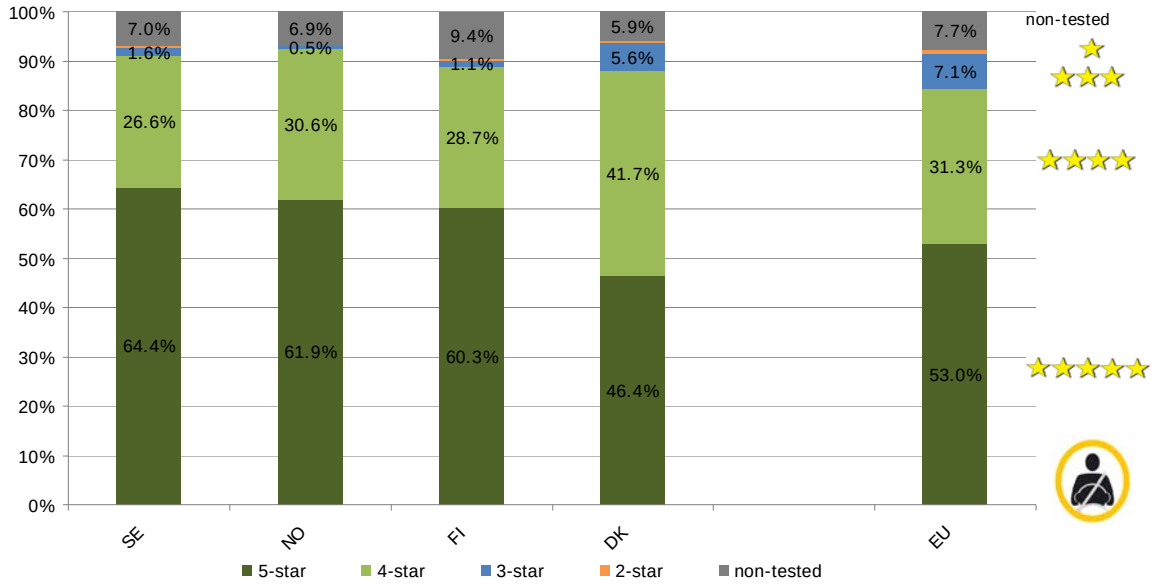


Fig.30: Occupant protection of new passenger cars sold in 2008.

Proportion of cars awarded 5 stars, 4 stars, 3 stars and 2 stars and proportion of non-tested passenger cars, ranked by the number of cars awarded 5 stars. None of the cars tested in 2008 was awarded 1 star only. Another way to measure the penetration of safe cars for occupant protection is to look at the average occupant protection scores across the fleet of new cars sold in 2008 by country (Tab.10).

Country	NO	FI	SE	DK	EU-27
% score	93.6	92.3	92.0	87.2	88.4

Tab.10: Average percentage occupant protection score for new passenger cars sold in 2008[27].

[25] Figures on car sales were not available for Iceland.

[26] ETSC (2009).

[27] Note: figures do not take into account the different proportions of non-tested cars (the average is of the scores for tested cars).

Fig.30 shows the results for occupant protection based on the simplified star award system. Tab.10 uses the scores in points. Tab.11 summarises the correspondence between scores and stars for occupant protection.

Occupant stars	★	★★	★★★	★★★★	★★★★★
Score in points	1-8	9-16	17-24	25-32	33-37
Percentage score (out of 35)	3-23%	26-46%	49-69%	71-91%	94-100%

Tab.11: Scores and corresponding stars for occupant protection under Euro NCAP's "Pre-2009 protocol".

In Norway, the average score of new cars sold in 2008 was 32.8 - equivalent to 93% of the maximum of 35 points for occupant protection. In Finland and Sweden, new cars received 92% of the maximum number of points. Only in Denmark is the total points score for occupant protection slightly below the EU average of 88.4%.

4.5.2 Pedestrian protection

Around 10,000 pedestrians die each year on European roads after being hit by a vehicle, and many more sustain life-long injuries. Norway, Finland and Denmark are almost in line with the EU average of 21.1% of cars awarded 3 stars for pedestrian protection. Only Sweden fails to impress in this area with 14.4%. Denmark and Norway exceed 70% in the proportion of 3-star and 2-star cars taken together.

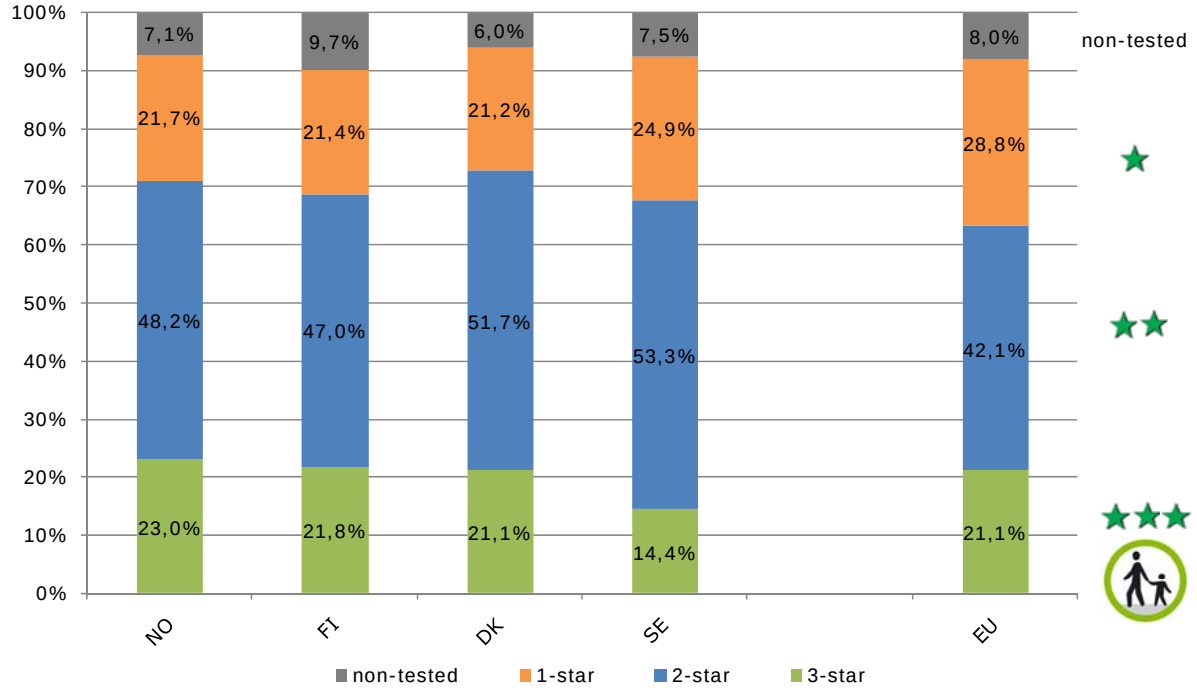


Fig.31: Pedestrian protection of new passenger cars sold in 2008.

Fig.31 shows the results for pedestrian protection based on the simplified star award system. Tab.12 uses the scores in points. Tab.13 summarises the correspondence between scores and stars for pedestrian protection.

Country	NO	FI	DK	SE	EU-27
% score	39.5%	39.0%	37.9%	36.9%	35.7%

Tab.12: Average percentage score of pedestrian protection for new passenger cars sold in 2008[28].

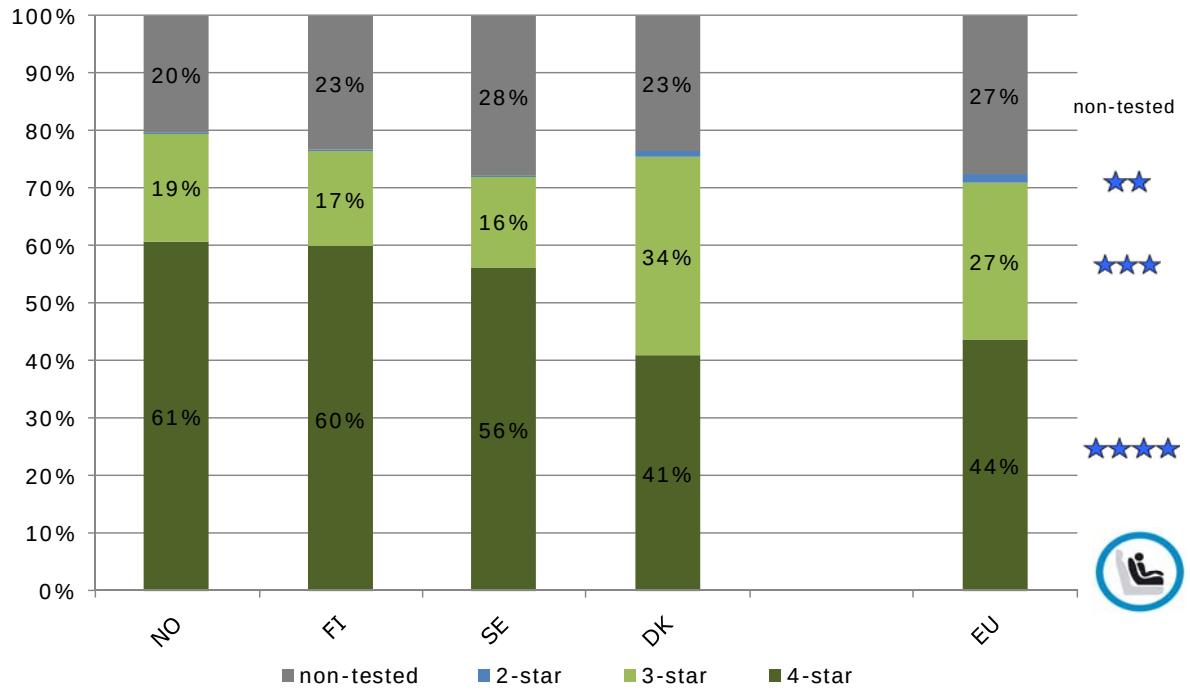
In the EU, the new cars sold in 2008 received on average only 36% of the maximum number of points for pedestrian protection.

Pedestrian stars	★	★★	★★★	★★★★	★★★★★
Score	1-8	9-16	17-24	25-32	33-36
Percentage scores	3-22%	25-44%	47-67%	69-89%	92-100%

Tab.13: Scores and corresponding stars for pedestrian protection under the Euro NCAP's "Pre-2009 protocol".

4.5.3 Child protection

Around 40% of children (0-16) killed in road accidents are killed when travelling in cars[29]. Since 2004, Euro NCAP assesses how well the car and the manufacturer's recommended child restraints protect young children in cars in the event of a crash. The protection for child occupants is particularly reassuring concerning the fleets sold in the four Nordic countries in 2008 as in Norway, Finland, and Sweden were sold the highest proportions in Europe of cars awarded the maximum of 4 stars for child protection. In Norway the proportion was 61% while the EU average in only 44%.



[28] Note: figures do not take into account the different proportions of non-tested cars (the average is of the scores for tested cars).

[29] ERSO (2008) and ETSC (2009).

Fig.32: Child protection of new passenger cars sold in 2008.

Denmark shows a proportion of 4-star cars below the EU average, but for 3- and 4-star cars taken together it shows 75% - above the EU average of 71%.

There is some uncertainly in this ranking as the child protection scores were not available for as many as 27% of new cars sold.

Proportion of cars awarded 4 stars, 3, 2 and 1 star and proportion of non-tested passenger cars, ranked by the number of cars awarded 4 stars are shown in Fig.32. None of the cars tested in 2008 were awarded 5 stars for child protection. In general, cars that offer good occupant protection to adults also offer good protection to children in cars.

4.5.4 Seat belt reminders

In the event of a collision, the seat belt remains the single most important passive safety feature in vehicles. Yet despite the legal obligation to wear a seat belt, wearing rates still vary greatly across Europe especially between front and rear seats and between urban and rural areas.

All Euro NCAP crash tests for occupant safety are based on the assumption that the driver and passengers are wearing seat belts. Euro NCAP introduced in 2002 additional bonus points under its occupant protection score for cars equipped with seat belt reminders. One additional bonus point is given to cars equipped with seat belt reminder (SBR) as a standard on the driver's seat, two points to cars equipped with SBR on front seats and three points to cars equipped with SBR as standard on all seats[30]. Those points can make the crucial difference between four and five stars under the pre-2009 rating.

In Finland and Norway, 18% of new cars in 2008 were equipped with seat belt reminders on all seats (Fig.33), followed by Sweden and Denmark (14%), compared to 13% for the EU. Concerning SBR front seats only, Norway comes first with 58%.

The penetration of seat belt reminders on drivers' seats has increased in the EU-27 since 2005. In 2005, some 56% of cars were equipped with a SBR for the driver's seat[31]; in 2008, it was 77%. Still, big differences persist between particular types of vehicles (see Fig. 34). Whereas 97% of the executive cars are equipped with a SBR for the driver's seat, only 68% of the Multi-Purpose Vehicles (MPVs) and 83% of the superminis are.

No specific studies have been carried out to identify the causes of the differences in safety of average new cars sold in different countries, but they are likely to follow from a combination of factors like differences in national market characteristics such as purchasing power, tax levels, availability of models, or cultural and mobility patterns.

[30] To fulfill Euro NCAP criteria, seat belt reminders must use a combination of visual and sound signals. For details see ETSC (2007).

[31] ETSC (2007).

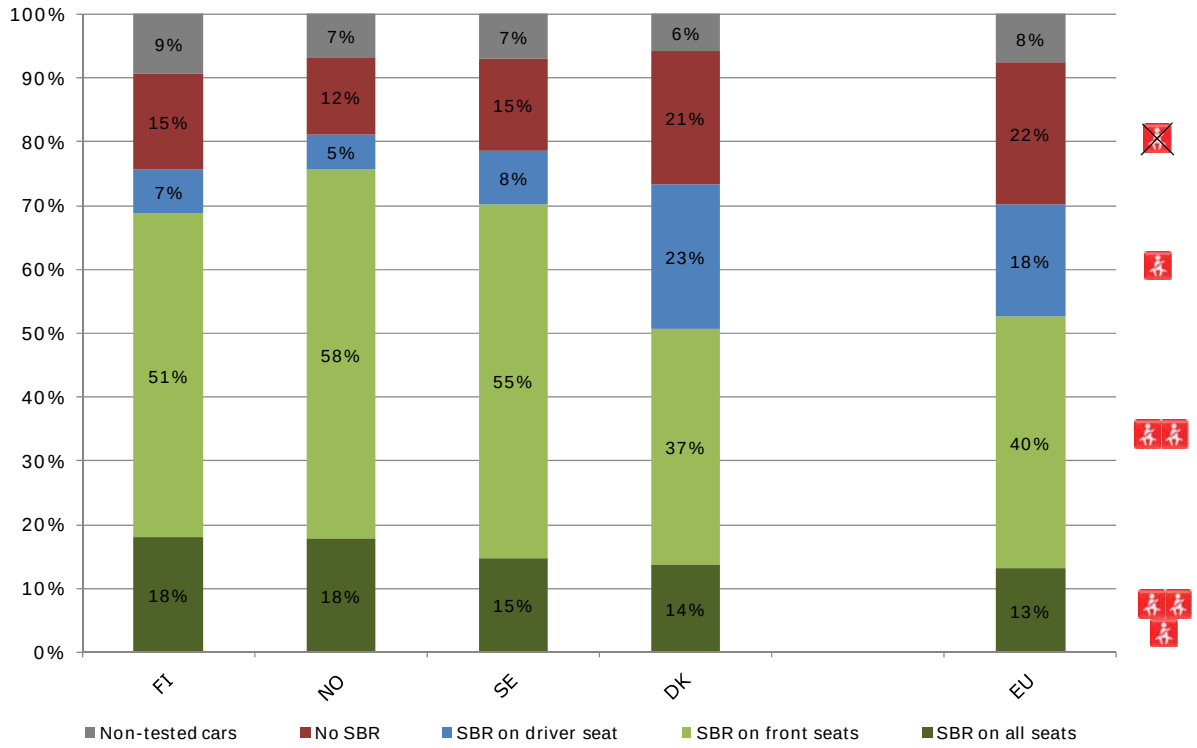


Fig.33: Proportion of seat belt reminders for all seats in new passenger cars sold in 2008.

Proportion of cars awarded 3 points, 2 points and 1 point and proportion of non-tested passenger cars, ranked by the number of cars awarded 3 points for seat belt reminders.

As shown in Fig.34, large differences exist between consumers' preferences for particular car categories in the four Nordic countries. Grouping of new cars into specific categories helps towards some understanding of the national market differences. More particularly, the low proportions of supermini vehicles among all new cars in Norway, Finland and Sweden partly explains the relatively good occupant protection scores and the less good pedestrian protection scores of cars sold in these Nordic countries. The size of the share of large family cars in these countries is in fact considerable and causes serious concern for the level of passive safety protection for vulnerable road users.

Four Nordic countries are at the forefront when it comes to Governmental incentives to promote the purchase of safest cars. Sweden had recently passed a new law according to which all governmental bodies can renew their own fleets only with cars awarded with the maximum of stars under the EuroNCAP protocols. In Denmark, safety equipment such as airbags is exempted from taxation and the level of car taxation is one of the highest in Europe. These are examples of policies clearly driven by safety purposes.

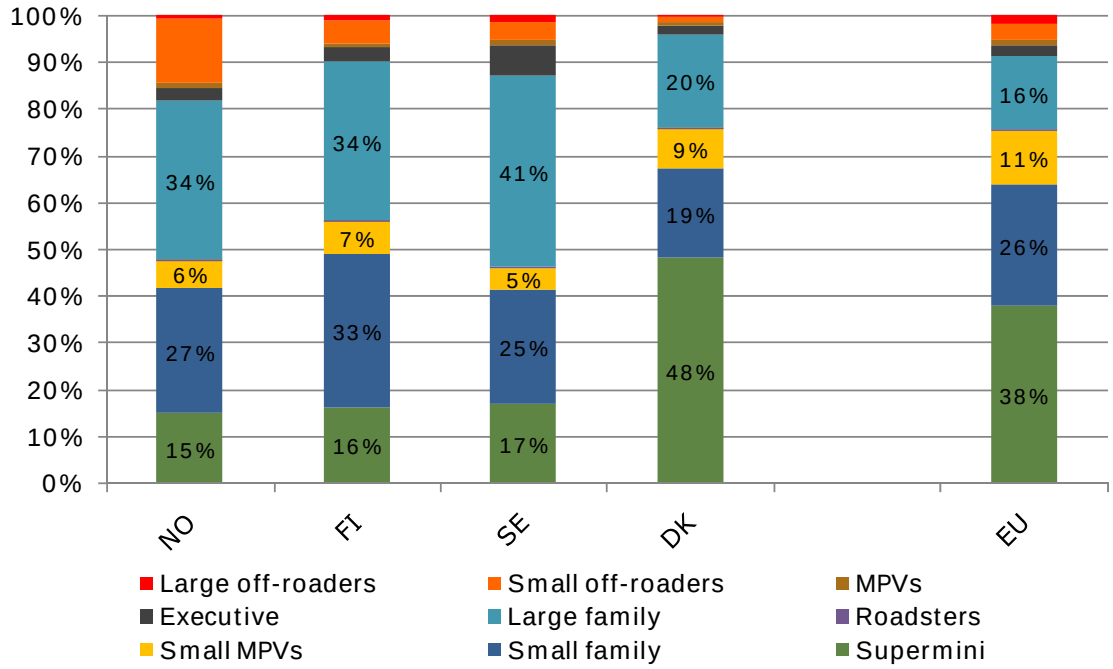


Fig.34: The percentage share of vehicles according to Euro NCAP vehicle category among the new cars sold in 2008, in reverse order of the proportion of superminis.

But new cars represent only the tip of the iceberg. More than half of all registered vehicles are older than 7 years. The renewal rate is a measure of the rate at which the new vehicles affect the makeup of the fleet. In 2007 it varied from around 8% in Denmark to less than 5% in Finland (Tab.14).

Country	DK	SE	NO	FI	EU-27
% score	7.9%	7.2%	6.4%	4.9%	6.7%

Tab.14: Annual renewal rate of passenger cars in 2007 (percentage of new cars among all registered passenger cars)[32].

[32] Source: ANFAC (Spanish Automobile Association) (2009). Total registrations: Report on motor vehicles in use in Europe 2007.

5 Summary overview

This report consists of a large number of different rankings on road safety performance of Nordic countries at national level. The comparisons are possible for the performance in different areas of road safety management.

	Level					Progress				
	NO	FI	SE	DK	IS	NO	FI	SE	DK	IS
Road mortality	2	4	1	5	3	3	2	4	1	5
Fatality rate	3	4	1	5	2	1	4	5	3	2
Fatality risk	2	4	3	5	1	1	4	5	3	2
Overal risk	3	4	1	5	2	1	3	5	2	4
Urban	1	NA	2	3	NA					
Rural	1	3	2	4	5	1	2	NA	3	NA
Motorways	3	1	2	4	NA	1	3	2	4	NA
Overal speeding	1	3	2	4	NA	1	3	2	4	NA
Seat belts front	2	3	1	4	NA	3	4	1	2	NA
Seat belts rear	1	2	4	3	NA	3	2	4	1	NA
Cyclist helmets	1	2	3	4	NA	1	3	2	NA	NA
Overal Protective Systems	1	3	2	4	NA	2	4	3	1	NA
Alcohol related deaths	1	4	2	5	3	NA	2	3	1	NA
Overal behaviour	1	3	2	4	NA	1	3	2	4	NA
Divided roads	4	3	1	2	NA	NA	1	3	2	NA
Children	4	2	1	5	3	5	3	2	4	1
Elderly	2	3	1	5	4	3	2	4	1	5
Two-wheelers	1	2	3	4	NA	1	5	3	2	4
Capitals						2	5	3	4	1
Occupants	2	3	1	4	NA					
Pedestrians	1	2	4	3	NA					
Child protection	1	2	3	4	NA					
SBR	2	1	3	4	NA					
Overall cars	1	2	3	4	NA					
Overall other indicators	2	3	1	4	NA	1	4	2	3	NA

Legend:	1	2	3	4	5	NA
	Very high	High	Good	Poor	Very poor	Not available

Tab.15: Overview of all indicators used and their aggregated values.

In this overview, the rank of individual countries among those for which the indicator is available is presented. The level and trend are used as two separate indicators shown on left and right hand sides.

Overall rankings in different areas (road risk, behaviour, other indicators) are presented, as the result of the weighting procedure applied for relevant sub-indicators. The weights are usually proportional to the number of sub-indicators, but there are some exceptions:

1. For the overall death rate, the weights are applied as 0.5 for deaths per population, and 0.25 for each of two other death rates, to put at the same level the measure of personal safety and road system safety.

2. For the overall rate of protective system use, the weight of 0.5 was applied for seat belt wearing rate on front seat and 0.25 to the rate on rear seats as well as to the rate of helmet use.

3. For the behaviour overall, the weights of 0.33 are used for alcohol overall, speed overall and protective systems overall indicators

The aim of this exercise is to identify areas of underperformance of each of 4 Nordic countries. While Sweden still comes out as the country with the best road safety performance, the trend calls for attention, as well as certain areas of road safety policy. Similarly, Denmark performs relatively weakly in most areas of road safety but displays an encouraging trend in recent years, and is thus catching up with other Nordic countries.

6 Conclusions and recommendations

This comparative study, as well as confirming their leading position in European road safety, has identified particular areas of underperformance of Nordic countries which lead to certain recommendations to particular countries:

To all Nordic countries:

- Overall road safety performance is still well above the EU average, but the gap between Nordic countries and the rest of Europe is shrinking over time. Bearing in mind that it is difficult to continue improving the situation when figures are getting better and better, renewed effort and innovative solutions are therefore needed to bring further improvement[33].
- Further promote the use of alcolocks in professional transport and by recidivist offenders.
- Further promote the use of ISA on all types of roads and improve seat belt wearing on rear seats and in heavy good vehicles.

To Sweden:

- The use of protective systems should be further improved, especially seat belts on rear seats and cyclist helmets. This could be done by further enhancing the penetration of all-seats seat belt reminders in passenger cars. The compliance with seat belt legislation by professional drivers should be a priority.
- Passive safety of new vehicles in respect of pedestrian protection is mediocre and should be a focus of policy actions.
- Safety of PTW riders requires continuous attention not only due to a high risk level, but also due to increasing numbers.
- Improve collection of speed data to allow for better evaluation of policies in place.

To Norway:

- Norwegian divided roads are less safe in comparison with other Nordic countries and the reasons for this should be investigated and safety measures identified and implemented.
- Identify and implement measures for improving child safety on roads.

[33] EU and Member States could look for advice to the ETSC Blueprint « Road Safety as a right and responsibility for all ». The report is available at http://www.etsc.eu/blueprint-4th-road-safety-action-programme.php

To Finland:

- With a relatively high risk levels and rather weak progress, road safety should be given higher attention in general.
- Elderly people are particularly at risk relative to the rest of the population and a relatively low level of vehicle safety and pedestrian safety contribute to this. Speed enforcement in urban areas may help improve the situation and get the annual numbers of deaths in the Capital city moving downwards again.
- Most road deaths and injuries occur on rural roads, where all three main behavioural factors (speed, non-wearing of seat belts, alcohol) are present. Enhanced enforcement could be a response to this.
- Identify and implement measures to reverse a negative trend in PTW deaths.

To Denmark:

- With the worst road safety performance among Nordic countries, the country certainly needs a new impetus in area of road safety. All major risk factors should be addressed, especially speeding. The extension of the stationary safety camera surveillance to most of the (motorway) network could be a viable and valuable measure.
- Initiatives are needed to improve penetration of safer cars in the national market.
- Children represent the top priority target group and their safety could be improved by safer cars, helmet use and better education.

To Iceland:

- The safety of elderly people appears to be a major problem and should be addressed by improvements in infrastructure design and its passive safety.

Annexes:

Annex A: Methodological notes

Regression estimation of the average annual percentage change in road mortality rates

To estimate the average yearly percentage change in road death occurring over a given period, one should make use of the whole time series of count, not just the counts in the first and the last year.

When the road death counts are too small numbers subjected to randomness, it is preferred to use central moving average numbers instead of single year values. The recorded number of deaths is replaced by the average of the counts registered this year, the previous year and the following year.

$Y_i^*=(Y_{i-1}+Y_i+Y_{i+1})/3$

The resulting estimate will be less sensitive to the randomness and likely more reliable. The task is now to estimate the average annual change in road mortality in the given period (most often 1998-2008), while using either single year counts or three-year centred averages instead of single year values. For year 2008, the average of 2007 and 2008 is used.

We assume a priori a reduction in risk of mortality rate over time, so to fix the sign of a change; we will assume reduction, so that a minus sign indicates an increase. Let the average reduction per year as a percentage of the previous year be p. If λ_n is the risk of deaths in year n, then we wish to fit a model $\lambda_n = \lambda_0(1-p/100)^n$, where in this case year 0 is 1998 and $n = 10$ in 2008.

This is equivalent to $\ln(\lambda_n/\lambda_0) = n.\ \ln(1-p/100)$ so if we fit $\ln(\lambda_n/\lambda_0) = an$ by linear regression, then a is the estimate of $\ln(1-p/100)$ and p is estimated by $100(1-e^a)$.

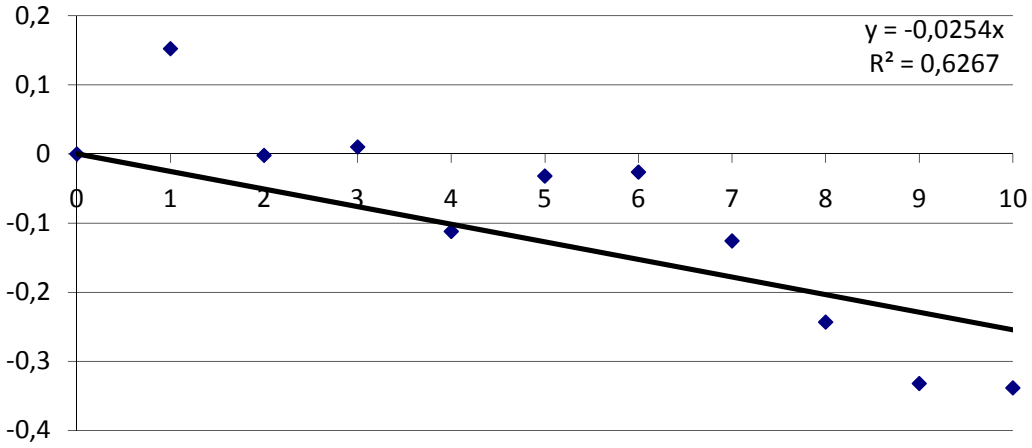


Fig.2: Linear regression function for logarithmically transformed changes in death counts since 1997-1999 as baseline.

In this figure illustrating the use of the method and constructed for road mortality in Vienna city, the function $\ln(\lambda_n/\lambda_0) = an$ corresponds to the function $y=ax$, so the a is equal to -0.0254. The p can now be estimated as $100(1-e^{a}) = 100(1-e^{-0.0254})= 2.51$. Average yearly reduction in road deaths is thus estimated as 2.5%. One can conclude that the average annual reduction in road deaths over the period 1998-2008 has been almost 3%.

Vehicle safety indicators

There is no overall indicator of what is a safe car. Since 1997, however, the European New Car Assessment Programme (Euro NCAP) provides an objective assessment of the protection provided by a car in case of a crash for the occupants of the vehicle and pedestrians outside the vehicle. Euro NCAP introduced in 2002 additional point bonus under its occupant protection score for cars equipped with seat belt reminders.

This report uses as main indicators of the penetration rates of safe cars among new cars sold two indicators that have equal importance: the penetration of cars awarded 5, 4, 3 or 2 stars for occupant protection and the penetration of cars awarded 3, 2 and 1 star for pedestrian protection. Two additional indicators are used: the penetration of cars awarded 4, 3 or 2 stars for child occupant protection and the penetration rates of cars equipped with seat belt reminders. New cars sold in first nine months of 2008 are considered.

Data concerning the number of passenger cars sold by models and by countries were bought from a German consultancy R.L. Polk Marketing Systems GmbH in February 2009. The information on Euro NCAP scores and star ratings for particular models was provided by Euro NCAP. The dataset is available in the PIN Flash 13 Background tables on www.etsc.be/PIN-publications.php. Euro NCAP tests around 30 car models each year. 250 car models have been crash tested to date. Euro NCAP test results were available for 90% of the new cars sold in 2008. Details of the tests used and the results are available on Euro NCAP's web site www.euroncap.com. It should be noted that most car models are available in different variants that may have different safety equipment. Euro NCAP typically tests the best selling variant (identified by the car manufacturer). For example, the Volkswagen Polo is sold in Europe in hatchback, saloon, coupé and estate variants. Euro NCAP tested the 5-door hatchback variant in 2002. For the purpose of this survey, those results are assumed to apply to most other variants as well.

In 2009, Euro NCAP introduced a new overall rating that will challenge vehicle manufacturers to make all-round safer cars. In April 2009, 6 car models had been tested under the "2009 protocol" and scores of 7 other models tested under the "pre-2009 protocol" had been converted into the new format. It would however not have been possible to use this new protocol for a pan-European comparison. Results are therefore based on the "pre-2009 protocol".

Estimation of lives saved by seat belts in cars and potential further lives saved

The following estimation is based on most recent data available in ERSO and on the methodology developed within the SafetyNet project and available in SPI Manual.[34] Aggregated rates of seat belts use are roughly estimated as follows (example is given for Nordic countries)[35]:

SPI-A: Daytime usage rate of seat belts on front seats of light vehicles.....92%

SPI-B: Daytime usage rate of seat belts on rear seats of light vehicles 81%

Seat belt wearing rates by occupant fatalities can be additionally estimated from the known daytime rate as observed during the survey and assumed values of effectiveness of belts and risk of fatal collision involvement of non-wearers relative to that of wearers. Applying Equation 1, and assuming the risk factor equals to 1.5, the estimated rate of using seat belts by fatally injured front seat occupant is:

$F(x)=((1-e)*x)/(x(1-e)+R(1-x))$

where x stands for daytime usage rate of the device use, e stands for the effectiveness and R is a risk factor showing how many times the risk of being involved in fatal crash for those users not using the system is higher than the risk for those using the system.

$F(x)=(1-e)*x/(x(1-e)+R(1-x))=(1-0.52)*0.92/(0.92(1-0.52)+1.5(1-0.92))=0.79\approx 79\%$

$F(x)=(1-e)*x/(x(1-e)+R(1-x))=(1-0.48)*0.81/(0.81(1-0.48)+1.5(1-0.81))=0.60 \approx 60\%$

In the absence of detailed accident data, the number of deaths on rear seats is assumed to account for 25% of all car occupants.

The seat belts saved some 608 car occupants from dying in road crash in Nordic countries in 2008, while additional 103 lives could be saved if all car occupants were belted in crash.

The development in the use of protective systems over time is assessed by conversion rates as well as simple absolute or relative increase in the use.

Conversion rate defined as the ratio of decrease of non-use from last year (*t-1*) to next one (*t*) to level of non-use last year

$CR_t=[(100-A_{t-1})-(100-A_t)] / (100-A_{t-1})$

The conversion rate provides an alternative measure of improvement to percentage point or percentage increase in use as it shows the percentage of belt non-users converted into users, each year. The improvement is thereby assessed in a way that does not penalise regions or other categories that already exhibit high wearing rates. The conversion rate is positive when the use increases, but it can also be negative when the use declines.

Note: A similar method leading to the same results without estimating explicitly the proportion of those killed who wore belts was applied in PIN Flash No.4 and is described on pages 54-55 of the first PIN Annual Report (ETSC 2007) and in:
http://www.etsc.eu/documents/Lives%20saved%20per%20country.pdf

[34] Hakkert and Gitelman (2007).

[35] Source: Vis and Eksler (2008)

Country	Seat Belts WR in 2008	Daytime rate	Rate by fatality	Killed total	Effectiveness	Killed belted	Killed unbelted	Lives saved	Potential
		R_t	R_{fa}	N	e (x100%)	D_s	D_0	$N_s=(e/(1-e))*D_s$	$N_p=e*D_0$
DK	Front	0.90	0.74	91	0.52	68	23	73	12
	Rear	0.79	0.57	30	0.48	17	13	16	6
	SUM			121		85	36	89	18
FI	Front	0.90	0.74	152	0.52	113	39	122	20
	Rear	0.82	0.61	51	0.48	31	20	29	9
	SUM			203		144	59	151	30
SE	Front	0.96	0.88	206	0.52	182	24	197	12
	Rear	0.74	0.50	69	0.48	34	35	32	17
	SUM			275		217	58	229	29
NO	Front	0.93	0.81	131	0.52	106	25	115	13
	Rear	0.85	0.66	44	0.48	29	15	27	7
	SUM			175		135	40	142	20
IS	Front	*0.80*	0.56	7	0.52	4	3	4	2
	Rear	*0.70*	0.45	2	0.48	1	1	1	1
	SUM			9		5	4	5	2
Nordic	Front	0.92	0.79	587	0.52	462	125	500	65
	Rear	0.81	0.60	196	0.48	117	79	108	38
	SUM			783		578	205	608	103

Tab. B: Estimation of deaths prevented by seat belt and the potential in 2008

Estimations for alcohol impairment

Various surveys indicate that the proportion of driving by those over the legal blood alcohol concentration (BAC) limit is of the order of 1 per cent and the proportion of killed drivers who are over the limit is an order of magnitude greater.

If 1% of all drivers were over the limit and 15% of killed drivers were over the limit, this would imply a risk of being killed when driving over the limit of x times the risk to those driving within the limit given by the equation:

$x/(99 + x) = 15/100$

i.e that $x = 17.6$

This is broadly consistent with findings concerning the relationship between risk of fatal accident and BAC taken together with the observation that the distribution of BACs in accident-involved drinking drivers has a long upper tail.

Annex B: Definition of serious injuries

Denmark	
Finland	Separate statistics on seriously and slightly injuries are not available. Definition based on accidents reported by the police: Any person who was not killed, but sustained as a result of the accident injuries requiring treatment or observation in hospital, at home (sick leave) or operative treatment, such as stitches. Bruises, scratches and the like not requiring aforementioned treatment are not regarded as injuries.
Iceland	Fractures, concussion, internal lesions, crushing, severe cuts and laceration, severe general shock requiring medical treatment and any other serious lesions entailing detention in hospital." (Economic Commission for Europe, Geneva).
Norway	Very serious injury: Any injury that is life-threatening or results in permanent impairment. Serious injury: Any injury from a list of specific injuries; these would normally require admission to hospital as an in-patient
Sweden	Severely injured according to the police: a person who has sustained a fracture, crushing injury, laceration, severe cuts, concussion or internal lesion. Other injury that is expected to cause hospitalisation is also counted as severe injury. Other personal injury is considered to be slight. Assessment whether an injury is severe or slight is made by the police at the site of the accident. Errors in classification can be made both ways.

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