ROAD TRAFFIC CASUALTIES IN THE ELDERLY IN EUROPE: ANALYSIS OF MACROSCOPIC AND IN-DEPTH DATA

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Abstract

Due to their greater fragility, the elderly are more likely to be seriously injured in any given accident than younger people. In 2010 6.563 elderly people were killed in traffic accidents in 24 European Union countries, constituting 22% of road fatalities of all ages. Although the number of elderly fatalities has decreased by 30% between 2001 and 2010, the overall fatalities number has fallen faster and the proportion of elderly fatalities has tended to rise. The objective of this research is the analysis of basic road safety parameters related to elderly people (> 64 years old) in European countries through the use of the EU CARE database with disaggregate data on road accidents, as well as of other international data sources (OECD/IRTAD, Eurostat, etc.). Time-series data from 24 EU countries over a period of 10 years (2001-2010) are correlated with basic safety parameters, such as road type, season of the year, age and gender. Data from the EU Injury Database are used to identify injury patterns and improve the assessment of injury severity, and additional insight into accident causation for elderly drivers and riders is offered through the use of in-depth accident data from the EC SafetyNet project Accident Causation System (SNACS).

The results of the analysis allow for an overall picture of the safety level of elderly people in Europe, providing thus useful support to all decision makers working for the improvement of safety of the elderly in the European road network.

Keywords: elderly, EU CARE database, road accident causation, road safety, European countries

Introduction

Elderly people (> 64 years old) constitute part of the vulnerable road users group, as due to their greater physical vulnerability they have a higher risk of serious injury and fatality in traffic. Their frailty leads to an overrepresentation of their crashes in databases based on injury outcomes (Hakamies-Blomqvist et al, 2004), since they are more likely to be seriously injured than younger people.

More specifically, the accident rate per vehicle-km for the elderly drivers is higher comparing to younger drivers, they go through more serious consequences for themselves by the accidents and they are responsible for most of the accidents in which they are involved (Evgenikos et al., 2009).

The number of people older than 65 years old is expected to almost double by 2050, while an even higher increase is expected for people over 80 years old within the same period (OECD, 2001). In the following Figure 1 the estimated proportion of people over 65 years old in all OECD countries is presented for the period 2000 - 2050.

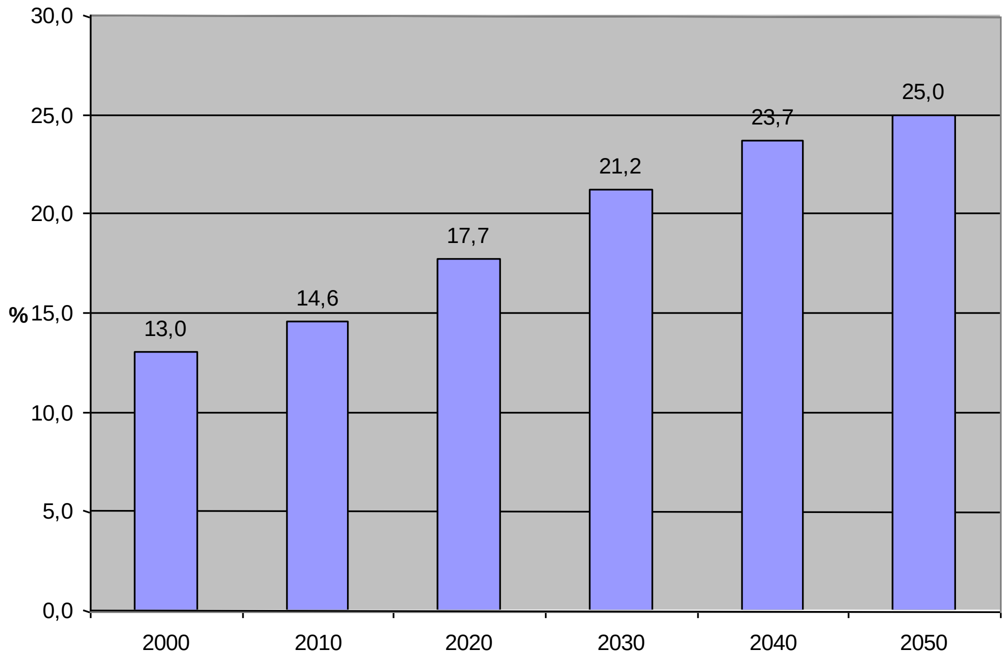


Figure 1: Estimated proportion of the population over 65 years old in all OECD countries, 2000- 2050 (Source: OECD, 2001)

A similar rate increase is also expected by 2030 in the number of drivers older than 65 years old in the U.S.A., constituting 20% of the overall drivers' population (NHTSA, 2008).

Between 2001 and 2010 more than 77.500 elderly people were killed in traffic accidents in 19 European Union countries (Broughton et al., 2012). This number represents about 19% of all traffic accident fatalities in those countries within the examined decade. Given the increased fatal crash risk of older adults, coupled with the continuing need for effective mobility and the expected increase of elderly drivers in the coming years, it is essential that traffic safety and mobility of older adults are further investigated and continuously monitored, allowing for the implementation of appropriate accident mitigation measures (FHWA, 2014).

The objective of this research is the analysis of basic road safety parameters related to elderly people (> 64 years old) in European countries, by the use of the EU CARE database with disaggregate data on road accidents, together with data from other international data files (e.g. Eurostat, as well as national sources), the EU Injury Database (EU IDB) and the SafetyNet Accident Causation System (SNACS). More specifically, time-series road accident data involving elderly people from CARE for 24 EU countries over a period of 10 years (2001-2010) are correlated with basic safety parameters, such as road network type, season of the year, casualty age and gender, as well as the day of the week, the time of the day and the season. Moreover, EU IDB data for the period 2005 - 2008 are used to identify injury patterns and improve the assessment of injury severity. Additional insight into accident causation recorded for elderly drivers and riders is offered through analysis of a set of in-depth data, collected for the period 2005 – 2008, using a common methodology for samples of accidents that occurred in Germany, Italy, The Netherlands, Finland, Sweden and the UK. The data, on which this analysis is based, along with much of the analysis and the way that the different types of databases were combined, is obtained through the 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 picture of the safety level of elderly people in Europe, providing thus useful support to all decision makers working for the improvement of safety of the elderly in the European road network.

Overall road safety trends for elderly people in EU

The research literature confirms conventional knowledge about the effects of aging on cognitive, perceptual, and motor abilities. These specific characteristics of elderly people and the changes in their abilities definitely affect their road safety level. Age-related changes in vision make it more difficult for older adults to accommodate to darkness, recognize objects under low lighting conditions, recover from glare, and search their environment. Making decisions becomes more difficult, as does changing a course of action once a commitment has been made, and memory deteriorates. On the other hand, experience and judgment are qualities that can contribute to compensating for slowed responses and sensory deficiencies. Evidence shows that most older drivers are aware of their changing abilities and adapt accordingly, making shorter trips and driving substantially less at night, in heavy traffic and in bad weather, reducing thus the risk of accident.

In 2010, 6.563 elderly people were killed in road traffic accidents in the 24 Member States for which CARE accident data are available, as shown in the following Table 1 which provides an overview of the changes in the number of elderly fatalities split by country:

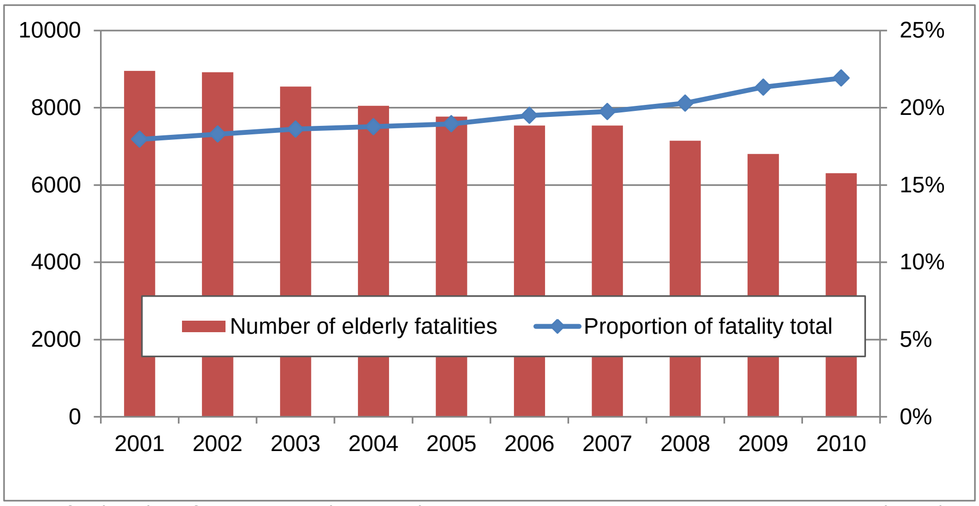
Table 1 - Number of elderly fatalities by country, 2001-2010

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BE	264	210	240	201	186	193	170	149	163	153
CZ	241	211	231	247	202	173	201	186	167	172
DK	102	103	99	80	70	72	95	97	61	67
DE	1.283	1.236	1.329	1.201	1.162	1.154	1.153	1.066	1.104	910
IE	47	60	53	61	56	66	58	47	26	30
EL	385	340	322	317	322	327	330	329	275	268
ES	867	835	817	746	719	671	604	544	507	527
FR	1.393	1.361	1.120	962	1.014	921	896	823	796	765
IT	1.369	1.461	1.379	1.293	1.199	1.220	1.105	1.099	1.111	1.059
LU	7	5	6	14	8	3	7	4	9	3
NL	222	213	221	199	188	209	181	174	187	-
AT	186	211	197	177	151	156	145	172	159	140
PL	910	976	885	965	931	888	945	962	810	674
PT	320	304	304	230	222	215	225	197	205	278
RO	417	458	417	483	491	504	617	570	593	494
SI	46	47	53	49	41	33	51	34	39	30
FI	96	99	96	97	91	71	79	93	69	64
SE	147	139	118	139	104	95	105	102	92	-
UK	652	655	658	589	616	572	575	499	432	391
EU-19	8.955	8.924	8.546	8.050	7.773	7.543	7.542	7.148	6.805	6.304
Yearly reduction	2,0%	0,3%	4,2%	5,8%	3,4%	3,0%	0,0%	5,2%	4,8%	7,4%
EE	-	-	-	-	21	32	41	29	18	-
HU	-	-	232	214	206	216	209	179	166	149
LV	-	-	-	-	-	61	73	55	-	44
MT	-	-	-	-	3	1	3	2	5	0
SK	-	-	-	-	77	95	97	72	51	48

2009 data for NI are used to estimate 2010 data for UK

Source: CARE Database / EC
Date of query: September 2012

In order to monitor the evolution of the elderly people safety level in Europe, accident trends for the decade 2001- 2010 were considered. According to the following Figure 2, although the number of elderly fatalities has decreased by 30% over this period in these countries, the overall number of road accident fatalities has fallen faster and the proportion of all fatalities who were elderly has tended to rise. Since 2008, more than one fifth of all road traffic fatalities have been at least 65 years old.



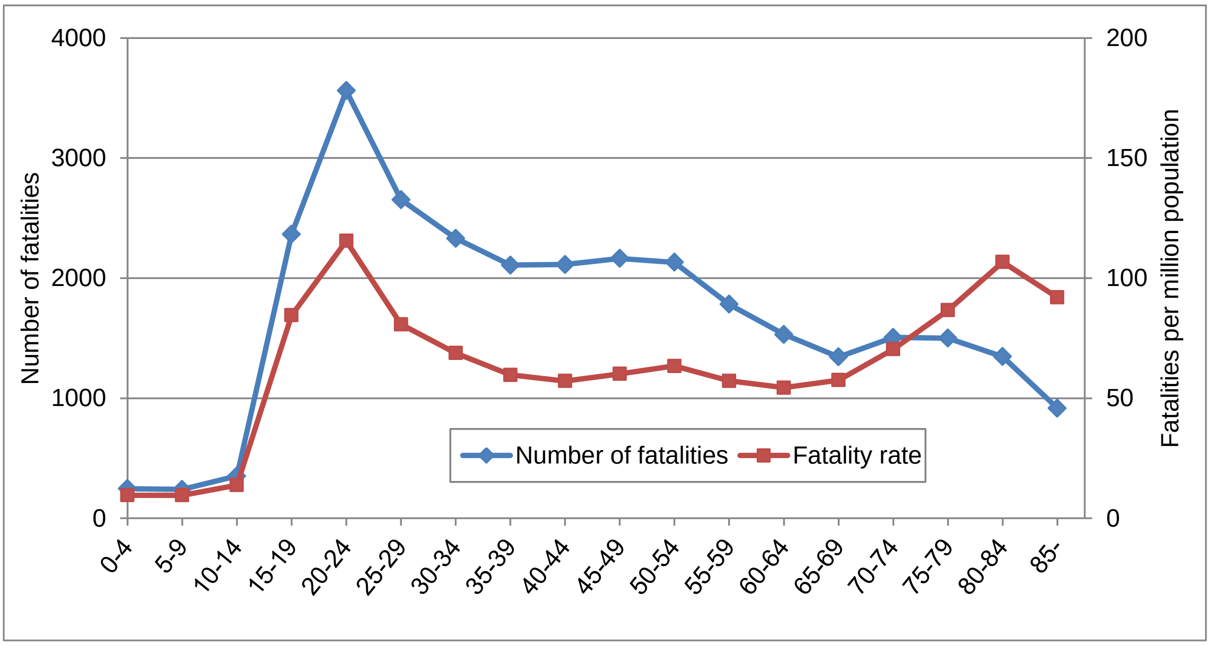
2009 fatality data for NI, NL and SE used as proxies for the 2010 data

Source: CARE Database / EC
Date of query: September 2012

Figure 2 - Number of elderly fatalities and share of fatality total in EU-19, 2001-2010

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), on that purpose data from other international databases such as OECD/IRTAD, Eurostat etc. were also used. Since there is no reliable data available about vehicle kilometres or person kilometres travelled by the elderly in each of the above countries, the population is used as exposure data. 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.

Figure 3 shows that in 2010 the elderly suffered fewer fatalities than the younger adult groups, but their fatality rates were amongst the highest. More specifically, the 75-84 age group has the highest fatality rate, averaged over the EU24, while the 65-74 group has the lowest. These differences are probably influenced by the tendency for personal mobility to reduce with increasing age, and for fatality rate to increase.

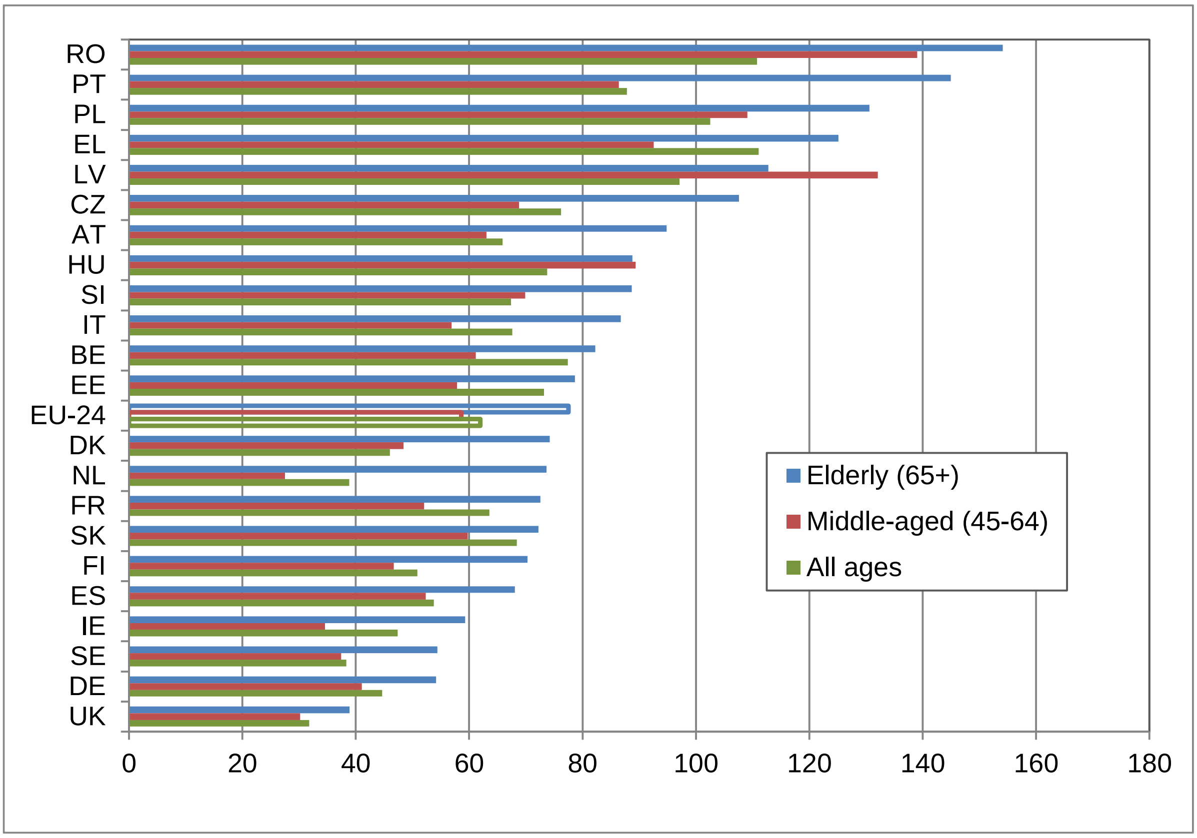


2009 fatality data for EE, NI, NL and SE used as proxies for the 2010 data

Source: CARE Database / EC
Date of query: September 2012
Source of population data: EUROSTAT

Figure 3 - Number of fatalities and fatality rate in EU-24 by age group, 2010

In most European countries, the elderly are at greater risk of being killed in a road accident than the overall population, with Romania, Portugal, Poland and Greece having not only the highest overall fatality rates but also among the highest rates for the elderly. Twelve EU countries have higher elderly fatality rates that the EU-24 average and on the other hand, as indicated in Figure 4, middle-aged people (45-64 years old) are at a lower risk of being killed than the elderly.



2009 fatality data for EE, NI, NL and SE used as proxies for the 2010 data

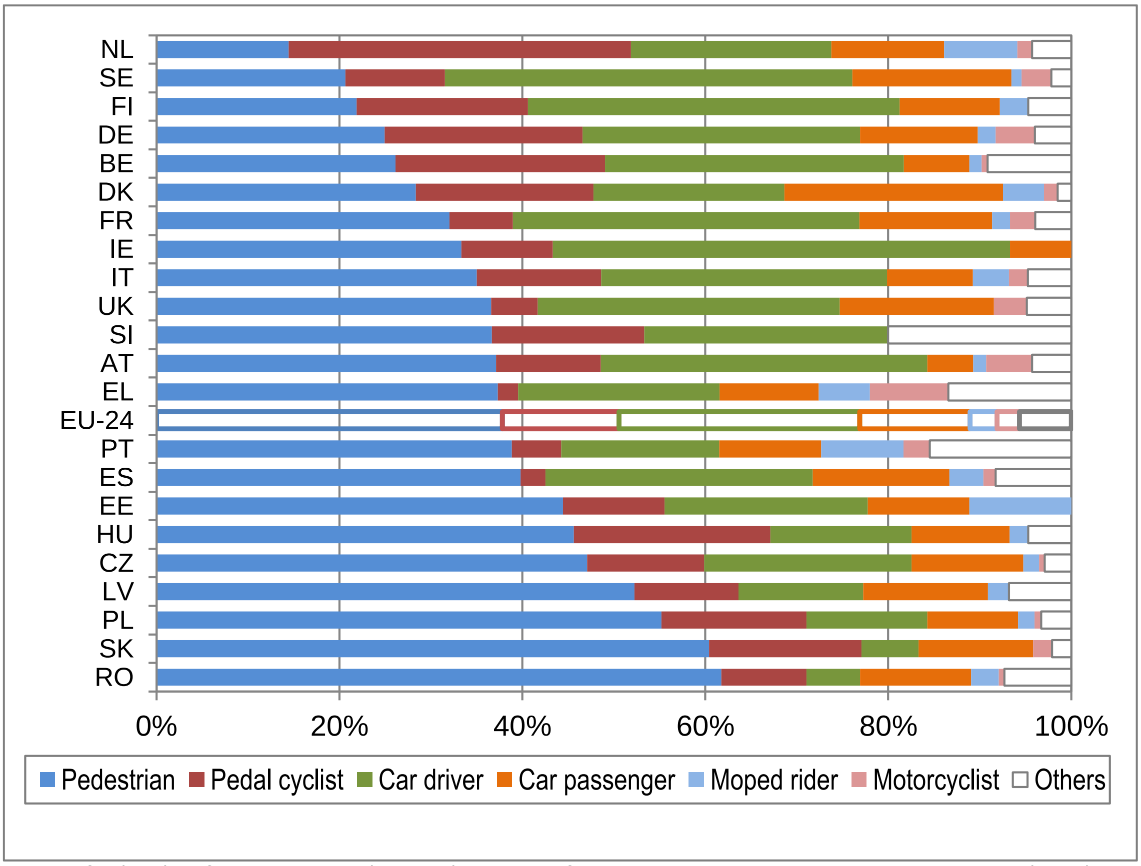
Source: CARE Database / EC
Date of query: September 2012
Source of population data: EUROSTAT

Figure 4 - Fatalities per million population, 2010

According to the results of a more detailed analysis by age groups and gender almost two thirds of elderly fatalities are men, whereas women make up a higher proportion of fatalities among the elderly (36%) than within the whole population (24%). In general, older women are much more likely to stop driving than are men of the same age, giving "lack of confidence" as their main reason for quitting. As illustrated in Figure 5, the proportion of elderly people killed in road accidents who are at least 85 years old is highest in the UK and the Netherlands. Moreover, the highest proportions of female elderly fatalities occur in Denmark (52%) and Slovakia (48%) and the highest proportions of elderly fatalities aged 65-74 occur in Ireland (60%) and Estonia (61%) (there are relatively many fatalities in Latvia with unknown age).

Road safety parameters of the elderly people in EU

The analysis of the distribution of elderly road accident fatalities according to the road user type showed that in 2010 across EU-24 almost two fifths (38%) of elderly fatalities were pedestrians, with the highest proportions being in Romania (62% - apart from Malta and Luxemburg) and the lowest in the Netherlands (14%). Conversely, the proportion of elderly fatalities who were car drivers ranged between 6% in Romania and 50% in Ireland. The results are illustrated in Figure 5 (sorted by the share of pedestrian fatalities, excluding Luxembourg).



2009 fatality data for EE, NI, NL and SE used as proxies for the 2010 data

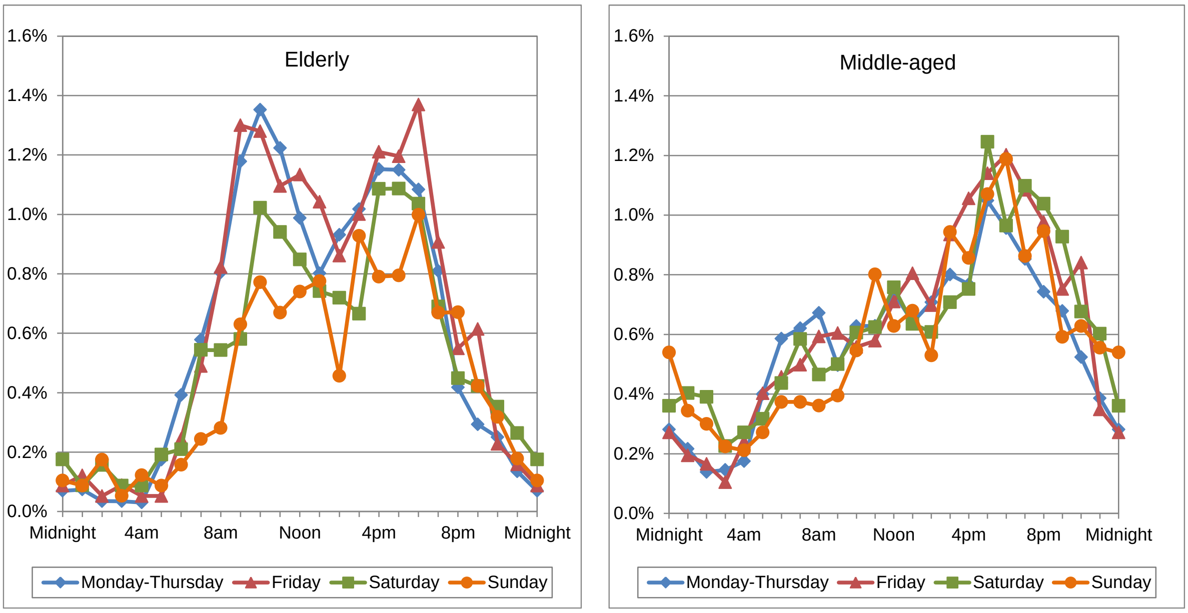
Source: CARE Database / EC
Date of query: September 2012

Figure 5 - Distribution of elderly fatalities by road user type, 2010

According to the analysis carried out the elderly compared to middle-aged people have a lower share of fatalities on motorways and on rural road network (4% and 36% respectively, comparing to 9% and 53% respectively of the middle-aged people), but a higher share on urban roads (61% comparing to 32%). This is a result of the elderly mobility pattern, as in general they have lower mobility than other age groups and are mainly pedestrians (most pedestrian fatalities occur on urban roads). Romania and Portugal are the countries with the highest proportions of the elderly fatalities in urban areas (more than 65% of the elderly fatalities).

Day of week and time of the day were also considered. As expected, more than 80% of elderly fatalities in 22 EU countries in 2010 occurred between 8 a.m. and 8 p.m. since people are more active within these hours of the day, however while the numbers generally decrease after 8 p.m., they stay high (over 13% of the respective fatalities) during evening hours in southern countries (Greece and Spain), as well as in Latvia and Ireland.

Data analysis revealed that the greatest number of elderly fatalities occurs on Fridays and the lowest on Sundays. Additionally, as Figure 6 indicates, there are clear differences between middle-aged and elderly fatality distributions and limited but significant differences by day of week. Relatively few elderly people are killed in road accidents at night. The middle-aged distributions have clear daily peaks in the late afternoon, especially at the weekend, whereas the elderly distributions have peaks slightly earlier in the afternoon, with additional peaks before noon.

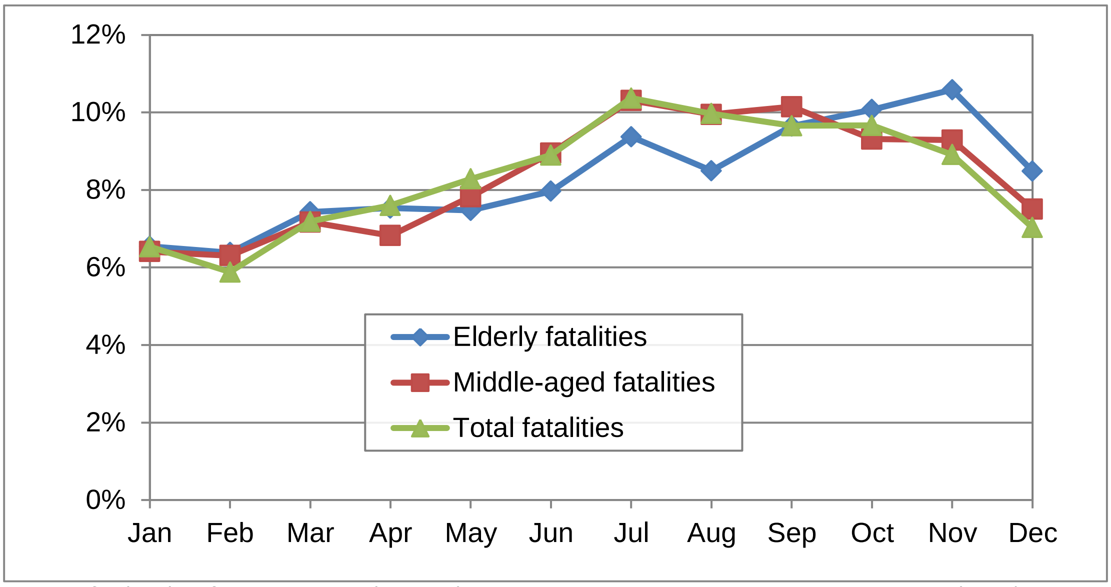


Monday-Thursday values are the averages of the daily values from Monday to Thursday. 2009 fatality data for EE, NI, NL and SE used as proxies for the 2010 data. DE is excluded as hour is unknown for all fatalities.

Source: CARE Database / EC
Date of query: September 2012

Figure 6 - Middle-aged and elderly fatalities by day of week and time of day in EU-22, 2010

Finally, with reference to the seasonal distribution of the elderly fatalities, although in most EU countries more elderly people are killed in road accidents in the fourth quarter (October to December) the peak in Ireland and Austria occurs in the second quarter (April to June). Figure 7 compares the distribution by month of elderly and middle-aged fatalities with the overall distribution. For all three, the lowest number of fatalities in 2010 occurred in February. The number of elderly fatalities rose steadily to a peak in November and declined in December.



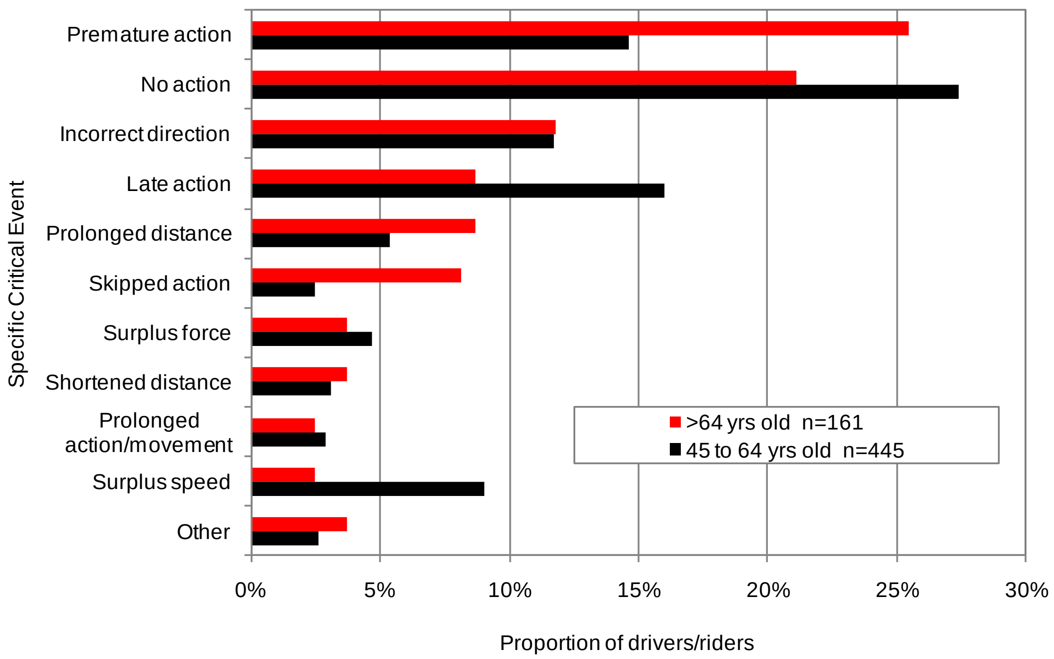
2009 fatality data for EE, NI, NL and SE used as proxies for the 2010 data

Source: CARE Database / EC
Date of query: September 2012

Figure 7 - Distribution of middle-aged, elderly and total fatalities by month in EU-24, 2010

Accident causation analysis
Additional insight into accident causation can be offered by in-depth data, such as those collected during the EU co-funded SafetyNet project. During that project, in-depth data were collected using a common methodology for samples of accidents that occurred in Germany, Italy, The Netherlands, Finland, Sweden and the UK (Bjorkman et al., 2008; Reed and Morris, 2008). The SafetyNet Accident Causation Database was formed between 2005 and 2008, and contains details of 1.006 accidents covering all injury severities. A detailed process for recording causation (SafetyNet Accident Causation System – SNACS) attributes one specific critical event to each driver, rider or pedestrian. Links then form chains between the critical event and the causes that led to it. For example, the critical event of late action could be linked to the cause observation missed, which was a consequence of fatigue, itself a consequence of an extensive driving spell. Links are established by trained personnel directly involved in the investigation according to the SNACS coding system, with full case evidence available to them.

These data have been analysed to compare the causation recorded for elderly and middle-aged drivers and riders. Of the accidents in the database, 15% (155) involve an elderly driver or rider (aged > 64 years old). Males account for 79% of this group and 75% are drivers of passenger cars, followed by 15% who were bicycle riders. Figure 8 compares the distribution of specific critical events for elderly drivers/riders against the distribution for the middle-aged group (45 to 64 year olds).



Source: SafetyNet Accident Causation Database 2005 to 2008 / EC
N=606 Date of query: 2010

Figure 8 - Distribution of specific critical events – elderly and middle-aged drivers/riders

Specific critical events under the general category of 'timing', no action, premature action and late action, are recorded for 55% of elderly drivers and riders in the sample, but are important also for the middle-aged group. A premature action is one undertaken before a signal has been given or the required conditions are established, for example entering a junction before it is clear of other traffic. Premature action is recorded more frequently for the elderly group, whilst no action and late action are more frequent for the middle-aged group. No action describes those drivers/riders who have not reacted at all (or at least in an effective time frame) to avoid a collision, for example, to avoid an oncoming vehicle. Looking at other differences, prolonged distance and skipped action are more prevalent in the elderly group, whilst surplus (excess) speed is less prevalent. Prolonged distance is an action taken too far, such as entering a junction across a give way line, and skipped action is missing a part of the driving task, such as not looking before changing lane. Examples of incorrect direction, the third most frequent specific critical event for the elderly group, are making a manoeuvre in the wrong direction, turning left instead of right and going off the road instead of following the lane.

The following Table 2 gives the most frequent links between causes in the chains recorded for elderly drivers/riders. For this age group there are 166 such links in total. How often causes appear in the chains indicates their importance for the road users selected. Here, only the most common links are presented but further interpretation can take place by following the chains from critical event back to the first cause in the chain, as demonstrated by Talbot et al. (2009) for inattention and distraction.

Table 2 - Ten most frequent links between causes – elderly drivers/riders

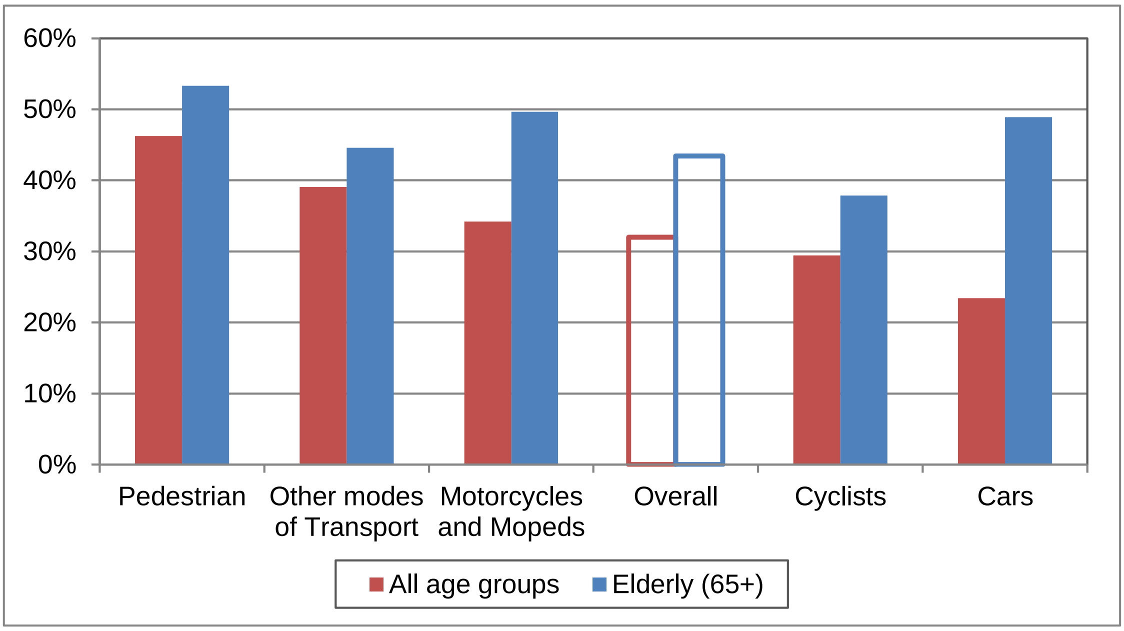
Links between causes	**Frequency**
Faulty diagnosis - Information failure (between driver and traffic environment or driver and vehicle)	20
Observation missed - Permanent obstruction to view	17
Observation missed - Temporary obstruction to view	14
Observation missed - Faulty diagnosis	13
Observation missed - Distraction	7
Observation missed - Inattention	7
Observation missed - Inadequate plan	6
Faulty diagnosis - Communication failure	6
Faulty diagnosis - False observation	5
Faulty diagnosis - Cognitive bias	5
Others	66
Total	166

Source: SafetyNet Accident Causation Database 2005 to 2008 / EC
Date of query: 2010

For elderly people, faulty diagnosis is an incorrect or incomplete understanding of road conditions or another road user’s actions. It is linked to information failure (for example, a driver thinking another vehicle was moving when it was in fact stopped and colliding with it) and communication failure (for example, pulling out in the continuing path of a driver who has indicated for a turn too early). For this group it is also linked, although in lower numbers, to false observation (for example, incorrectly recognising a green traffic light as being red) and cognitive bias (taking in and processing information but with incorrect cognitive interpretation, for example, reading a green light for the next set of traffic lights further on). The causes leading to observation missed fall into two groups, physical 'obstruction to view' type causes (for example, parked cars at a junction) and human factors (for example, missing a red light due to distraction or inattention).

Road accident health indicators

Injury data variables obtained through the EU Injury Database (EU IDB) can complement information from police records and thus, provide a better insight for injury patterns and the improved assessment of injury severity in road accidents. EU IDB is a system developed following a recommendation issued by the EU Council that urges member states to use synergies between existing data sources and to develop national injury surveillance systems rooted in the health sector. At present, thirteen member states are routinely collecting injury data in a sample of hospitals and delivering these data to the EC (http://ec.europa.eu/health/data_collection/databases/idb/index_en.htm). IDB data used in this research comes from nine EU Member States (DE, DK, LV, MT, AT, NL, SE, SI, CY) and concerns accidents that occurred between 2005 and 2008.



Source: EU Injury Database (EU IDB) - hospital treated patients. IDB AI Transport module and place of occurrence (code 6.n [public road]); n = 23.568, n-elderly = 7.447, n-elderly = 3.235 (DE, DK, LV, MT, AT, NL, SE, SI, CY, years 2005-2008).

Figure 9 - Proportion of casualties who were admitted to hospital, by age group and mode of transport

The above Figure 9 shows that 32% of all road accident casualties recorded in the IDB were admitted to the hospital overall, with the respective percentage being 43% for older people. Additionally, in Figure 10 it is presented that the average length of stay in the hospital for the elderly is 12 days, whereas on average, for all age groups, it is 8 days.

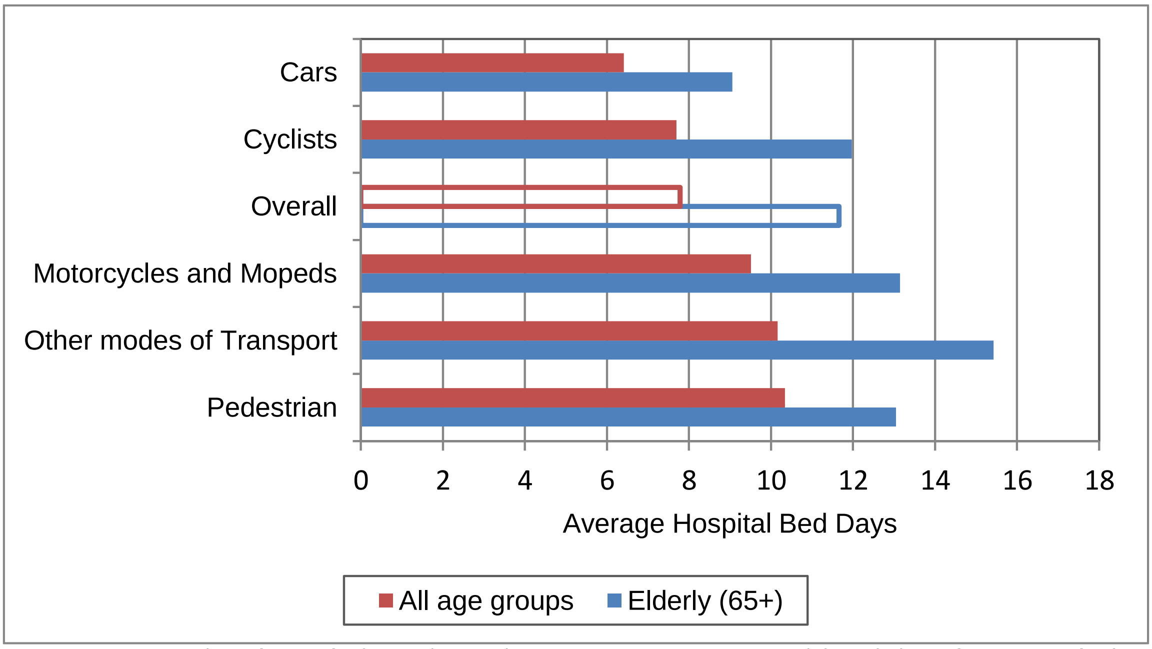


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Figure 10 - Average length of stay (hospital bed days), by age group and mode of transport

Analysis of the IDB data revealed also that fractures account for more than 40% of all traffic injuries suffered by the elderly attending hospital, whereas concussion and bruise is the most frequently recorded type of injury for casualties from all age groups (34%). Finally, Figure 11 illustrates the distribution of body parts injured in elderly casualties by type of road user.

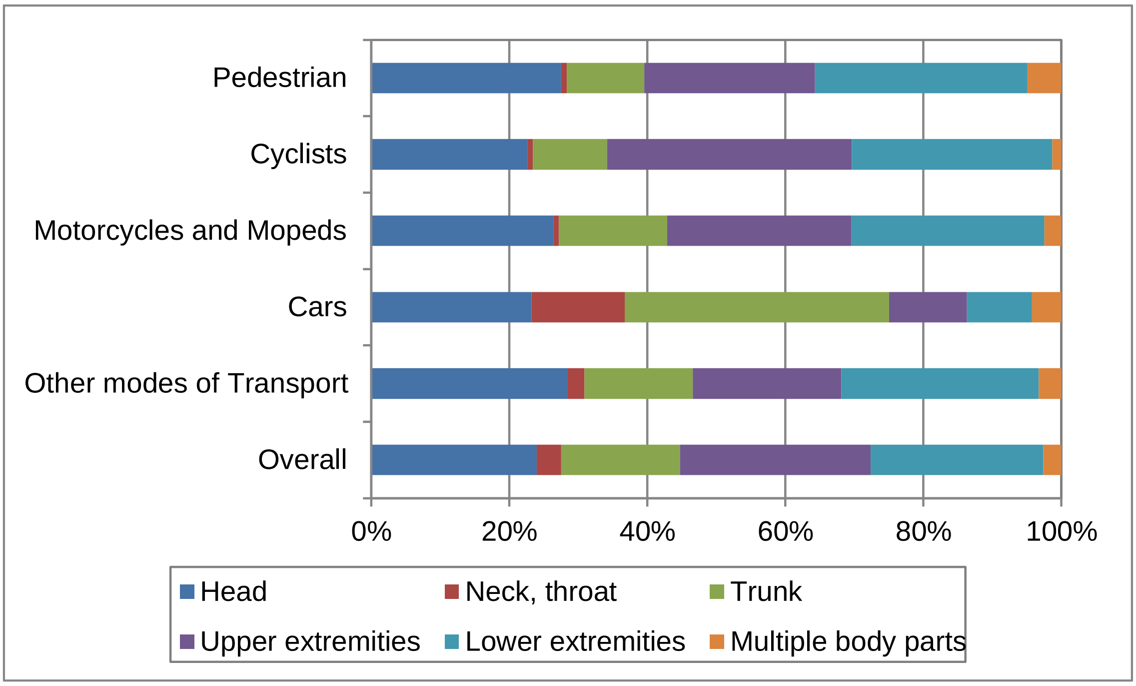

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Figure 11 - Body part injured in older people (65+ years), by mode of transport

Conclusions - Discussion

The various road safety parameters examined revealed that the elderly are a special age group of road users, with increasing numbers and different needs and characteristics than other road users, mainly due to their specific physical characteristics, but also to their different mobility behaviour. Elderly drivers are not really a threat for the other road users. The increased number of road accidents with serious injuries and fatalities for elderly people is due to their increased frailty, as well as to their reduced driving ability attributed to limited driving and physical impairment (NTUA, 2009). We could say that elderly drivers have a higher risk for road accidents, which is though balanced by the reduced exposure (driving) and the lower speeds (Breker et al, 2003).

Analysis of elderly people road accident data derived from the EC CARE database for the decade 2001 – 2010, showed that although the number of elderly fatalities has decreased by 30% over this period in 24 EU countries, the overall number of road accident fatalities has fallen faster, the proportion of all fatalities who were elderly has tended to rise and since 2008, more than one fifth of all road traffic fatalities have been at least 65 years old. CARE accident data were also combined with exposure data (population), allowing the more accurate comparison of the calculated rates between EU countries.

According to the results of the analysis, in most European countries the elderly - specifically those between 75 and 84 years old - are at greater risk of being killed in a road accident than the average person. Additionally, more than one third of elderly fatalities were pedestrians and also elderly people are proportionately more likely than middle-aged people to be killed in an accident on urban road network.

The analysis of other types of data such as in-depth accident data and injury data, allowed for additional insight into accident causation recorded for elderly drivers and riders, as well as for the identification of injury patterns improvement of the assessment of injury severity for casualties of this age group.

The results of the analysis allow for an overall assessment of the elderly safety level in the European road network relative to other age groups of road users, 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 the elderly 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 elderly road safety and the underlining reasons behind the elderly casualties.

Acknowledgement

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Appendix I - Country abbreviations used and definition of EU-level

EU - 19	
BE	Belgium
CZ	Czech Republic
DK	Denmark
DE	Germany
IE	Ireland
EL	Greece
ES	Spain
FR	France
IT	Italy
LU	Luxembourg
NL	Netherlands
AT	Austria
PT	Portugal
PL	Poland
RO	Romania
SI	Slovenia
FI	Finland
SE	Sweden
UK	United Kingdom (GB+NI)

EU-24= EU-19 +	
EE	Estonia
HU	Hungary
MT	Malta
LV	Latvia
SK	Slovakia