Comparative analysis of road safety parameters in the European motorways

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Abstract

The objective of this research is the analysis of road safety related parameters in the European motorways by the use of the EU CARE database with disaggregate data on road accidents as well as of other international data files (OECD/IRTAD, Eurostat, etc.). Data for ten years and 14 EU countries on motorway road accidents are correlated with basic safety parameters like the vehicle type, the manoeuvre type, the casualty age and person class as well as the lighting conditions. This comparative analysis revealed a decrease of 16% in traffic accident fatalities on motorways in the decade 1995 - 2004, lacking behind the respective decrease of 27% in the total number of fatalities. It was also shown that more middle age drivers (35-64 years old) are killed on motorways whereas more younger drivers (25-34 years old) are killed on the remaining road network. Specific countries with higher motorway accident fatalities for particular accident types were also identified. The results of the analysis allow for an overall picture of the road safety level in the European motorways in comparison to the remaining road network, providing thus useful support to all decision makers working for the improvement of safety in the European road network.

Key-words

Motorways; road accident data; road accident analysis; road safety.

1. Introduction

Motorways form an important part of the overall road infrastructure system in a country and are generally acknowledged as the safest roads by design (Elvik, Vaa, 2004). Traffic at higher speed, traffic travelling in opposite directions separated by medians, grade separated junctions (interchanges), more lanes in order to enable straightforward overtaking are only some of their specific characteristics that increase the road safety level on motorways. On the other hand, the

existence of higher speed limits than on the remaining road network and the increased number of drivers violating these limits, seem to have a large impact on the severity of road accidents (KfV, 2005).

Between 1995 and 2004 more than 25.000 people were killed in traffic accidents on motorways in 14 European Union countries (KfV, 2007). This number represents only about 7,6% of all traffic accident fatalities in those countries, however, the proportion of fatalities on motorways within the same period was around 16%, which is much lower compared to the overall decrease (by almost 27%) of fatalities in these counties. For this reason, and given that the motorway networks are continuously developing across Europe it is essential that motorway road accidents are investigated and continuously monitored, allowing the implementation of appropriate accident mitigation measures.

The objective of this research is the macroscopic analysis of road safety related parameters in the European motorways, using data from the EU CARE database with disaggregate data on road accidents, together with data from other international data files. More specifically, road accident data on motorways and other roads for the period 1995-2004 and 14 EU countries are correlated with basic safety parameters like the vehicle type, the manoeuvre type, the casualty age and person class as well as the lighting conditions.

The results of this comparative analysis among countries will allow for drawing an overall picture of the road safety level in the European motorways in comparison with the remaining road network, providing thus useful support to all decision makers working for the improvement of safety in the European road network.

2. Road safety on the motorways of the EU countries

Motorways are designed to carry heavy traffic at high speed with the lowest possible number of accidents. They are also designed to collect long-distance traffic from other roads, so that conflicts between long-distance traffic and local traffic are avoided (Elvik, Vaa, 2004). According to the common European definition, a motorway is defined as "a road, specially designed and built for motor traffic, which does not serve properties bordering on it, and which: (a) is provided, except at special points or temporarily, with separate carriageways for the two directions of traffic, separated from each other, either by a dividing strip not intended for traffic, or exceptionally by other means; (b) does not cross at level with any road, railway or tramway track, or footpath; (c) is specially sign-posted as a motorway and is reserved for specific categories of road motor vehicles" (Eurostat / UNECE / ECMT, 2003). Urban motorways are also included in this definition. However, the respective national definitions and the type of roads covered may present slight differences in different EU countries (NTUA, 2005).

In order to assess the safety level of motorways at an EU level, analyses of related accident data maintained into the EU CARE database can be performed. CARE is the Community database on road accidents resulting in death or injury, consisting of data with high level of disaggregation, contrary to most other existing international databases. This structure allows maximum flexibility and potential, with regard to analysis of the information available.

In order to monitor the evolution of the safety level on European motorways, accident trends for the decade 1995 - 2004[1] were considered. According to the following Figure 1 there was a decrease of 15,9% in traffic accident fatalities on motorways in 2004 compared to the 2.545 fatalities in 1995, though the total number of traffic accident fatalities also fell significantly, by almost 27%, in the 14 European Union countries (all except Germany) within the same decade. Specifically in 1999 there was an increase of 7,4% in motorway road accident fatalities compared to 1998 and, within the same year, a decrease of 1,2% in the overall number of road

fatalities. It is also worth noting that between 2000 and 2002 the number of fatalities on motorways in the 14 countries did not really change, whereas the overall number of road accident fatalities decreased by 5,2%.

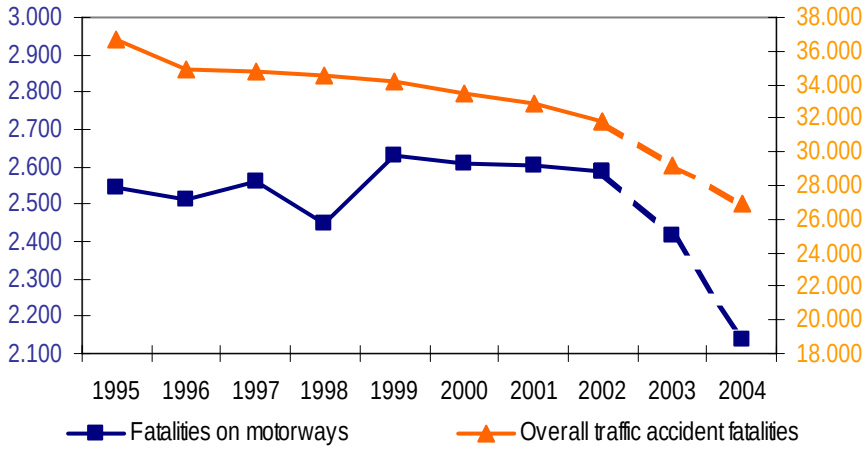


Figure 1. EU-14 Fatalities evolution, 1995-2004[1]

The following Table 1 provides an overview of the changes in the number of fatalities on motorways split by country. It can be seen that Italy in 2004[1] has far more persons killed on motorways than any other of the examined EU countries (648 persons killed, 105% more than France, the country with the second higher figure).

Table 1. Fatalities on motorways by country, 1995-2004[1]

	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
BE	209	201	192	223	213	238	196	172	137	124
DK	31	30	32	30	41	29	38	48	31	27
EL	1	148	72	61	105	61	86	69	58	116
ES	356	314	313	353	327	354	376	324	372	279
FR	465	453	470	497	492	527	487	521	439	316
IE	6	2	3	0	1	6	4	5	8	-
IT	782	752	848	711	804	764	773	801	711	648
LU	9	16	11	8	6	9	7	12	-	-
NL	190	182	156	108	132	138	124	123	151	-
AT	166	104	121	141	146	126	156	126	107	118
PT	99	116	104	105	123	128	112	115	127	116
FI	16	8	3	10	9	13	11	16	7	17
SE	31	20	40	25	25	25	30	27	34	42
UK	184	169	195	176	205	191	206	228	220	166
EU-14	2.545	2.515	2.560	2.448	2.629	2.609	2.606	2.587	2.414	2.140
% yearly change	-	-1,2%	1,8%	-4,4%	7,4%	-0,8%	-0,1%	-0,7%	-6,7%	-11,4%

Source: CARE Database / EC
Date of query: November 2006

[1] or last available year

However, as in road safety analysis, exposure data is often used to calculate risk estimates, those being defined as the rate of the number of accidents (or casualties) divided by the amount of exposure of a population over a time period (Hakkert and Braimaster, 2002, Hauer, 1995), data from other international databases such as OECD/IRTAD, Eurostat etc. (i.e. population, length of network etc.) were also used. The calculated risk figures may be used for different purposes, but their main objective is to enable the comparison of safety performance among different units, populations or countries.

In Table 2 it can be seen that the fatality rates on motorways per million inhabitants in Austria and Belgium are higher than the respective rates in the other 12 European countries, and hence the average rate of the EU-14, for 2004[1].

Table 2. Fatalities on motorways per million inhabitants, 1995-2004[1]

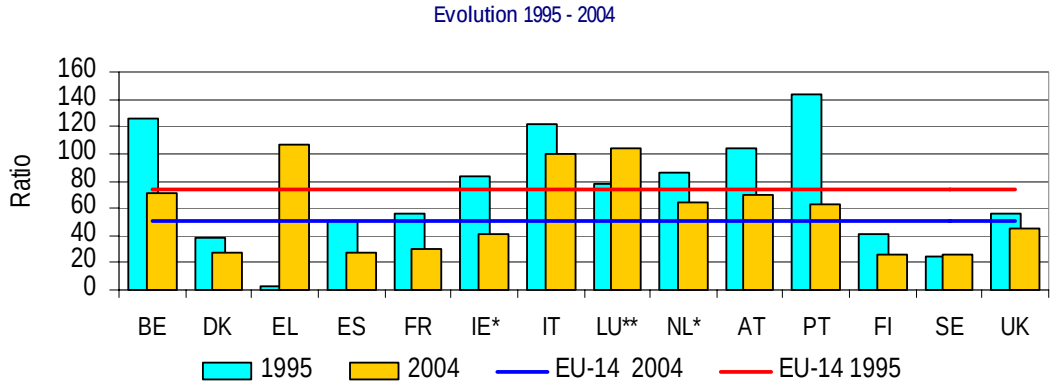
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
BE	20,6	19,8	18,9	21,9	20,9	23,2	19,1	16,7	13,2	11,9
DK	5,9	5,7	6,1	5,7	7,7	5,4	7,1	8,9	5,8	5,0
EL	0,1	13,9	6,7	5,6	9,7	5,6	7,9	6,3	5,3	10,5
ES	9,1	8,0	7,9	8,9	8,2	8,9	9,3	7,9	9,0	6,6
FR	8,1	7,8	8,1	8,5	8,4	9,0	8,2	8,8	7,4	5,3
IE	1,7	0,6	0,8	0,0	0,3	1,6	1,0	1,3	2,0	2,0
IT	13,8	13,2	14,9	12,5	14,1	13,4	13,6	14,1	12,4	11,2
LU	22,2	38,9	26,4	19,0	14,0	20,8	15,9	27,0	26,8	26,6
NL	12,3	11,7	10,0	6,9	8,4	8,7	7,8	7,6	9,3	9,3
AT	20,9	13,1	15,2	17,7	18,3	15,7	19,4	15,7	13,2	14,5
PT	9,9	11,6	10,3	10,4	12,1	12,6	10,9	11,1	12,2	11,1
FI	3,1	1,6	0,6	1,9	1,7	2,5	2,1	3,1	1,3	3,3
SE	3,5	2,3	4,5	2,8	2,8	2,8	3,4	3,0	3,8	4,7
UK	3,1	2,9	3,3	3,0	3,5	3,2	3,4	3,9	3,7	2,8
EU-14	8,8	8,7	8,8	8,4	9,0	8,9	8,8	8,7	8,1	7,1

Source: CARE Database / EC; EUROSTAT
Date of query: November 2006

Additionally, it is evident that between 1995 and 2004 the fatality rate on motorways decreased by 19% (from 8,8 per million people in 1995 to 7,1 in 2004), compared to an approximate 30% decrease (from 117,7 to 82,5) in the corresponding fatality rate on the remaining road network. Belgium is the country which experienced the most significant reduction during this last decade (42,2%), whereas in Sweden the fatality rate actually increased (by 33,1%). Luxembourg has the highest fatality rate (27 in 2002), whereas seven of the countries are lower than the average rate of all EU-14 countries for 2004[1].z

A most reliable comparison of the changes on the safety level of motorways in different countries involves calculating the fatality rate per thousand kilometres of motorway. Taking this exposure indicator (motorway network length) into account, from Figure 1 it was proved by the analysis that within the examined period, Portugal experienced a considerable reduction in fatality rates on its motorway network (56,1%).

[1] or last available year



* Data from 2003, ** Data from 2002

Source: CARE Database / EC, EUROSTAT
Date of query: November 2006

Figure 2. Fatalities on motorways per thousand km of motorways, 1995 versus 2004[1]

Greece and Italy are the countries with the most fatalities per thousand kilometres of motorway network in 2004. Conversely, the motorways in Finland and in Sweden were safer than the ones in the remaining 12 EU countries, and subsequently the fatality rate for these countries in 2004[1] is significantly lower than the average rate for the EU-14 countries (26 and 26,4 respectively, compared to the average 50,1).

According to the analysis performed, the ratio of fatalities on motorways to all fatalities in the European Union countries has increased since 1995 and especially in Austria, almost 14% of the overall road accident fatalities in 2004 occurred on motorways, the largest proportion in the EU-14, whereas in Finland and the United Kingdom fatalities on motorways constitute the smallest proportion of road accident fatalities.

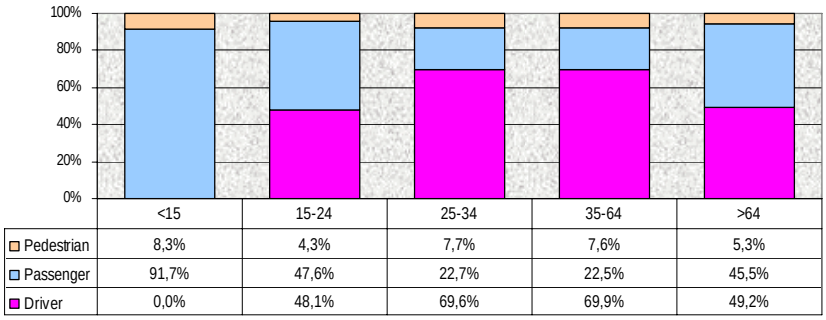
3. Road safety parameters of the European motorways

The analysis of the distribution of road accident fatalities according to the mode of transport used on motorways and on non-motorway road network, showed that almost 70% (1.460 persons) of the fatalities on motorways across the European countries concern passenger car occupants. Another interesting outcome of the analysis was that on average, only 9,9% of the fatalities occurring on motorways in the 14 countries concerns two-wheelers (motorcycle, moped or pedal cycle users), with the Netherlands having the largest percentage (15,9%), though the absolute number is small (24 fatalities). On the other hand, the two-wheeler user fatalities on the non-motorway road network constitute 35,1% of the respective number of fatalities, with Portugal and Italy having the largest shares (43,4% and 42,5%).

The data analysis also revealed that the single biggest category of fatalities occurring on motorways, in terms of vehicle manoeuvre type, in all EU-14 (with the exception of The Netherlands) countries (29,5%) concern fatalities resulting from accidents in which occupants killed were in a vehicle moving straight ahead and where no other manoeuvre took place. The respective percentage for the same manoeuvre type on the remaining road network is higher (39,2%).

Age and person class of the persons killed were also considered. As Figure 2 indicates, pedestrians constitute only a small percentage of the overall fatalities occurring on motorways

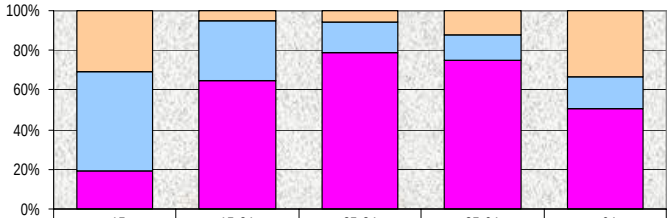
(4,3% - 8,3%). However, as shown in Figure 3, children (persons younger than 15 years old) and elderly people (persons older than 64 years old) seem to be more vulnerable pedestrians on the remaining road network, as 31% and 33% of fatalities amongst children and elderly people respectively are pedestrians.



	<15	15-24	25-34	35-64	>64
Pedestrian	8,3%	4,3%	7,7%	7,6%	5,3%
Passenger	91,7%	47,6%	22,7%	22,5%	45,5%
Driver	0,0%	48,1%	69,6%	69,9%	49,2%

Figure 3. Fatalities on motorways per thousand km of motorways, 1995 versus 2004[1]

Furthermore, a larger proportion of middle age drivers (35 - 64 years old) are killed on motorways (69,9%), compared with those of other age groups, whereas more younger drivers (25 - 34 years old) constitute the largest proportion of fatalities occurring on the remaining road network. Finally, drivers up to 24 years old are mainly killed on the remaining road network and not on motorways, where the respective percentages are significantly lower: there is a relatively small number of fatalities in this age group on motorways (192 people, compared to 3.572 people on the remaining road network), possibly indicating that young people do more driving on the non-motorway network.



	<15	15-24	25-34	35-64	>64
Pedestrian	31,0%	5,0%	5,6%	12,0%	33,0%
Passenger	50,1%	30,3%	15,4%	13,1%	16,4%
Driver	19,0%	64,7%	78,9%	75,0%	50,6%

Figure 4: Fatalities on non-motorway road network by age and person class, 2004[1]

Finally, with reference to the lighting conditions, almost one-third of the fatalities on motorways, but also on the non-motorway road network occurred when it was dark in 2004[1]. However, 11.030 (48%) people, almost half of the respective fatalities, are killed on non-motorway roads in daylight or twilight, whereas on motorways the respective percentage is lower (39%).

4. Conclusions

The various road safety parameters examined have different impact the motorways safety level, than on the remaining road network due to the specific design characteristics but also to the different behaviour of the drivers.

According to studies on motorways safety, the special driving conditions on this road network type, in which average speeds measured are high and distances between vehicles often surprisingly small (Aron et al., 1999) result to different accident frequency and severity than on

the remaining road network. Especially in cases where motorway traffic is low, the increased relaxation felt by the driver can lead to overcompensation in speed and subsequently to the detriment of his safety (Martin, 2002).

Analysis of motorway road accident data derived from the Community CARE database for the decade 1995 - 2004 showed a decrease in accident fatalities on motorways in 2004 compared to 1995, which was though lower than the respective reduction of the overall road accident fatalities in the 14 European Union. CARE accident data were also combined with exposure data (population, length of motorways), allowing the more accurate comparison of the calculated rates between EU countries. According to the results of the analysis, motorways in two countries of the Southern part of Europe (Greece and Italy) seem to be the least safe than motorways in the remaining 12 EU countries, whereas two Nordic countries (Sweden and Finland) have the lower motorway fatality rates.

Within this research it was demonstrated that analyses using disaggregate data lead to results which do not always coincide with analyses using aggregate data. The CARE disaggregate data may be proved very useful for these more detailed analyses. At a next phase, an analysis using statistical models is also necessary for the identification of the combined correlation of the parameters with an impact on motorway safety and the underlining reasons behind the motorway casualties.

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