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Road traffic accidents in European urban areas

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Abstract

More than 135.000 people were killed in traffic accidents on roads inside urban areas in the 27 European Union countries between 2004 and 2013, representing 38% of all road accident fatalities in those countries. The objective of this research is the analysis of characteristics of road accidents inside urban areas in European countries through the use of the EU CARE database with disaggregated data on road accidents, as well as of other international data sources (Eurostat, OECD/IRTAD, etc.). Time-series data from 27 EU countries and 3 EFTA countries over a period of 10 years (2004-2013) were correlated with basic safety parameters such as mode of transport, presence of junction, seasonality, road user type and personal characteristics like age and gender. During this period an overall decrease of almost 42% in road accident fatalities inside urban areas was recorded, however, the percentage of all fatalities that occurred within urban areas has slightly increased. It was also found that the percentages of elderly road fatalities (65+ years old) as well as of pedestrians, were much higher inside urban areas than outside. Moreover, the proportion of fatalities at junctions inside urban areas was twice the proportion of fatalities at junctions outside urban areas. The results of the analysis allow for an overall assessment of the road safety levels in European urban areas also in comparison to the remaining road network, providing thus, useful support to decision makers working for the improvement of safety on the European road network.

1. Introduction

The urban population in 2014 accounted for 54% of the total global population, up from 34% in 1960, and continues to grow. It is estimated that by 2017, the majority of people will be living in urban areas (GHO, 2016). This increase of population in urban areas leads to increasing need for mobility and subsequently to the potential deterioration of the issue of road safety. Especially for many low– and middle- income countries, rapid urbanization, economic growth and the need for improved mobility have led to increased motorization, while road infrastructure has not kept pace (WHO, 2015).

In European Union urban areas, pedestrians, cyclists, motorcyclists, car drivers and public transport compete for the limited space. The constant interaction between unprotected or *vulnerable* road users and moving [powered] vehicles creates situations where people are regularly put at risk. Urban road safety is therefore to a high degree an issue of vulnerable road user safety (EC, 2013).

Between 2004 and 2013 nearly 140.000 people were killed in road accidents in urban areas in the EU. While urban road fatalities experienced a significant decrease over this decade, their proportion of all fatalities increased slightly from 36% in 2004 to 38% in 2013. For that reason, and due to the presence of more vulnerable road users in urban areas, it is essential that urban road accidents are investigated and continuously monitored, allowing the implementation of appropriate accident mitigation measures.

The objective of this research is the analysis of characteristics of road accidents inside urban areas in the European countries, through the exploitation of the EU CARE database with disaggregate data on road accidents.

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More specifically, time-series data on road accidents inside urban areas for 27 EU countries and 3 European Free Trade Association (EFTA) countries (Iceland, Norway and Switzerland) over a period of 10 years (2004-2013) taken from the CARE database are correlated with basic safety parameters, such as mode of transport, presence of junction, seasonality, road user type and personal characteristics such as age and gender. The paper is based on work done within the development of the Traffic Safety Basic Facts 2015 – Urban Areas (European Commission, 2015), as well as through SAFETYNET and DaCoTA EC co-funded research projects and the European Road Safety Observatory (ERSO - http://ec.europa.eu/transport/wcm/road_safety/erso/index-2.html).

The results of the analysis allow for an overall assessment of the road safety level in the European urban areas in comparison to the remaining road network, thus providing useful support to decision makers working for the improvement of safety on the European road network.

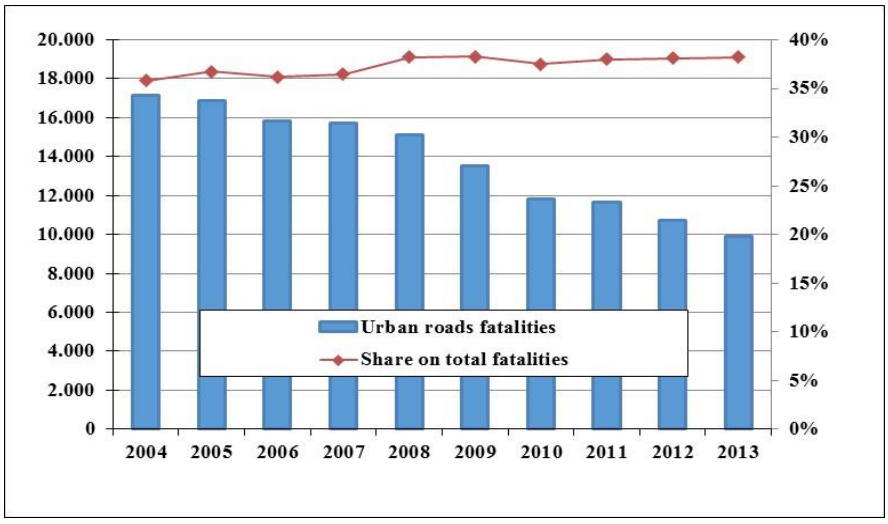
2. Overall road safety trends in urban areas of the European countries

In urban areas, roads do not only ensure that destinations can be reached, but they also have many other functions (commercial, residential) which usually make them relatively unsafe. The danger posed by traffic within the inner urban/built-up areas is especially a problem involving pedestrians, cyclists and moped riders coming into conflict with fast-moving traffic (Kraay, Dijkstra, 1989).

According to the common European definition, urban roads are roads within the boundaries of a built-up area, with entries and exits sign-posted as such, which often have a maximum speed limit of around 50km/h. Motorways, express roads and other roads of higher speed traversing the built-up area, if not sign-posted as built-up roads, are excluded while streets are included (UNECE-ITF-EUROSTAT, 2009).

In 2013, 26.090 people were killed in road accidents throughout the European Union, 9.930 of whom were killed in accidents on urban roads in the EU. This is the 38% of all road accident fatalities in 2013. In order to assess the safety level of the road network inside urban areas at the 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 urban roads, accident trends for the decade 2004 - 2013 were considered. According to the following Figure 1, although the number of urban road fatalities has decreased by more than a third (42%) over this period in the 27 EU countries, the overall number of road accident fatalities has fallen faster (reduction by 45%) and the share of urban road fatalities of all road fatalities in the EU increased from about 36% to almost 38%, especially after 2007.

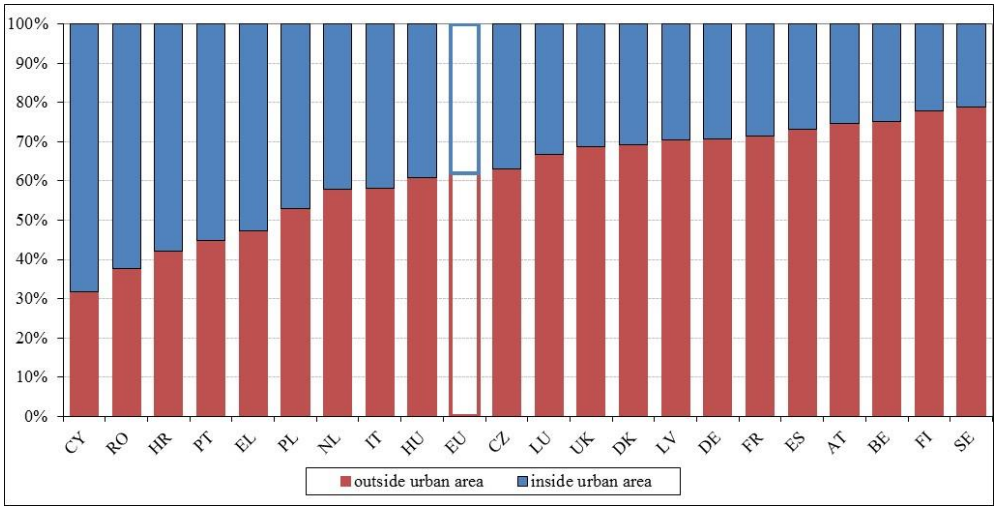


Source: CARE database, data available in May 2015

Fig. 1. Number of urban road fatalities and percentage of all road fatalities, 2004-2013

Furthermore, Figure 2 presents the distribution of fatalities between roads in- and outside urban areas in 2013 by country. The analysis revealed that the highest percentages of urban road fatalities were recorded in Cyprus, Romania and Croatia, while the lowest percentages are found in Sweden, Finland and Belgium. It is also worth noting that the Southern EU countries (except for Spain) recorded higher percentages of road fatalities in urban

areas, indicating that the Northern EU countries may have better and safer facilities for vulnerable road users (pedestrians, cyclists).



Source: CARE database, data available in May 2015

Fig. 2. Distribution of road fatalities by country and area type, EU, 2013

The following Table 1 provides an overview of the changes in the number of fatalities on urban roads per country. It can be seen that in 2013 more people were killed in urban areas in Poland than in any other of the examined EU countries (1.581 fatalities). During 2004-2013, the number of urban road fatalities decreased in all the examined European countries, with 15 of the EU countries having recorded higher reductions than the EU on average. Ireland and Latvia had the highest reductions in urban road fatalities (67% and 63% respectively), while the total number of road accident fatalities in those countries were 57% and 65% respectively over the same period. In contrast, although Spain experienced the greatest reduction in road fatalities during 2004-2013 (65%), the reduction of urban road fatalities was much lower (50%).

Table 1. Number of urban road fatalities by country, 2004-2013

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
BE	295	255	265	275	274	257	246	281	213	179
BG	-	-	-	-	-	312	-	-	-	-
CZ	525	503	427	442	444	329	291	280	265	241
DK	120	95	101	129	129	92	78	69	59	59
DE	1.484	1.471	1.384	1.335	1.261	1.225	1.011	1.115	1.062	977
EE	-	46	46	63	41	19	-	-	-	-
IE	108	80	62	77	62	56	45	38	36	-
EL	766	758	774	724	744	646	593	559	499	464
ES	900	790	736	740	634	584	550	457	461	450
FR	1.534	1.664	1.346	1.359	1.235	1.252	1.133	1.096	1.027	932
HR	-	-	-	328	414	316	265	252	230	213
IT	2.596	2.588	2.494	2.269	2.070	1.892	1.782	1.744	1.602	1.421
CY	74	-	-	49	57	42	42	40	31	30
LV	142	125	148	165	97	68	78	53	53	53
LU	17	13	8	9	9	10	3	7	7	15
HU	476	502	508	505	419	301	272	234	210	232
MT	-	17	11	12	9	15	13	-	-	-
NL	252	254	283	270	243	227	199	233	208	201
AT	232	202	200	173	189	173	141	139	151	115
PL	2.755	2.495	2.349	2.549	2.499	2.171	1.813	1.959	1.652	1.581

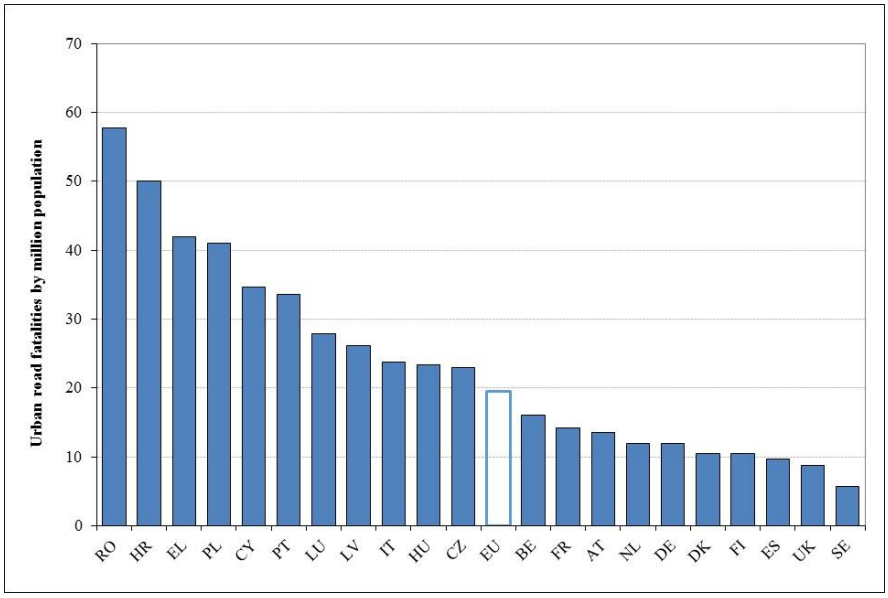
PT	556	537	448	389	417	386	484	487	397	352
RO	1.697	1.895	1.638	1.780	1.922	1.756	1.493	1.271	1.246	1.160
SI	83	81	92	94	73	64	60	47	42	53
SK	-	277	291	298	280	176	157	-	-	-
FI	82	101	93	81	108	76	63	74	56	57
SE	125	110	106	127	99	89	67	80	87	55
UK	1.349	1.302	1.326	1.178	1.087	1.000	597	645	632	553
EU*	17.148	16.875	15.825	15.732	15.128	13.535	11.807	11.661	10.727	9.930
Annual change		-1,6%	-6,2%	-0,6%	-3,8%	-10,5%	-12,8%	-1,2%	-8,0%	-7,5%
IS	8	3	10	1	5	5	4	3	2	4
NO	-	-	-	-	-	54	34	41	-	31
CH	191	137	124	141	135	137	114	133	125	113

Source: CARE database, data available in May 2015

* Totals for EU include latest available data (Data for Lithuania not included in totals)

In road safety analysis exposure data is often used to calculate risk estimates, 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). Since there are no reliable data available about vehicle kilometres or person kilometres travelled on urban roads in each of the examined countries, mortality rates have been used as a measure for comparison (population used as exposure). 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.

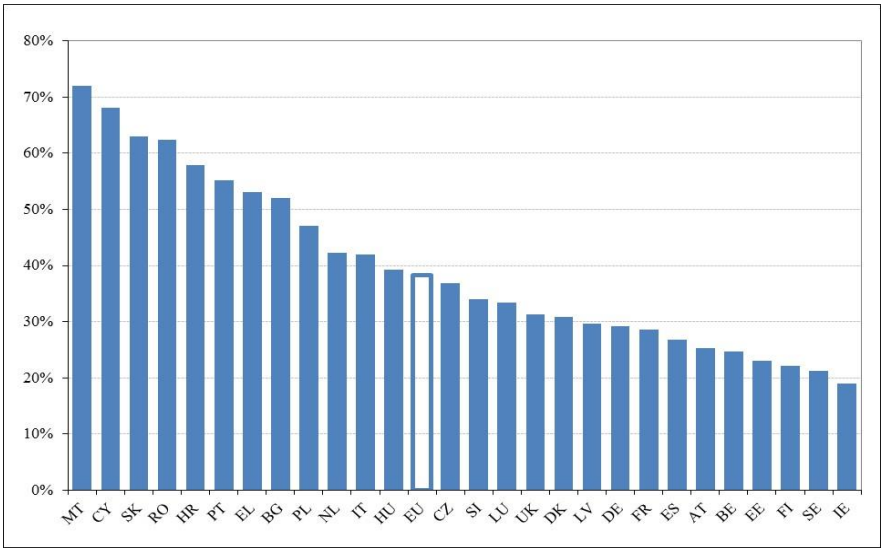
In Figure 3 it can be seen that the fatality rates on urban roads per million population in Romania and Croatia are higher than the respective rates in the other EU countries, and hence the average rate of the EU, for 2013. On the other hand, the three Nordic countries (Sweden, Finland and Denmark), as well as the United Kingdom and Spain seem to have the safest urban areas in terms of road safety.



Source: CARE database (EUROSTAT for population data), data available in May 2015

Fig. 3. Urban road fatality rates per million population by country, 2013

The proportion of the total number of fatalities in 2013 that occurred within urban areas is shown for each EU country in Figure 4. This proportion varies from 19% in Ireland to 68% in Cyprus. Slovakia and Romania also show a proportion of urban road fatalities of more than 60%.

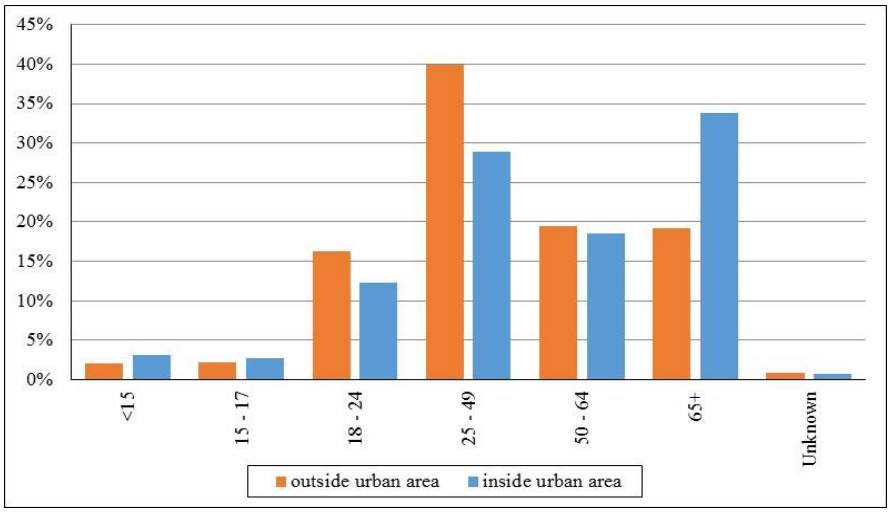


Source: CARE database, data available in May 2015

Fig. 4. Ratio of urban road fatalities to total fatalities by country, 2013 or latest available year

3. Road safety parameters of the European urban areas

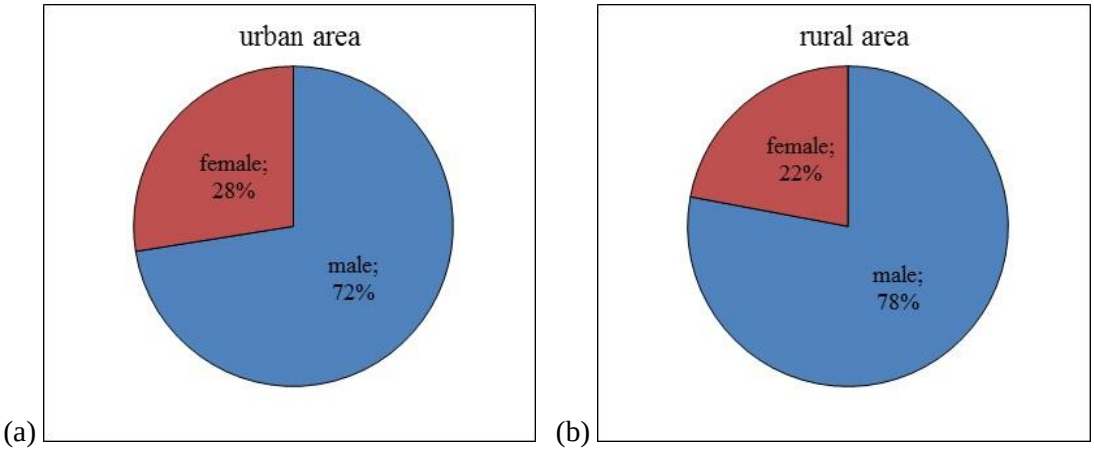
The analysis of distribution of road accident fatalities according to the age group of road users shows that the percentage of the elderly fatalities in road accidents in 2013 was much higher inside urban areas than outside (33,8% and 19,2% respectively). A possible explanation may be that trips made by the elderly are usually short and mostly done as pedestrians. In addition, the elderly travel outside urban areas less often. This trend is inverted for the age groups between 18 and 49 years old where the percentage of fatalities is clearly higher outside urban areas.



Source: CARE database, data available in May 2015

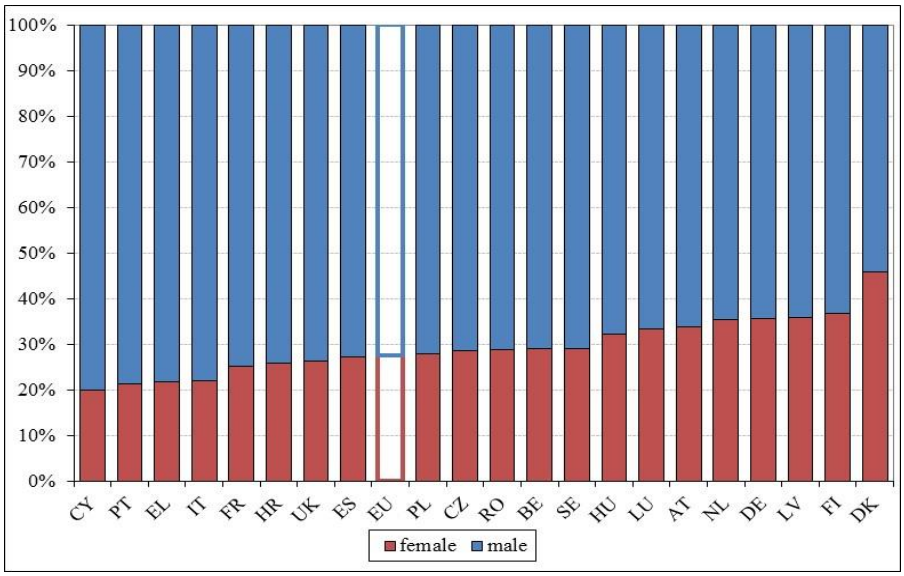
Fig. 5. Distribution of road fatalities by age group and area type, EU, 2013

The gender of the road users was also considered in the analysis. In Figure 6 the proportion of fatalities by gender in urban and rural areas is compared. It is evident that a higher proportion of females were killed in road accidents in urban areas (28%) compared to rural areas (22%) in the European Union in 2013. This may be explained by the fact that women drive more in urban areas where the accident risk is higher than in rural areas or on motorways (Elvik, Vaa, 2004). The data analysis also revealed that Cyprus, Portugal, Greece and Italy are the countries with the lowest percentage of female urban road fatalities (below 25%), as shown in Figure 7. On the other hand, Denmark is the country with the highest percentage of female fatalities in road accidents in urban areas (about 46%), more than 24% higher than Finland, which holds the second highest percentage.



Source: CARE database, data available in May 2015

Fig. 6. Distribution of road fatalities by gender and area type, EU, 2013



Source: CARE database, data available in May 2015

Fig. 7. Distribution of urban road fatalities by country and gender, 2013

Table 2 shows the distribution of the fatalities by road user type inside and outside urban areas in 2013. As it is shown, pedestrians constitute a large percentage of the overall fatalities occurring inside urban areas (39%), which is much higher than the respective percentage outside urban areas (below 11%). The highest proportions of urban pedestrian fatalities in the EU were recorded in Latvia, Estonia and Slovakia. In contrast, the Netherlands had the lowest percentage (17%) in 2013, followed by Slovenia and Croatia.

Furthermore, 50% of fatalities inside urban areas in the EU in 2013 were drivers and 11% were passengers, while these percentages were 68% and 11% respectively outside urban areas.

Table 2. Total number and distribution of road fatalities by country, area and road user type, 2013 or latest available year

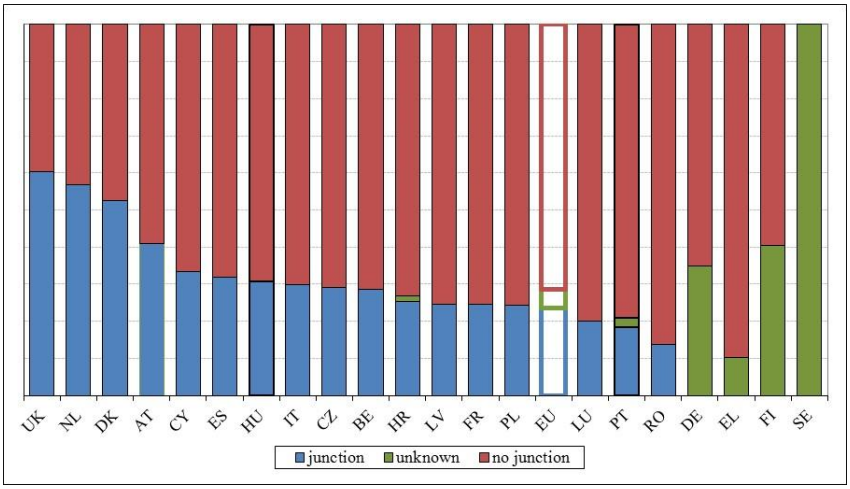
	Inside urban area				Outside urban area			
	Driver	Passenger	Pedestrian	Total	Driver	Passenger	Pedestrian	Total
BE	61%	9%	30%	179	75%	17%	8%	543
BG	38%	19%	43%	312	54%	35%	11%	589
CZ	46%	10%	44%	241	67%	19%	13%	413
DK	58%	10%	32%	59	66%	23%	11%	132
DE	52%	7%	41%	977	76%	17%	7%	2.362
EE	32%	11%	58%	19	54%	30%	15%	79

IE	44%	6%	50%	36	67%	24%	9%	126
EL	62%	12%	26%	464	71%	21%	8%	415
ES	47%	5%	48%	450	65%	22%	13%	1.230
FR	55%	11%	34%	932	76%	18%	6%	2.336
HR	57%	18%	25%	213	61%	30%	10%	155
IT	64%	8%	29%	1.421	71%	22%	7%	1.964
CY	67%	7%	27%	30	64%	36%	0%	14
LV	25%	6%	70%	53	56%	18%	26%	126
LU	60%	13%	27%	15	87%	10%	3%	30
HU	47%	9%	44%	232	60%	27%	13%	359
MT	54%	31%	15%	13	-	-	-	0
NL	76%	7%	17%	201	84%	11%	6%	275
AT	57%	4%	39%	115	76%	13%	11%	340
PL	41%	13%	46%	1.581	52%	25%	23%	1.776
PT	57%	11%	32%	352	65%	24%	11%	285
RO	34%	15%	51%	1.160	47%	34%	19%	701
SI	70%	6%	25%	53	71%	19%	10%	72
SK	31%	14%	55%	157	57%	25%	19%	214
FI	54%	11%	35%	57	75%	18%	7%	201
SE	59%	7%	33%	55	69%	19%	12%	201
UK	43%	11%	46%	553	69%	18%	12%	1.217
EU	50%	11%	39%	9.930	68%	21%	11%	16.155
IS	75%	0%	25%	4	64%	36%	0%	11
NO	61%	3%	35%	31	75%	20%	5%	135
CH	42%	8%	50%	113	79%	13%	8%	156

Source: CARE database, data available in May 2015

Figure 8 shows the distribution of urban road fatalities that occurred at – or away from – junctions in the EU countries. Romania had the lowest percentage of junction fatalities (14%), whereas more than half of urban fatalities in the United Kingdom, the Netherlands and Denmark occurred at junctions. It should be noted that in three countries (Germany, Greece, and Finland), for a significant number of fatalities recorded in the CARE database it is not specified whether they occurred at junctions, while for Sweden this information is not available at all.

Additionally, the analysis revealed that the proportion of fatalities at junctions inside urban areas was double the proportion of fatalities at junctions outside urban areas in the EU in 2013.

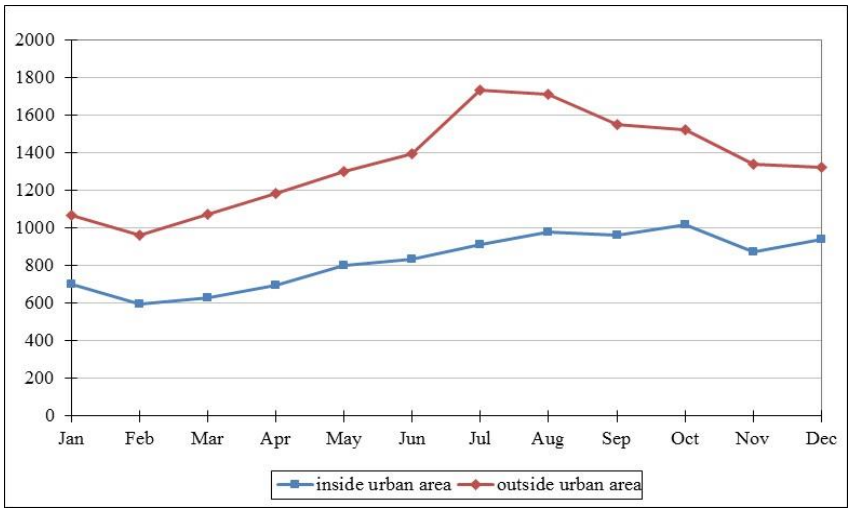


Source: CARE database, data available in May 2015

Fig. 8. Distribution of urban road fatalities by country and “junction”, 2013

Finally, Figure 9 shows the comparison of fatalities per month inside and outside urban areas. The number of fatalities per month has a similar pattern for both, except during the summer months, when there is a peak of fatalities outside urban areas.

According to the analysis of fatalities by day of the week, on working days, the percentage of fatalities was slightly higher inside urban areas than outside urban areas, while the opposite was true during weekends.



Source: CARE database, data available in May 2015

Fig. 9. Number of road fatalities by month and area type, EU, 2013

4. Conclusions

The examined road safety parameters have different impact on the safety level of urban areas than on the remaining road network, due to the specific design characteristics, different mix of traffic using the road but also to the different behaviour of road users.

According to earlier studies, there are differences both in the frequency and the severity of accidents inside and outside urban areas. Relatively low mortality rates recorded in urban areas compared to rural areas can be partly explained by the increased use of public transport and the shorter trips which reduce exposure to risk, as well as by low travelling speeds due to congestion resulting in less serious injuries (Wegman et al., 2004). Factors affecting road accident severity inside and outside urban areas also differ. Young drivers, bicycles, intersections and collisions with fixed objects have been found to affect accident severity only inside urban areas in Greece, whereas factors affecting severity only outside urban areas are weather conditions, head-on and side collisions (Theofilatos et al., 2012).

Analysis of urban road accident data derived from the Community CARE database for the decade 2004 - 2013 showed a decrease of 42% in accident fatalities in urban areas in 2013 compared to 2004, which was lower than the respective reduction of the overall road accident fatalities in the European Union. Thus, the proportion of urban road fatalities in all fatalities over the same period was slightly increased from 36% to 38%. CARE accident data were also combined with population data, allowing for a more accurate comparison between the EU countries. According to the results of the analysis, the fatality rates in urban areas per million inhabitants in Romania and Croatia were higher than the respective rates in the other EU countries, for 2013, whereas Sweden, Spain and the United Kingdom had the lowest urban road fatality rates.

The data analysis also revealed that the percentage of the elderly fatalities in road accidents in 2013 was much higher inside urban areas than outside, while this trend is inverted for the age groups between 18 and 49 years old, for which the percentage of fatalities is clearly higher outside urban areas. Pedestrians constitute a large percentage of the overall fatalities occurring inside urban areas, which is much higher than the respective percentage outside urban areas (below 11%). Furthermore, the proportion of fatalities at junctions inside urban areas was double the proportion of fatalities at junctions outside urban areas in the EU in 2013.

The results of the analysis allow for an overall assessment of the safety level in the European urban areas relative to the remaining road network, providing thus useful support to decision makers working for the improvement of safety in the European road network. Certainly, the effort of data-collection is an on-going challenge and there are additional data that could help shed light to the problem of road safety. Of particular interest are exposure data related to the mobility of road users (veh-kms, passenger-kms travelled). Furthermore, the macroscopic analysis presented in this paper could in the future be combined with more detailed analysis using statistical models, which

is necessary for the identification of the combined correlation of the parameters with an impact on urban road safety and the underlining reasons behind the casualties in urban areas.

Acknowledgements

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Appendix A. Country abbreviations

Belgium	BE
Bulgaria	BG
Czech Republic	CZ
Denmark	DK
Germany	DE
Estonia	EE
Ireland	IE
Greece	EL
Spain	ES
France	FR
Croatia	HR

Italy	IT
Cyprus	CY
Latvia	LV
Lithuania	LT
Luxembourg	LU
Hungary	HU
Malta	MT
Netherlands	NL
Austria	AT
Poland	PL
Portugal	PT

Romania	RO
Slovenia	SI
Slovakia	SK
Finland	FI
Sweden	SE
United Kingdom	UK

References

1) Elvik, R., Vaa, T., (2004), The Handbook of Road Safety Measures. Elsevier, 2004.

2) European Commission, (2013), Targeted action on urban road safety, Commission staff working document accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Together towards competitive and resource-efficient urban mobility, Brussels.

3) Eurostat / ITF / UNECE, (2009), Illustrated glossary for transport statistics (4th Edition), Document prepared by the Intersecretariat Working Group on Transport Statistics, United Nations Economic Commissions for Europe, International Transport Forum, Eurostat.

4) Global Health Observatory (GHO) data, (2016), http://www.who.int/gho/urban_health/situation_trends/urban_population_growth_text/en/

5) Hakkert, A. S. and Braimaister, L., (2002), The uses of exposure and risk in road safety studies, SWOV report R-2002-12, SWOV, Leidschendam, the Netherlands.

6) Hauer, E., (1995), On exposure and accident rate. Traffic Engineering and Control, 36 (3), pp. 134-138.

7) Kraay J.H. & Dijkstra A., (1989), Safety Aspects of Urban Infrastructure - From traffic humps to integrated urban planning, Paper presented to the International Conference on Traffic and Environmental Management in Cities, Prague, Czechoslovakia, 23-24 May 1989.

8) NTUA - National Technical University of Athens (2005). Improvement of accident data compatibility throughout Europe, Deliverable 1.5 of SafetyNet WP1 - Intermediate Progress Report on Task 1.4, SafetyNet Consortium, Athens.

9) Theofilatos A., Graham D., Yannis G., (2012), "Factors Affecting Accident Severity Inside and Outside Urban Areas in Greece", Traffic Injury Prevention, Vol. 13, Issue 5, 2012, pp. 458-467.

10) Wegman, F., Commandeur, J., Doveh, E., Eksler, V., Gitelman, V., Hakkert, S., Lynam, D., Oppe, S., (2008), SUNflowerNext: Towards a Composite Road Safety Performance Index, SWOV Institute for Road Safety Research, Leidschendam, the Netherlands.

11) WHO, (2015), Global status report on road safety 2015, World Health Organisation, Geneva.