TRANSPORT SAFETY PERFORMANCE IN THE EU A STATISTICAL OVERVIEW

2003

European Transport Safety Council
Rue du Cornet 34
B – 1040 Brussels

Tel: 0032 2 230 4106
Fax: 0032 2 230 4215
email: info@etsc.be

ISBN: 90-76024-154

Acknowledgements

ETSC gratefully acknowledges the contributions of the Chairman and members of ETSC's Transport Accident Statistics Working Party to this review:

Working Party Members

Mr. Matthijs KOORNSTRA (Chairman)
Dr. Jeremy BROUGHTON
Mr. Jean-Pierre CAUZARD
Mr. Robert ESBERGER
Prof. Andrew EVANS
Mr. Cees GLANSDORP
Mr. Lasse HANTULA
Dipl. Ing. Werner KÖPPEL
Mr. Michel PIERS
Mr. Frank TAYLOR
Mr. Ward VANLAAR

ETSC Working Party Secretary: Mr. Antonio Avenoso

ETSC is grateful for the financial support provided by Directorate of Energy and Transport of the European Commission. ETSC also acknowledges the contribution towards the printing and dissemination costs of this review provided by Bombardier Transportation, BP, CEA, KeyMed, Railway Safety, Railtrack Group plc, Scania, and Shell International. The contents of this review are the sole responsibility of ETSC and do not necessarily reflect the view of sponsors nor organisations to which research staff participating in the Working Party belong.

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. Cutting across national and sectoral interests, ETSC provides an impartial source of advice on transport safety matters to the European Commission, the European Parliament and, where appropriate, to national governments and organisations concerned with safety throughout Europe.

The Council brings together experts of international reputation on its Working Parties, and representatives of a wide range of national and international organisations with transport safety interests and Parliamentarians of all parties on its Main Council to exchange experience and knowledge and to identify and promote research-based contributions to transport safety.

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EXECUTIVE SUMMARY

Transport crashes in the EU killed about 39,200 EU citizens in 2001, cause over 3.3 million casualties and presently cost over 180 billion Euros, around twice the total EU budget for all activity.

Nowadays road crashes in the EU lead to 97% of all transport deaths and to more than 93% of all transport crash costs and are the leading cause of death and hospital admission for citizens under 50 years. Road crashes cost more than congestion and pollution, or cancer and heart disease.

Comparisons across the modes
Risk comparisons for the EU show that the fatality risk for motorised two-wheelers is the highest of all modes, being on average 20 times higher than for car occupants. Also cycling and walking have on average a 7 to 9 times higher fatality risk per distance travelled than car travel. Road traffic collectively has the highest fatality risk per passenger kilometre of all passenger transport modes.

Rail and air travel are the safest modes per distance travelled, followed by bus. The passengers of trains, bus/coach and planes within the EU have the lowest fatality risk per passenger kilometre. For the average passenger trip in the EU, bus travel has a 10 times lower fatality risk than car travel and air travel within the EU has for the average flight distance about the same fatality risk per passenger kilometre as train travel and both are half as risky as travel by coach. The risks associated with ferry travel fluctuate, but the expected fatality risk is 4 to 8 times that of train travel.

Fatality risk in road transport: the current EU countries
France, Germany, Italy, and Spain account for 68 per cent of the total of 38,935 road fatalities in the EU in 2001. France and the UK have about the same number of inhabitants, but France has about twice the number of fatalities as the UK as its risk is twice as high.

The southern EU countries, France, and Belgium have fatality risks above the average for the EU, and risks in the other EU countries are below-average. A five times higher death rate per motor vehicle kilometre is nowadays present in the worst than the best performing Member States (in 1997 this ratio was 7).

The fatality risk order of EU countries in 2000/2001 changed with respect to 1997, due to noticeable differences between the rates at which national risks have fallen. The six countries with lowest fatality risks have had numerical targets for casualty or fatality reduction in the past decade or decades.

The fatality rate in the EU has decreased almost constantly in an exponential way, by an average annual reduction of 5.3%. Combined with extrapolated traffic growth it leads to a predicted 27,000 fatalities in 2010 within the present countries of the EU. The EU target of reducing fatalities by 50% between 2000 and 2010 (i.e. to 20,000 fatalities in 2010) will only be achieved if the EU takes additional actions that reduce the risk more rapidly than in the past.

Fatality risk in road transport: the ten accession countries
Motor vehicle kilometre data are not available for the accession countries. In order to compare their fatality risks with those of the present EU countries, it is assumed that on average each vehicle drives 10 thousand kilometres per year, which seems approximately correct overall. With this assumption, the average fatality risk of the 10

accession countries is about 3 times higher than the EU average, slightly higher than Greece (worst performing EU country) and 5 times higher than the UK (best performing EU country).

The multiplication of extrapolated trends for fatality rate and vehicle growth predicts a total of 8,625 fatalities in 2010 in the 10 accession countries, where in 2001 about 11,000 road traffic deaths (within 30 days after the crash) are reported.

The safety of motorised two-wheelers in the EU

Users of motorised two-wheelers have the highest fatality risk of all road user groups. Moped and mofa fatalities are predominantly in the southern EU countries. This is also true for motorcycle and scooter fatalities, but also Germany and the UK have relatively many motorcycle and scooter fatalities.

Railway passenger safety in the EU

The fatality risk per billion train passenger kilometre fell from 1970 to 2000 by an average of 5.5% per year. The mean annual number of train passenger fatalities in the EU decreased from about 400 in the early 1970s to around 100 in 1999 and 2000. The rail passenger kilometre in the 15 EU-nations increased from about 200 billion in 1970 to about 300 billion in 2000. The expected fatality risk per billion train passenger kilometre is about 0.35 for 2001/2002 within the EU.

Passenger safety in civil aviation within the EU

Air transport fatality statistics refer mainly to scheduled flights, because air travel fatalities on unscheduled flights are only partially reported by international air transport organisations. A similar practice exists for private plane fatalities – they are neither registered worldwide nor for the EU. Due to large annual variations of air passenger deaths in scheduled flights and the absence of reliable data on unscheduled flights within the EU, the most probable passenger risks in civil aviation within the EU is obtained from the average of (1) the world-wide risk statistics with corrections for the share, duration or distance and occupancy of flights within the EU and (2) the actual observed risks for scheduled flights within the EU, both adjusted for the estimated additional share of unscheduled flights with estimated risks from their partially available data. The passenger fatality risk in civil aviation within the EU is estimated to be about 0.035 per 100 million passenger kilometre, but 16 per 100 million passenger travel hours. Air and train travel within the EU have now on average the same risk per distance. However, planes have much higher risks during the take-off, climb, descent, approach and landing manoeuvres than when cruising. Therefore, air travel trips have the higher risks per distance the shorter the air travel trips are, whereby trips below 600 kilometres ground distance are safer by (high speed) train than by plane. Due to regional differences in the safety procedures and ground communications around airports, the risks of air travel differ markedly according to region of departure and of destination, and less by the home country of the flight operator. The main airport regions within the EU belong to the safest in the world.

Passenger risk by sea transport in EU waters

Casualty risks per ship type and size are given in the ETSC Report of 1999 on “Exposure data for travel risk assessment”. This Report shows that tankers and ships of more than 6 million kg cargo capacity have a casualty risk per million nautical miles that is more than twice as high as for all vessels (about 2.8 compared with about 1.35), while casualty risk for ferries and roll-on/roll-off container ships is almost half of the risk for all vessels.

There were no ferry passenger fatalities in EU waters after the ESTONIA disaster in 1994. The risk levels identified in the ETSC Report of 1999 can now be updated for the longer period 1984-2001 and are thus less dominated by the exceptional number of fatalities in 1994. The updated fatality risks of ferry passengers that are comparable with other transport modes risks become:

fatalities/100 million passenger hours	8.0
fatalities/100 million passenger kilometres	0.25

Recommendations

1. Road safety needs more priority in the transport policies of EU Member States and the EU, because 97% of all transport fatalities in the EU are caused by road transport. Road transport accounts for 88% of all passenger transport in the EU, but accounts for over 100-times more deaths than all other modes together.

2. It is recommended that national and EU health policies recognise the relatively high mortality and injury incidence rates for road traffic.

3. The EU target of 50% road traffic fatality reduction between 2000 and 2010 to about 20,000 fatalities in 2010 will not be achieved unless the EU takes additional actions that reduce the fatality risk more rapidly than in the past. Therefore, it is recommended that further actions within the competence of the EU itself (mainly vehicle safety regulations) are taken and that a EU road safety subsidy fund is created for financial incentives that support and trigger national road safety actions and measures with a proven effectiveness.

4. Priority setting for transport safety must recognise the very high fatality risk of motorised two-wheelers (15 times the average road risk per kilometre travelled).

5. It is recommended that the safety of pedestrians and cyclists be improved, because their fatality risks per kilometre are 7 to 9 times higher than for car travel.

6. Passenger transport policies of the EU and its countries should promote the use of (high speed) trains in long distance trips, because the fatality risk of air travel for ground distances of less than 600 kilometres is higher than for trains.

7. Intermodal passenger transport policies have to recognise that large differences exist between the risks of travel modes. The safety of walking and cycling needs also to be improved in order to optimise the safety of public transport, due to the high risk of the necessary walking and/or cycling in the ‘before and after’ phases of these trips.

8. Initiatives to improve the recording of road travel volumes and fatalities are being undertaken by the EU, but progress is lacking for rail travel in the EU, travel on EU waters and inland waterways of the EU, and air travel by unscheduled flights and private planes within the EU. Moreover, serious injury risks for different travel modes are hard to assess because the necessary incident and exposure data are defined differently and not consistently gathered. It is recommended that research and development as well as reporting harmonisation on these matters be initiated by the EU.

Similar recommendations (except the third) were formulated in 1999 in the ETSC Report on “Exposure data for travel risk assessment”, but it is disappointing that they have had so little effect. In view of the EU road traffic fatality reduction target that has been set and the urgency of taking action to achieve the target, the recommendations need to be implemented soon.

1 INTRODUCTION

Transport crashes in the EU killed about 39,200 EU citizens in 2001, cause over 3.3 million casualties and presently cost over 180 billion Euros (estimate taken from ETSC (1997) and corrected for inflation and improved safety), around twice the total EU budget for all activity.

Road crashes in the EU each year lead to 97% of all transport deaths and to more than 93% of all transport crash costs and are the leading cause of death and hospital admission for citizens under 50 years. Road crashes cost more than congestion, pollution, cancer and heart disease and result in a five times higher death rate in the worst than the best performing Member States.

As part of the current programme of activity which receives matched funding from the European Commission, the European Transport Safety Council has brought together independent experts from across the EU to update the analyses of the risk of death on travel modes within the EU that were presented in the1999 ETSC Report on “Exposure data for travel risk assessment”.

This Report discusses the risk trends up to 2000/2001 or 2001/2002 and considers what they mean for EU citizens and policy makers.

Section 2 looks at passenger transport risks in the EU and updates the figures of road, rail, air and ferry passenger risks within the EU for 2000/2001 or 2001/2002. Risk comparisons of intermodal trips and comparisons between the risks of transport and other activities are also summarised[1].

Section 3 analyses fatality risks in road transport. This section includes predictions of road traffic fatalities in the EU and its ten accession countries for 2010 and an analysis of the number of deaths among users of motorised two-wheelers in the EU countries. The feasibility of achieving the EU target of 50% road fatality reduction in 2010 is assessed.

Section 4 considers railway safety in the EU. Passenger safety in air transport within the EU is covered in Section 5 whereas Section 6 deals with passenger risk by sea transport in EU waters.

Finally, recommendations are made for appropriate national and EU actions in the short to medium term.

1. Risk comparisons of intermodal trips and comparisons between the risks of transport and other activities (for work types and at home) as well as comparisons between the health risks of transport and diseases are extensively discussed in the ETSC Report “Exposure data for travel risk assessment” (1999).

2. SUMMARY OF PASSENGER TRANSPORT RISKS AND THEIR COMPARISONS

Tables 1 and 2 show the death risk for the different travel modes in the EU (over distance and time) for the period 2001/2002.

Road (Total)		0.95
Motorcycle/moped	13.8	
Foot	6.4	
Cycle	5.4	
Car	0.7	
Bus and coach	0.07	
Ferry		0.25
Air (civil aviation)		0.035
Rail		0.035

Table 1: Deaths per 100 million person kilometres

Road (Total)		28
Motorcycle/moped	440	
Cycle	75	
Foot	25	
Car	25	
Bus and coach	2	
Air (civil aviation)		16
Ferry		8
Rail		2

Table 2: Deaths per 100 million person travel hours

2.1 EU risks across the modes

- Road travel has by far the highest fatality risk per distance travelled.
- Rail and air travel are the safest modes per distance travelled, followed by bus. The passengers of trains, bus/coach and planes within the EU have the lowest fatality risk per passenger kilometre. For the average passenger trip in the EU, bus travel has a 10 times lower fatality risk than car travel, and air travel within the EU has for the average flight distance the same fatality risk per passenger kilometre as travel by train and both have half the risk of travel by coach.
- Passenger fatality risks per time spent travelling are lowest for bus and train travel followed by ferry and air travel. Also per distance travelled the (high speed) train is safer than the plane in trips of up to 600 km (the longer the flight distance the less its risk per distance becomes). The risks to plane passengers mainly arise during the take-off and landing phases, the cruise part of the flight accounts for only a small percentage of the risk. Trips by plane shorter than 600 km have an increasingly higher fatal and serious injury risk per passenger kilometre than train trips. Only flights within the EU for longer ground distances than 800 km have a lower fatality risk per passenger kilometre than trips by train. However, railway fatality risks differ markedly between the countries of the EU, so this conclusion depends upon the countries involved in the journey.
- The risks associated with ferry travel fluctuate, but the expected fatality risk is 4 to 8 times that of train travel.

2.2 Risks within the road mode

- The highest death rate by far in road transport is for the two-wheeled motor vehicle users. Motorcycle or moped travel death risk is 17½ (per time) to 20 (per distance) times higher than for car travel.
- Travelling by car is about 1 to 3 (per time) and 7 to 9 (per distance) times safer than by cycling or walking, but car occupants are still 10 (per distance) to 12 (per time) times less safe than bus occupants.
- If the walking or cycling before and after a train or bus trip comprises more than 15% of the trip distance then it is safer for the individual to travel by car (avoiding the high risk of walking or cycling) than by bus or train. However, cars mainly cause

the road traffic death of other car occupants, motorised two-wheelers, cyclists and pedestrians. Therefore, trips by public transport and before and after walking or cycling are collectively safer than car trips.

2.3 Risks in road transport

- ❑ Road accidents caused 38,935 deaths (within 30 days after the crash) in 2001, comprising almost 97% of all transport deaths in the EU.
- ❑ The road passenger transport death rate per million inhabitants is about 100 times higher than for all other passenger transport modes together, because road travel has a much higher fatality risk and about 88 per cent of all passenger travel in the EU is by road.
- ❑ Road accidents lead to more than 93% of all passenger transport accident costs each year and are higher than the congestion costs or the costs of environmental pollution, as estimated by the European Commission.

2.4 Road travel and health risks

- ❑ Involvement in road accidents is one of the three leading causes of death and hospital admission for EU inhabitants (together with cancer and coronary heart diseases), and it is the leading cause of death for EU citizens under 50 years old.
- ❑ Road accidents cause a larger loss of expected life years than any kind of disease in the EU, due to the low mean age (about 32) of road accident victims.

2.5 Road travel and activity risks

- ❑ The fatality risk per hour spent in road travel is
  - 40 times higher than for work,
  - 12 times higher than at home.
- ❑ The fatality risk of the safest road travel modes –bus or coach – is more than twice higher than that at work.

3 FATALITY RISK IN ROAD TRANSPORT

3.1 Road fatality distribution and comparisons of road fatality risks

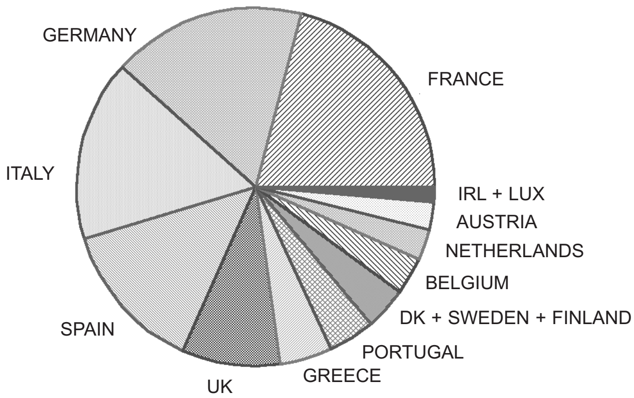

Fig. 1 Road fatality distribution in the EU

- ❑ France, Germany, Italy, and Spain account for 68 per cent of the total of 38,935 road fatalities in the EU in 2001.

- ❑ France and the UK have about the same number of inhabitants, but France has about twice the number of fatalities as the UK as its risk is twice as high.

- ❑ The southern EU countries, France and Belgium have fatality risks above the average for the EU, and risks in the other EU countries are below average.

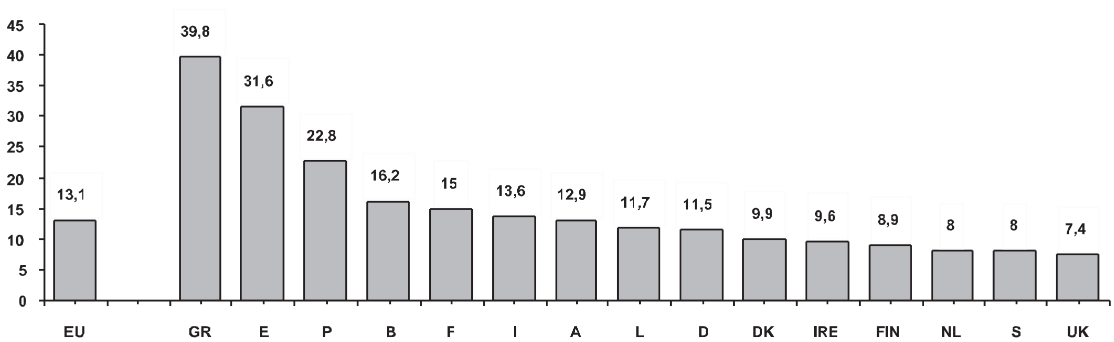

Fig. 2 EU death rates 2000/2001 per billion motor vehicle km

- ❑ The highest road fatality risk in EU countries is over 5 times greater than the lowest (in 1997 this ratio was 7).

- ❑ The fatality risk order in 2000/2001 changed with respect to 1997, due to noticeable differences between the rates at which national risks have fallen:

  - between 1997 and 2001 the Irish and Portuguese fatality risks reduced over twice as fast as the EU average, whereby Ireland moved from 9th to 5th safest EU country and Portugal became safer than Spain.

  - between 1997 and 2001 the fatality risk in Belgium and Sweden hardly reduced, whereby France became safer than Belgium (having been less safe in 1997) and the UK safer than Sweden (the Swedish and British risks were almost equal in 1997).

- ❑ The six countries with lowest fatality risks have had numerical targets for casualty or fatality reduction in the past decade or decades.

3.2 Past and future road safety development in the EU

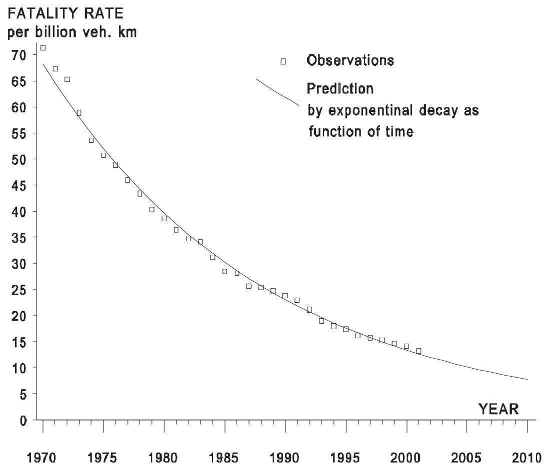

Fig. 3 Fatality rate decay in the EU (including the GDR before 1990) and its prognosis to 2010

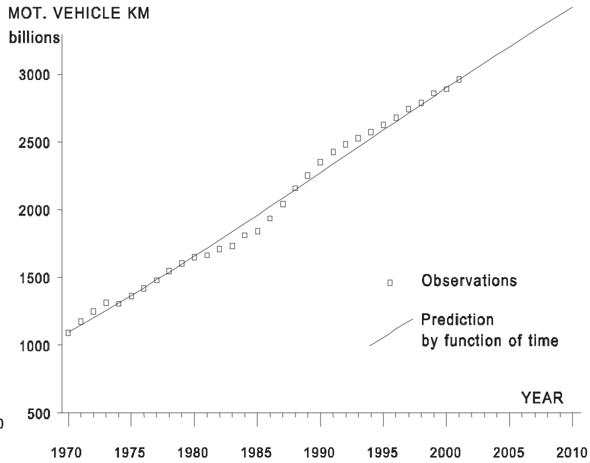

Fig. 4 Road traffic growth in the EU (including the GDR before 1990) and its prognosis to 2010

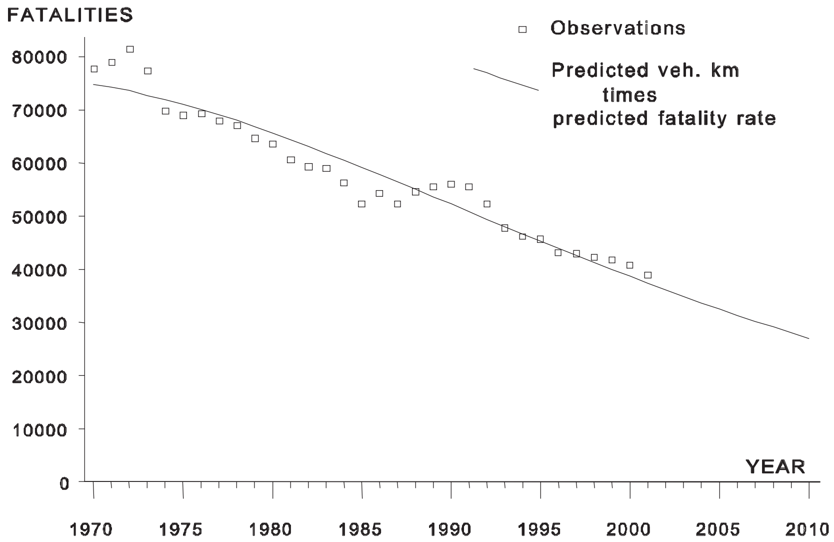

Fig. 5 Fatality development in the EU (including the GDR before 1990) and its prognosis to 2010

The fatality rate in the EU (regarding all present EU countries from 1970 onwards and including the GDR before 1990) has decreased almost constantly in an exponential way, by an average annual reduction of 5.3%.

Before 1970, the volume of road traffic grew by more than 5.3% per year. Since 1972, however, the rate of increase in motor vehicle kilometres in the EU declined, despite an almost constant growth year on year. As a consequence, the EU road fatality total reduced from 80,500 in 1972 (including GDR) to 38,935 in 2001, and is predicted to reduce further to 27,000 fatalities in 2010. The forecast is derived by multiplying the extrapolated trends for fatality risk and traffic growth.

The EU has a target of reducing fatalities by 50% from 2000 to 2010, i.e. to 20,000 fatalities in 2010. It will only be possible to achieve this target if the EU takes additional actions that reduce the risk more rapidly than in the past.

Such an acceleration of the fatality risk decay is possible, as shown below for the combination of the three least safe EU-countries (Greece, Spain, and Portugal).

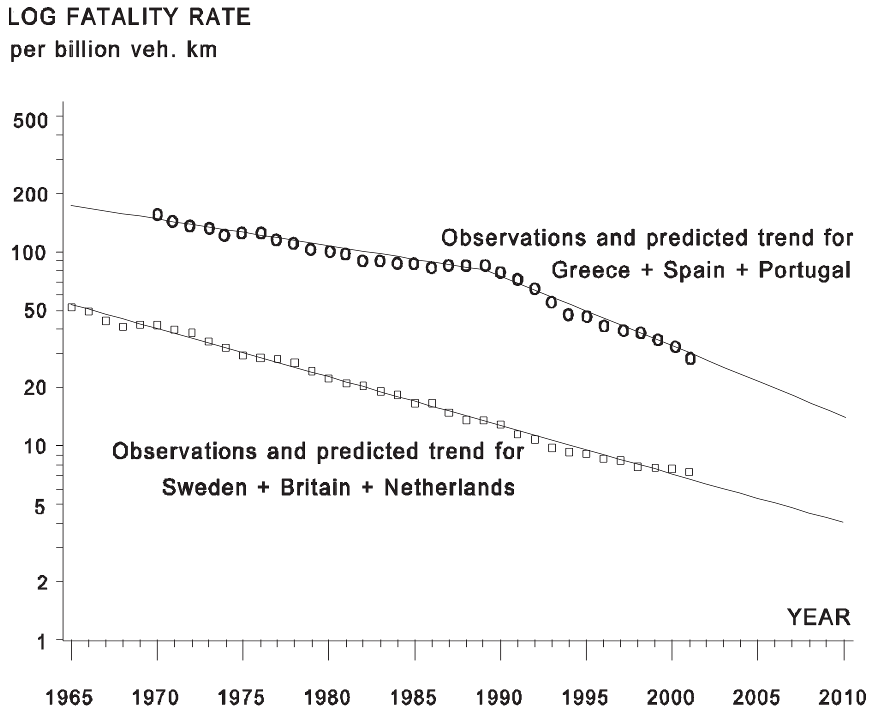

Fig. 6 Fatality risk decay in the least safe and in the safest EU countries

Between 1970 and 1988 the fatality risk in these three countries reduced by almost 3.5% per year but by over 7.5% thereafter, as shown in the figure. The figure also shows that there has been no significant diminution of the annual rate of improvement in the three safest EU-countries (Great Britain, Sweden, and the Netherlands) between 1965 and 2001.

3.3 Past and future road safety in the ten EU accession countries

Thirteen countries have applied to become EU members. Membership has been discussed with 12 of the 13 applicant countries (not with Turkey, which does not yet meet political conditions). The Commission recently accepted accession for 10 countries (not Bulgaria and Romania, due to economic criteria). The objective is that these 10 "accession" countries (Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovak Republic and Slovenia) join the EU on 1st May 2004. This Review also presents the road traffic risks for these10 accession countries.

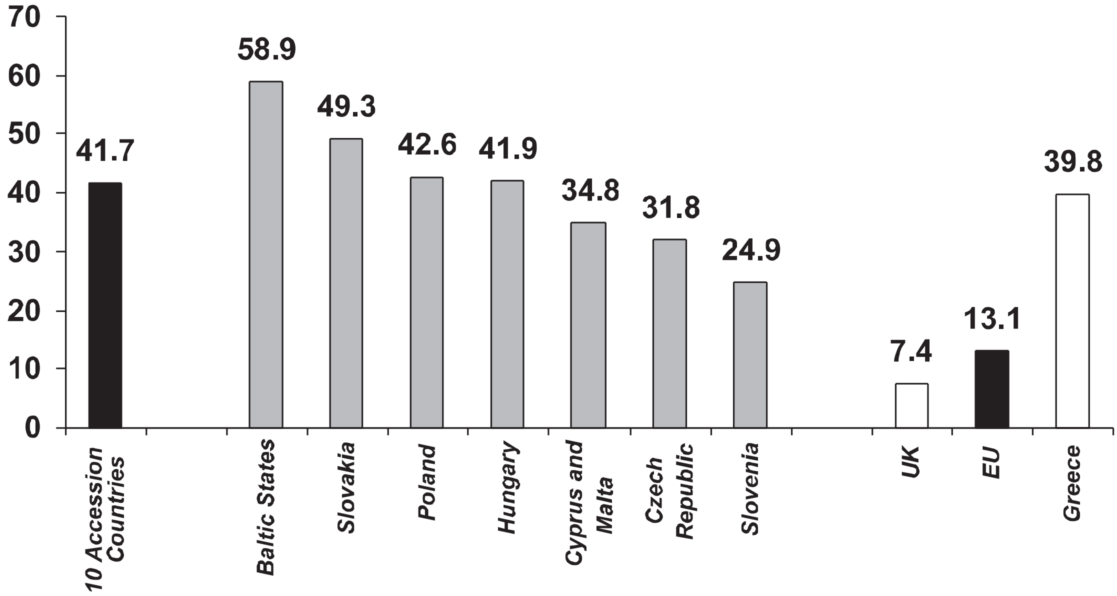

Fig. 7 Fatality rate per 100 thousand motor vehicles in the 10 accession countries
(the risks per billion vehicle km of UK, EU and Greece are comparable if on average 10,000 km are driven per vehicle per year in the accession countries)

- ❑ Motor vehicle kilometres are not available for the accession countries. In order to compare their fatality risks with those of the present EU countries, it is assumed that on average each motor vehicle drives 10 thousand kilometres per year, which seems approximately correct for Poland and overall, although marked national differences seem also present (based on estimates of the kilometres per motor vehicle in 2000, reported in World Road Statistics 2002 of the IRF).

- ❑ With this assumption, the average fatality risk of the 10 accession countries is slightly higher than 3 times the EU average, slightly higher than Greece (worst performing EU country), and slightly higher than 5 times the UK (best performing EU country).

The fatality rate per 10,000 vehicles (Figure 8) has decreased regularly by 6% per year in the accession countries, with the exception of an upward shift in 1989/1990 (probably due to more annual kilometre per vehicle, higher speeds of imported western cars, and less enforcement of traffic laws). But the fatality risk has fallen since 1991 at the same rate as before 1990.

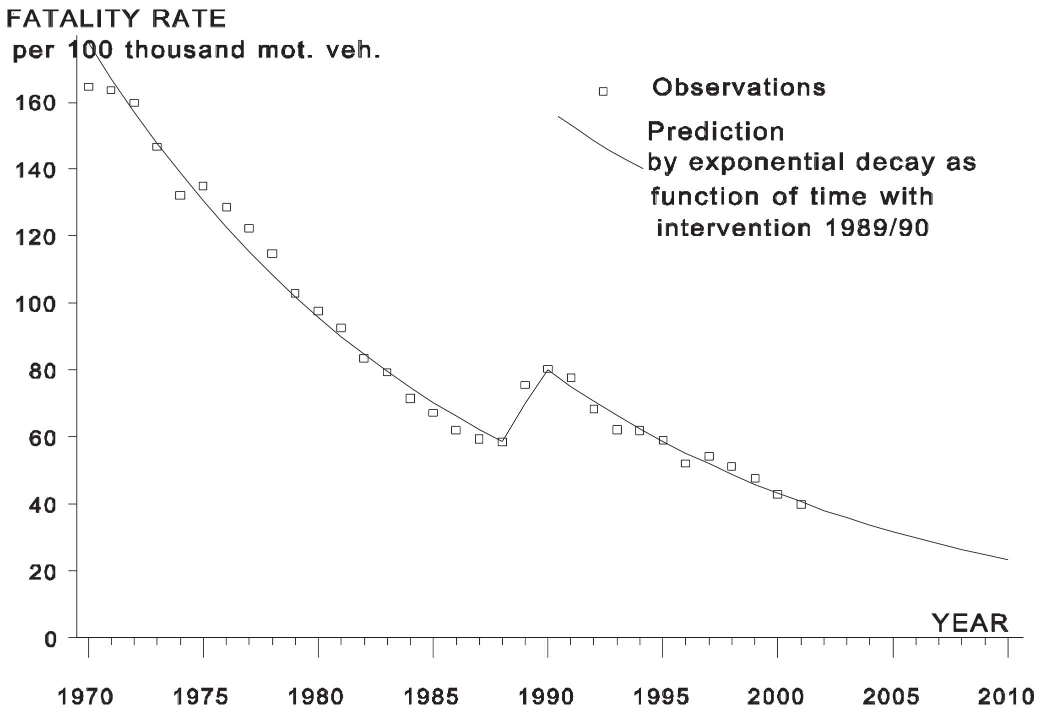

Fig. 8 Fatality rates and their forecast to 2010 for the total of the accession countries

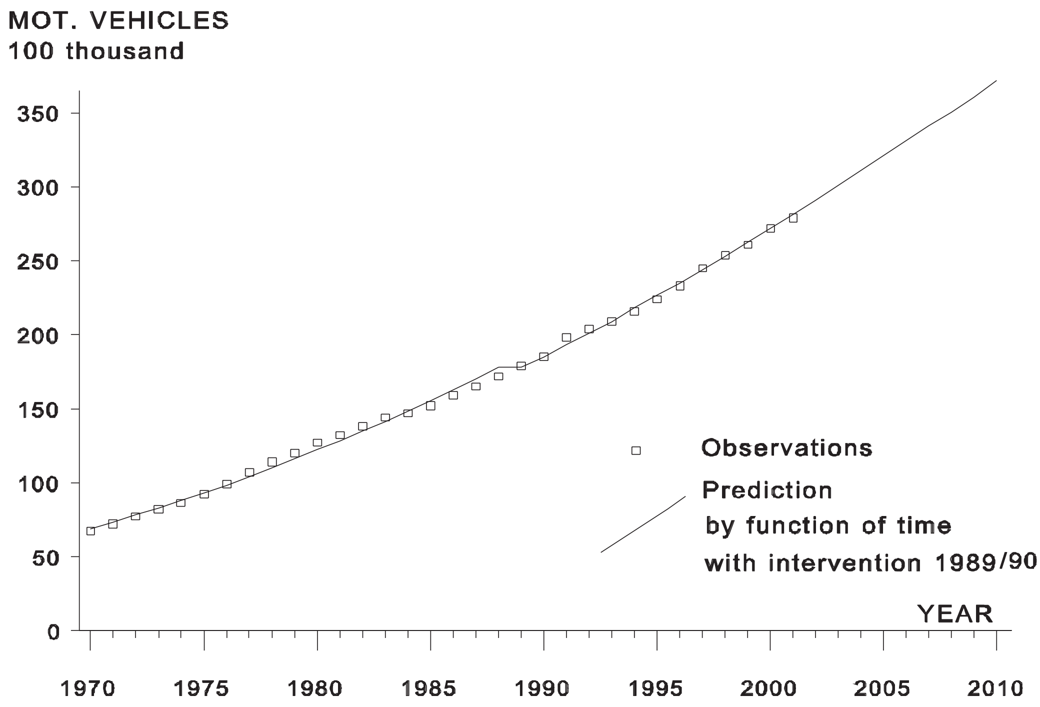

Fig. 9 Motor vehicle growth and its forecast to 2010 for the total of the accession countries

Traffic growth in the accession countries after 1970 followed the same pattern as in the EU nations before 1972. Traffic growth in the accession countries is still in the first part of the S-shaped growth curve, as shown by figure 9 (the shift in 1989/1990 is not significant).

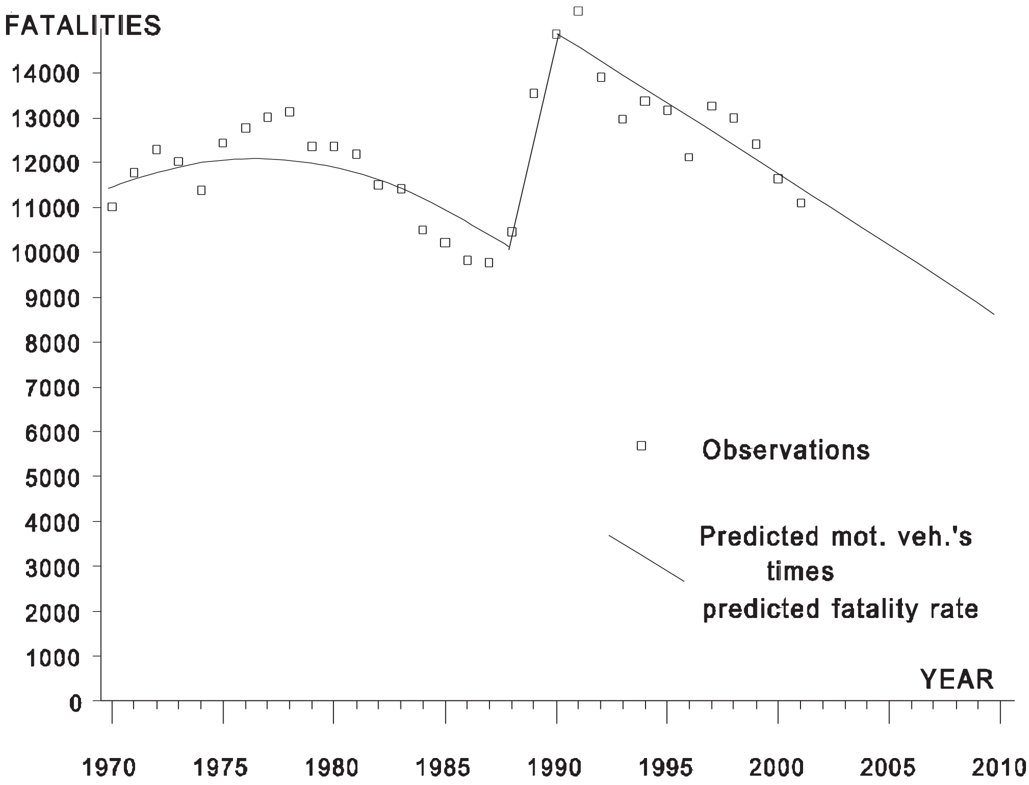

Fig. 10 Fatalities and their forecast to 2010 for the total of the accession countries

The fatality forecast is obtained by multiplying the trend curves for fatality rate and vehicle growth. Figure 10 shows that this reproduces the sudden increase of fatalities in 1989/1990 as well as the reducing trends before and after this period. The fatality total in 2000 is 11,650 and the estimated total for 2001 is about 11,000.

The multiplication of extrapolated trends for fatality rate and vehicle growth predicts a total of 8,625 fatalities in 2010 in the 10 accession countries.

3.4 The safety of motorised two-wheelers in the EU

Users of motorised two-wheelers have the highest fatality risk of all road user groups. Therefore, details of these fatalities in the EU Member States are shown next. They show that moped and mofa fatalities are predominantly in the southern EU countries (in 2000: 615 in Italy, 474 in Spain, 456 in France, and 278 in Portugal – but data from Greece are not available). This is also true for motorcycle and scooter fatalities (France 937, Italy 561, Spain 392, and Portugal 211), but also Germany (945) and the UK (597) have relatively many motorcycle and scooter fatalities.

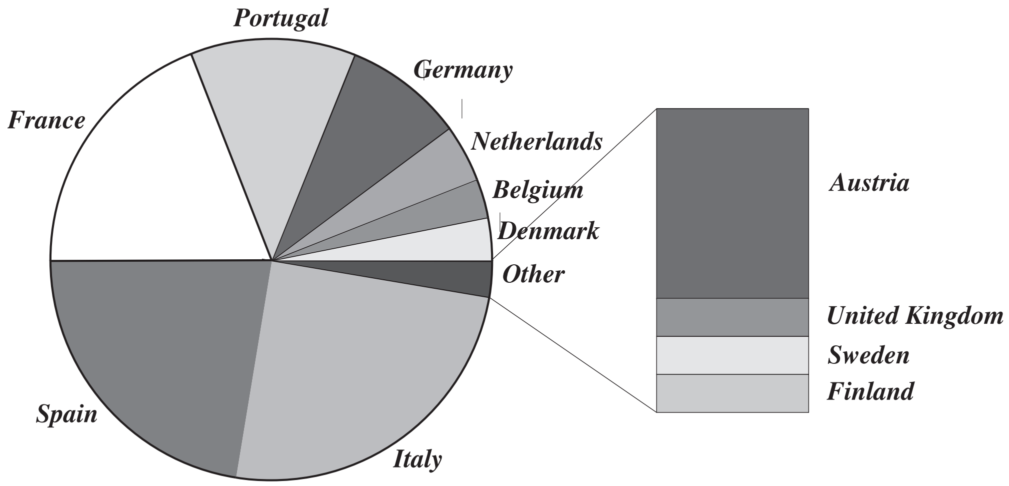

Fig. 11 Moped/mofa fatality distribution in 2000

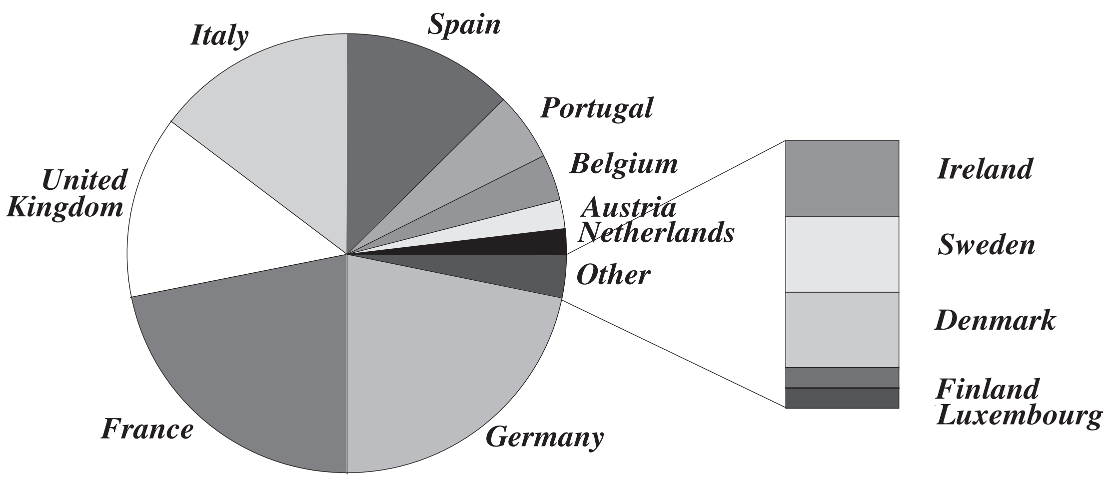

Fig. 12 Motorcycle/scooter fatality distribution in 2000

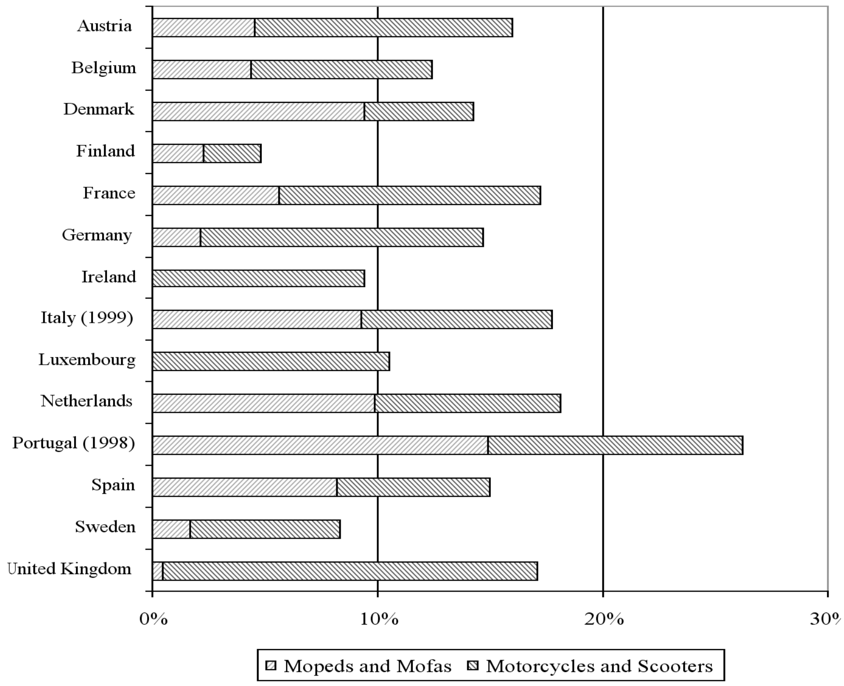

Fig. 13 Proportion of 2-wheeler fatalities in the total of EU Member states in 2000 (no data for Greece; Irish data concern all motorised two-wheelers together).

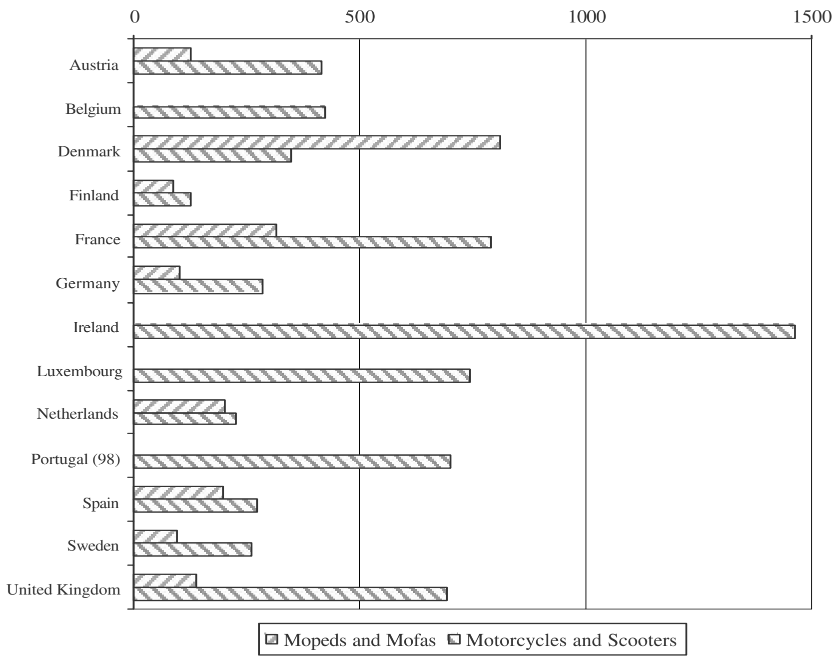

Fig. 14 Motorised two-wheeler fatalities per million motorised 2-wheel vehicles

Motorised two wheeler fatalities vary from 5% to over 25% of the national road fatality totals. The largest proportion of national fatalities accounted for by motorcycle fatalities is in the UK, while for moped/mofa fatalities as well as for all motorised two-wheeler fatalities the largest proportion is in Portugal. The high British scooter/motorcycle fatality share is due to the high risk of their scooter/motorcycle users. Similarly high risks are found in Portugal, Luxembourg and France. The risk for all the motorised two-wheelers in Ireland and for moped and mofa riders in Denmark seems to be extremely high, but both absolute numbers are less than 50 fatalities.

4 PAST AND FUTURE RAILWAY SAFETY IN THE EU

The annual fatality risks for travellers of the railway systems in the countries of the EU show large fluctuations, but their moving averages seem to differ consistently between the countries. The five-year averages of the risk per rail passenger kilometre seems to differ between the two safest (Spain and Netherlands) and the two most risky (Luxembourg and Portugal) railway systems by a factor of more than 60. But these consistent risk differences are likely to be largely the result of differences in reporting and definition.

Nonetheless, the moving national averages of train passenger risks also show that these risks tend to decay in each EU-country, which allows the development of the overall passenger fatality risk for the total railway system in the EU to be analysed. The fatality risk per billion train passenger kilometre fell from 1970 to 2000 by an average of 5.5% per year, derived from the fitted exponential risk decay model shown in Figure 15.

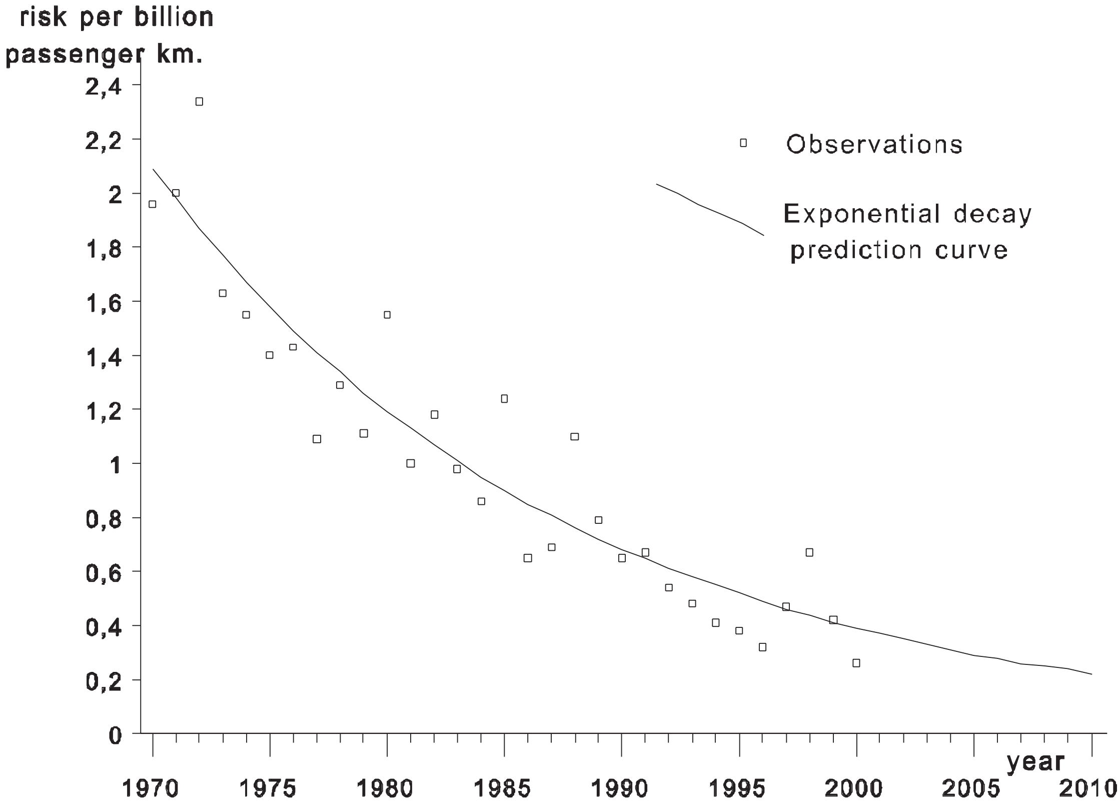

Fig. 15 Rail passenger fatality risk 1970-2000 and forecast to 2010 for the 15 EU-countries

The mean annual number of train passenger fatalities in the EU decreased from about 400 in the early 1970s to around 100 in 1999 and 2000. The rail passenger kilometre in the 15 EU-nations increased from about 200 billion in 1970 to about 300 billion in 2000. The fitted risk curve shows that the expected fatality risk per billion train passenger kilometres is about 0.35 for 2001/2002 within the EU.

This means about 110 expected fatalities per year in 2001/2002, based on 313 billion train passenger kilometre per year. The number of train fatalities actually reported in 2000 in the EU is 78. As can be seen in the figure the observed risks in most years are close to or somewhat lower than the fitted exponential curve. Five exceptional years have markedly higher risk due to rail disasters with many fatalities in these years.

The latest rail disaster was the crash of the high-speed train in Germany in 1998. Such disasters seem to occur on average once in six years, and in such years the actual rail passenger fatality risk is much higher than the risk predicted by the exponential curve. Nonetheless these estimated risks are the best indicators of the underlying level of risk.

The mean annual number of rail staff fatalities decreased from almost 350 in the early 1970s to 45 in 1998-2000. The corresponding average for third party fatalities decreased from around 1,300 in the early 1970s to nearly 700 in the late 1980s, but increased to over 800 in the period 1993-1996 and thereafter decreased again to about 650 in 1999-2000. This would mean that train travel is many times more risky for other persons than for travellers. However, the exposure to risk for non-passenger fatalities should not be measured by passenger kilometres. Their mortality risk, expressed as deaths per 100 thousand inhabitants of the EU, is now about 0.01 for rail staff and 0.20 for third party fatalities, compared to 0.03 for train passengers.

5 AIR PASSENGER SAFETY WITHIN THE EU

Air transport fatality statistics refer mainly to scheduled flights, because air travel fatalities on unscheduled (charter) flights are only partially reported by international air transport organisations. A similar practice exists for private plane fatalities – they are neither registered worldwide nor for the EU. There are large variations in the annual death number of air passengers on scheduled flights within the EU. After 1980, four years had more than 200 fatalities and five years showed no deaths; the four years of 1996 to 1999 inclusive had an average of about 35 crew and passenger deaths, while 2000 had zero and 2001 had 117 fatalities (2001 was the worst year since 1989 with 247 deaths).

In the ETSC Review on “Exposure data for travel risk assessment” the risk trend for air passenger transport within the EU, therefore, was obtained from the world statistics by corrections for the average share, duration or distance and occupancy for flights within the EU (ETSC, 1999). This revealed that air passenger fatality risks were reduced exponentially by an average of nearly 6% per year from about 0.24 per 100 million air passenger kilometres in 1970 to about 0.04 for the expected risk in 1997 (ICAO, 1998). After 1997 the annual risks fluctuate, but have been lower than expected and decreased to about 0.02 for scheduled flights in 2001 (ICAO, 2002). Based on the partially available world data, the estimated risk for unscheduled fights seems about twice higher, while the intra-continental passenger share is estimated to be about 30% of the scheduled flights. Thereby the expected fatality risk per 100 million passenger kilometre for civil aviation (scheduled and unscheduled flights) worldwide is updated by the fitted exponential decay function from 1970-2001 to the estimate of about 0.025 for 2001/2002, where the estimated annual reduction is now more than 7%.

In contrast to road and rail, the rate of increase of air travel in the last decade has been not less than the reduction in fatality risk (both about 7% per year), but the volume of air travel declined after 11 September 2001. Therefore, the moving average of air travel deaths in scheduled flights scarcely decreased in the last decade, but may now decline because of the slower growth of air travel after 2001.

The above mentioned ETSC Review of 1999 showed that planes have much higher risks during the take-off, climb, descent, approach and landing manoeuvres than when cruising. Due to regional differences in the safety procedures and ground communications around airports, the risks of air travel differ markedly according to the region of departure and of destination, and less by the home country of the flight operator (Ho, 1997). The next table shows relative fatality risk per flight, flight duration and distance for four flight types relative to the risk for a flight of 1.6 hours.

Flight duration	ground distance	non-cruise time	non-cruise risk	cruise time	cruise risk	accident risk index per flight	accident risk index per hour	accident risk index per distance
1.0 hour	360 km.	0.64	0.92	0.36	0.03	0.95	1.52	1.90
1.6 hours	720 km.	0.64	0.92	0.96	0.08	1.00	1.00	1.00
2.5 hours	1500 km.	0.64	0.92	1.86	0.16	1.08	0.69	0.52
7.0 hours	5750 km.	0.64	0.92	6.36	0.53	1.45	0.33	0.18

Table 4 Relative fatality risks per flight, flight duration and distance.

The study of Ho (1997) also found that the European region (without the former USSR) and the North-American and South-West Pacific regions had approximately equal air travel risks before 1994 and that these three regions had about half the risk of all other regions together. Flights within and between the three safer regions account for 65% of all scheduled passenger flights (IATA, 1998). Thus the European risk as one of these safer regions can again be derived from the worldwide risk, because 65% times the European risk plus twice the 35% of that risk equals the worldwide risk. Therefore, the air passenger risk per 100 million passenger kilometres for the European region relates to that worldwide risk by the proportional factor of 1/(0.65 + 2 x 0.35) = 0.74. Thus the risk for all civil aviation flights within and from or to the EU for 2001/2002 is estimated to be 0.74 x 0.025 = 0.0185. However, the fatality risk per passenger kilometres for flights within the EU (mean 1.6 hours) is greater than for all European flights (mean 2.5 hours) by a factor 1.0/0.52 = 1.92 (shorter flight distance) times 1.25 (20% less passengers per flight). This indicates that the fatality risk would be 1.92 x 1.25 x 0.0185 = 0.044 for civil aviation flights within the EU.

From this risk estimate, one can derive the expected fatalities or other risks that relate to other exposure measures by using the average flight factors of 1.6 hour duration, 720 km ground distance, and 85 crew and passengers for about 6.5 million flights (including the estimate for unscheduled ones) per year in 2001/2002 between airports in the EU. The expected annual number of fatalities for the years 2001/2002 is about 175, estimated by 0.044 x 85 (flight occupants) x 6.5 (million flights) x 7.2 (100 km flight distance)=175, which is higher than the 117 air travel fatalities for scheduled flights in 2001 within the EU and much higher than the observed five year average of almost 50 fatalities for scheduled flights in 1997-2001 within the EU. It likely means that the main airport regions within the EU have become much safer than those in North America and the South Pacific region (before 1994 these three regions had the same level of risk and were twice safer than other regions).

The available data for scheduled flights within the EU from 1980 to 2001 (taken from the database of the NLR, the Dutch Air Transport Research Institute) show by a fitted exponential risk decay that the estimated risk is almost 0.02 per 100 million passenger kilometre for 2001. Corrected for about 30% more passenger km of unscheduled flights with a twice higher risk (probably due to shorter trips and more destinations to less safe airports than the main airports in the EU) it amounts to a risk of 0.025 per 100 million passenger kilometre, whereby the expected number of fatalities in civil aviation within the EU would be about 100 for 2001. It would mean that the civil aviation risks within the EU have decreased faster than estimated by the share in the world wide risks, as calculated above and used for the risk assessment in the ETSC Report of 1999 for the civil aviation risks up to 1997.

The next figure shows the difference in level and slope of the trends derived by the two risk estimation methods. This figure also shows clearly that the observed annual risks for scheduled flights within the EU vary considerably (the five observations with zero risk are years without fatalities), but the five-year moving average risks show a sharply decreasing risk trend over time with an average risk reduction of more than 9% per year, while the not-shown world-wide risk observations for scheduled flights show a clear exponential decay from 1970 to 2001 with an annual risk reduction of about 7%.

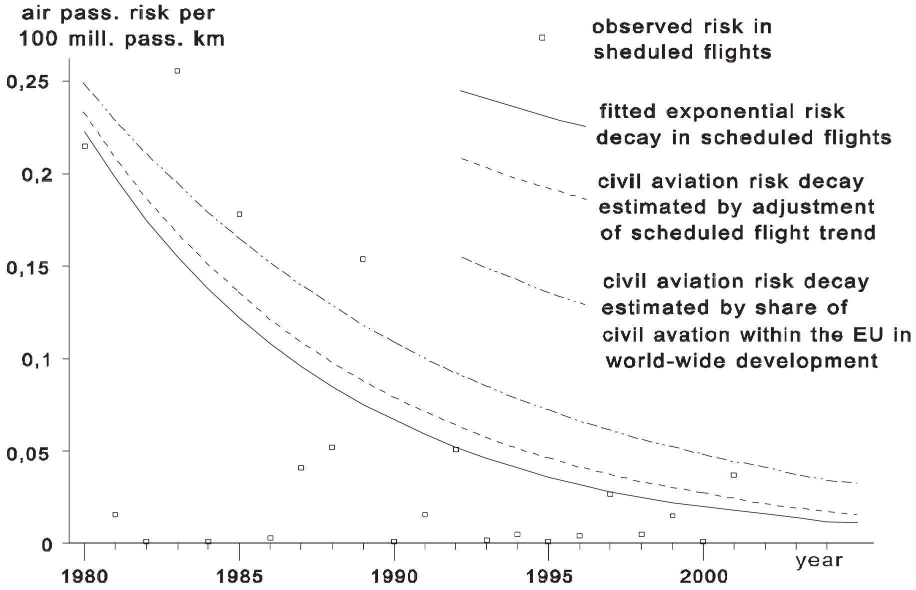

Fig. 16 Estimated risk trends for scheduled flights and civil aviation within the EU

Given the uncertainties in both estimation methods (with respect to unscheduled flights, variations of registered deaths, and estimates of passenger kilometres) it seems fair to take the risk value for 2001/2002 as the average of the estimated risks by both methods, that is (0.025 +0.044)/2=0.035 per 100 million air passenger kilometre in civil aviation within the EU for 2001/2002. It yields 140 expected fatalities in civil aviation within the EU for 2001/2002. Its risk per 100 million passenger kilometre multiplied by 720/1.6=450 km/h average ground speed becomes the risk per 100 million passenger travel hours as 0.035 x 450 = 16. Summarised below are the estimated risks of civil aviation that are comparable with other modes and the expected annual fatalities for 2001/2002.

	All flights (incl. intercontinental)		Domesticl and continental
	Worldwide	European (ex. USSR)	flights within EU region
Fatalities/100 million pass. km.	0.025	0.018	0.035
Fatalities/100 million pass. h.	15	11	16
Expected fatalities	1200	190	140

Table 5 Expected annual estimates for passenger safety in civil aviation for 2001/2002 based on word-wide trends 1970-2001 and on trends 1980-2001 for European flights

These estimates are lower than the extrapolated figures from the referred ETSC Report of 1999 (Table 3, page 29), due to the likely faster reduction in civil aviation risk within the EU than worldwide. The recent decline of air travel (which might be temporary) may further reduce the expected fatalities for the coming years. The average plane and train risks per distance are now equal, that is about 0.035 per 100 million passenger km, but it has been shown that the longer the flight, the less the risk per kilometre. Consequently, flights of more than 800 km ground distance are nowadays safer than such trips by (high speed) trains (the figure in 1998 was 1,200 km), while trips of less than 600 km distance become increasingly safer by (high speed) train than by plane.

6 PASSENGER RISK BY SEA TRANSPORT IN EU WATERS

Various risk statistics for maritime transport were summarised in the ETSC report on "Exposure data for travel risk assessment" (ETSC, 1999). Regional accident risk and exposure measures are of great importance for the size of rescue and assistance fleets required by coastal states to minimise the consequences of ship disasters. The following table (from ETSC, 1999) shows how encounter exposure (frequency of ships penetrating the area of nautical mile around another ship) is used to assess the effects of vessel traffic services (VTS) on the collision rate (CR) per 100.000 encounters of different types.

Type	CR Total	CR (VTS)	CR (no VTS)	effectiveness
meeting	0.589	0.310	0.636	48.7%
crossing	4.381	3.888	4.500	86.4%
overtaking	0.640	0.104	0.765	13.6%
all	0.817	0.533	0.871	61.2%

Table 6 Encounters exposure and the effects of Vessel traffic service on the collision rate

This table demonstrates the usefulness of relevant detailed exposure data for the assessment of the effectiveness of countermeasures. The use of encounter frequency as exposure measure would also be relevant for other modes, especially in road transport, but hardly any research exists on this type of exposure in the other modes. However, this Review is concerned with personal safety on ships, not the frequency of ship disasters.

Casualty risks per ship type and size are given in the ETSC Report of 1999. It shows that tankers and ships of more than 6 million kg cargo capacity have a casualty risk per million nautical miles that is more than twice as high as for all vessels (about 2.8 compared with about 1.35), while the casualty risk for ferries and roll-on/roll-off container ships is almost half of that risk for all vessels. After the ESTONIA disaster in 1994 the fatality risk of ferry travel in European waters from 1985 to 1994 (in total 1,408 fatalities) was investigated and is given in the ETSC report as:

fatalities/million ferry hours	0.84
fatalities/million ship kilometre	2.61
fatalities/100 million passenger hours	14.80
fatalities/100 million passenger kilometre	0.46

The ESTONIA disaster of 1994 with 850 fatalities dominates these reported risks. The year 1984 and the 8 years after 1994 show no ferry passenger fatalities in EU-waters. The above risks, therefore, can now be updated for the larger period 1984-2001 by a correction factor of 10/18=0.555 because, unlike with the other modes, there has been no consistent reduction in the fatality risk decay. The updated risk level cover now a longer period and are thus less dominated by the exceptional number of fatalities in 1994.

Thus, the updated fatality risks of ferry passengers that are comparable with other transport modes' risks become:

fatalities/100 mill. passenger hours	8.0
fatalities/100 mill. passenger kilometres	0.25

Since the risk for ferries appears to be constant, the expected number of fatalities from ferry passenger transport in 2002 is 320 x 0.25=80 (assuming about 32 billion ferry passenger kilometres on ferries within and to/from EU countries). About 80% of ferry disasters do not involve passenger fatalities, while fatalities mainly occur when ferries capsize. About 16% of ferry disasters are due to capsizing, and these account for about 80% of the total of about 1,400 fatalities in ferry disasters in EU waters since 1983. One fire and one collision account for about 300 other fatalities on ferries. Only about 6% of fatalities on ferries are due to collisions. This is quite different to rail and road transport (for example: about 70% of the road fatalities in EU are due to collisions between road users and the other 30% are mainly due to single vehicle accidents, including bicyclists).

7 RECOMMENDATIONS

1. Road safety needs more priority in the transport policies of EU Member States and the EU, because 99% of all transport fatalities in the EU are caused by road transport. Road transport accounts for 88% of all passenger transport in the EU, but accounts for 100-times more deaths than all other modes together.

2. It is recommended that national and EU health policies recognise the relatively high mortality and injury incidence rates for road traffic.

3. The EU target of 50% road traffic fatality reduction between 2000 and 2010 to about 20,000 fatalities in 2010 will not be achieved unless the EU takes additional actions that reduce the fatality risk more rapidly than in the past. Therefore, it is recommended that further actions within the competence of the EU itself (mainly vehicle safety regulations) are taken and that a EU road safety subsidy fund is created for financial incentives that support and trigger national road safety actions and measures with a proven effectiveness.

4. Priority setting for transport safety must recognise the very high fatality risk of motorised two-wheelers (15 times the average road risk per kilometre travelled).

5. It is recommended that the safety of pedestrians and cyclists be improved, because their fatality risks per kilometre are 7 to 9 times higher than for car travel.

6. Passenger transport policies of the EU and its countries should promote the use of (high speed) trains in long distance trips, because the fatality risk of air travel for ground distances of less than 600 kilometres is higher than for trains.

7. Intermodal passenger transport policies have to recognise that large differences exist between the risks of travel modes. The safety of walking and cycling needs also to be improved in order to optimise the safety of public transport, due to the high risk of the necessary walking and/or cycling in the 'before and after' phases of these trips.

8. Initiatives to improve the recording of road travel volumes and fatalities are being undertaken by the EU, but progress is lacking for rail travel in the EU, travel on EU-waters and inland waterways of the EU, and air travel by unscheduled flights and private planes within the EU. Moreover, serious injury risks for different travel modes are hard to assess because the necessary incident and exposure data are defined differently and not consistently gathered. It is recommended that research and development as well as reporting harmonisation on these matters be initiated by the EU.

Similar recommendations (except the third) were formulated in 1999 in the ETSC Report on "Exposure data for travel risk assessment", but it is disappointing that they have had so little effect. In view of the EU-target that has been set and the urgency of taking action to achieve the target, the recommendations need to be implemented soon.

REFERENCES

ETSC (1999) Exposure data for travel risk assessment: Current practices and future needs in the EU. Brussels

ETSC (1999) Crash risks in EU transport. Brussels

The references to statistics and literature are already given in the first of the above mentioned ETSC publications, while the updated data for road transport are mainly based on the OECD-IRTAD database or, if absent for some countries, obtained from national reports or recent UN and IRF world road statistics yearbooks. The statistics for rail and air transport are taken respectively from the UIC-report on 2000 and the ICAO Journal Issue on 2001, both with the same reference as for 1998 given in the earlier ETSC Report. Statistics for rail transport are also taken from

Railway Safety (2002) Annual Safety Performance Report 2001/02. London.