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SEASONAL DISTRIBUTIONS OF ROAD FATALITIES IN EUROPE

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This is an abridged version of the paper presented at the conference. The full version is being submitted elsewhere. Details on the full paper can be obtained from the author.

ISBN: 978-85-285-0232-9

13th World Conference on Transport Research

www.wctr2013rio.com

15-18 JULY 2013
Rio de Janeiro, Brazil

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ABSTRACT

Although the annual number of people who were killed in road accidents in Europe has fallen over many years, the distribution of the annual number by month has scarcely changed. This research examines the extent to which the number of people killed in road accidents varies by month across the EU through the use of the EU CARE database with disaggregated data on road accidents. Time series data from 19 EU countries over a period of 10 years (2000-2009) are correlated with basic safety parameters such as the mode of transport, type of road, time of day, day of week, weather, hours of daylight, age and gender of the driver. The distribution of fatalities by month tends to vary most in Central Europe and least in Western Europe. The seasonal variation of fatalities depends also upon gender, age and is greater on Sundays than on other weekdays, while motorcycling is the mode of transport with the most seasonal fatality distribution. Furthermore, variations through the year according to weather and the hours of daylight are likely to contribute to the seasonality that has been observed, and these also vary across Europe. The results of the analysis allow for an overall assessment of seasonal variation of road accident fatalities by socioeconomic characteristics, providing thus useful support to decision makers working for the improvement of safety in the European road network. These observations, along with the other findings presenting in this paper, could be used to shape public policy in a way that it improves the road safety level across Europe.

Keywords: Seasonality; Seasonal distributions; Road fatalities; Road accident data; Road safety; European countries

INTRODUCTION

It is well known that the weather conditions play an important role in road accidents, as well as on their impact, due to slippery roads, bad visibility and other adverse weather conditions. Radun I. and Radun J. (2006) give an additional explanation for the summer peak of the road accidents. Their study showed that falling asleep while driving has its maximum occurrence during summer months. The authors explain that in relation to different driving and lifestyle habits between seasons, including sleep quality. According to their outcomes, during the summertime many drivers are engaged in unusual activities on the day or night before the accident, such as partying, alcohol consumption, long drives and outdoor activities.

Sivak (2009) examines the variation in the U.S. road fatality rate per distance driven across the months of the year for a 13-year period (1994-2006). The author notes that the highest numbers in the fatality rate are observed in October, followed by November and December; while the lowest rate is observed in March, followed by February. Sivak explains that there are several known factors with major influences on the risk of driving that show strong seasonal variations, including the duration of darkness, consumption of alcohol, proportion of older drivers, amount of leisure driving, and possibly inclement weather. However, the peaks and troughs of the seasonal variations of these factors do not fully match the pattern of the overall driving risk. Consequently, the obtained pattern of the seasonal variation of driving risk is likely a result of a joint influence of several of these factors.

Farmer and Williams (2005) have made a research on monthly and seasonal distribution of the numbers of fatal motor vehicle crash deaths in the United States for the period 1986-2002. According to their study, “summer and fall months experience more crash deaths than winter and spring,” mainly because of increased vehicle travelling. The month with the highest number of motor vehicle crash deaths was August - and the six months when most fatalities were recorded were the summer and fall months, June through November. On the other hand, January and February had the lowest number of deaths per day; however, they were with the lowest vehicle miles traveled per day. The authors explain their findings due to the good weather conditions during the summer, allowing for use of motor vehicles. Good weather could encourage motorcyclists and other vehicle operators, and increasing speed as well, the major factor for road fatalities. Farmer and Williams include among factors alcohol usage and helmet use as well. For pedestrian fatalities they pay attention to visibility, which determines the maximum number of deaths among pedestrians in the period from October to January – the season with the least amount of daylight.

Furthermore, it is acknowledged that the weather conditions partly determine the road conditions and the driver's behaviour. Most studies concerning the relation between weather and road safety deal with accident causation during rainfall. However, many other weather conditions also have serious effects on road safety, such as fog, snow and black ice, low sun, hard wind, and high temperatures. Several studies have collected data about the weather influence on the crash risk and various measures have been taken to increase road safety, such as compulsory rear fog lamps, porous asphalt, and the introduction of slipperiness warning systems (SWOW, 2012).

Furthermore, Karlaftis and Yannis (2010) used an integer autoregressive model (INAR) to estimate the effects of weather conditions on four traffic safety categories: vehicle accidents, vehicle fatalities, pedestrian accidents and pedestrian fatalities, using 21 years of daily count data for Athens, Greece. The results suggest that the most consistently significant and influential variable is mean daily precipitation height along with its lagged value. It is found that, contrary to much previous research, increases in rainfall reduce the total number of accidents and fatalities as well as the pedestrian accidents and fatalities, a finding that may be attributed to the safety offset hypothesis resulting from more cautious and less speedy driver behaviour. Similarly, temperature increase was found to lead to increased accidents.

Finally, regarding how seasonal and weather conditions influence road accidents, Smith (2008) suggested that dry-day road accidents in winter are around 15% higher than in summertime. It is possible that this difference is partly related to the visibility problems created by the longer periods of winter darkness and icy surfaces resulting from early precipitation.

Table I summarizes the definition of the country abbreviations that are used in the remainder of this paper. It has to be underlined that for all presented statistics (where specific dates are not indicated), latest available data are used i.e. 2009 for all countries except IE (2008) and SE (2008). Additionally, where a number is missing for an EU-14/24 country in a particular year, its contribution to the EU-14/24 total is estimated as the closer known value.

Table I – Definition of used country abbreviations

EU-14			**EU-24=EU14+**		
Belgium	BE		Czech Republic	CZ	
Denmark	DK		Germany	DE	
Ireland	IE		Estonia	EE	
Greece	EL		Latvia	LV	
Spain	ES		Hungary	HU	
France	FR		Malta	MT	
Italy	IT		Poland	PL	
Luxembourg	LU		Romania	RO	
Netherlands	NL		Slovenia	SI	
Austria	AT		Slovakia	SK	
Portugal	PT				
Finland	FI				
Sweden	SE				
United Kingdom	UK				

The objective of this research is to examine the extent of the interannual distribution road accidents across the EU. Most other researches focus on particular groups of accidents or casualties, whereas in this paper general patterns in the CARE road accident data are examined. Most analyses are of grouped data from 2005-2009, to minimise the effects of chance.

OVERALL TRENDS

The trends of the overall fatalities number months in 14 European Union countries are shown in Figure 1. The distribution of fatalities by month has varied very little over the period covered by the CARE accident data, with the fewest fatalities in February and the most in July. The only clear change has been for the peak in July to become slightly more pronounced. To achieve consistency between the four periods, the analysis has been restricted to those countries with data for each year between 1991 and 2009, as defined in Table I (the 15 states that were members of the EU in 1995 without Germany). Note that if there was no seasonality impact, 8.3% of fatalities would occur each month, as shown by the line “No seasonality”, so there were relatively few fatalities per month from January to April and relatively many from June to October.

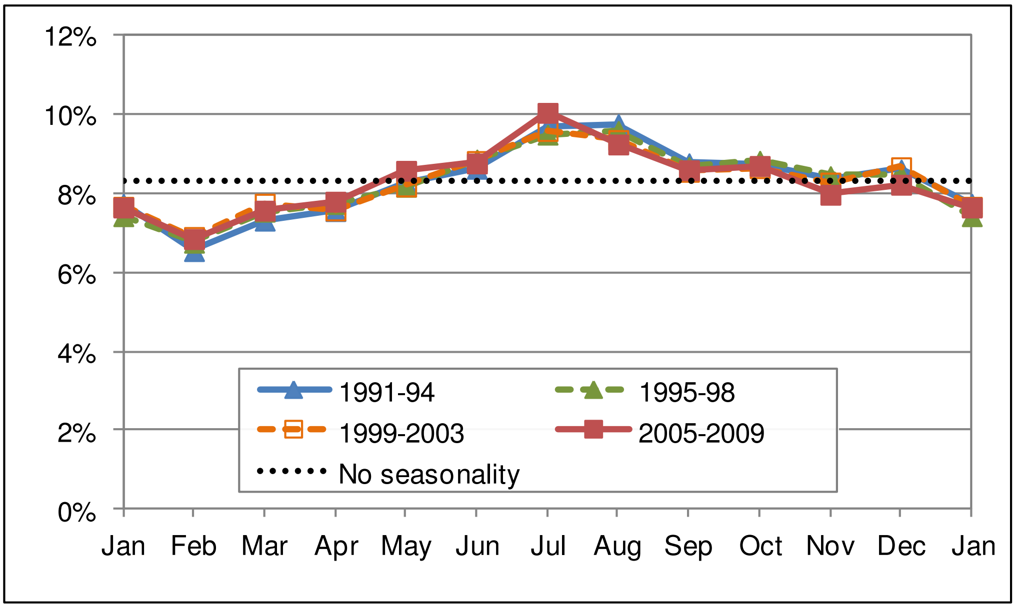

Figure 1 – The proportion of fatalities in the EU-14 by month, 1991-20092

In order to see whether seasonality varies by country, Figure 2 compares the distribution for the EU-24 in 2005-2009 with the distributions for the five member states with the greatest fatality totals in this five year period.

There are clear differences, with the distribution for France being very similar to the EU-24 distribution, whereas the July peak in Italy is especially pronounced. The overall proportion of EU fatalities in each of the five member states is also shown in the legend; together they accounted for nearly 60% of fatalities in these five years.

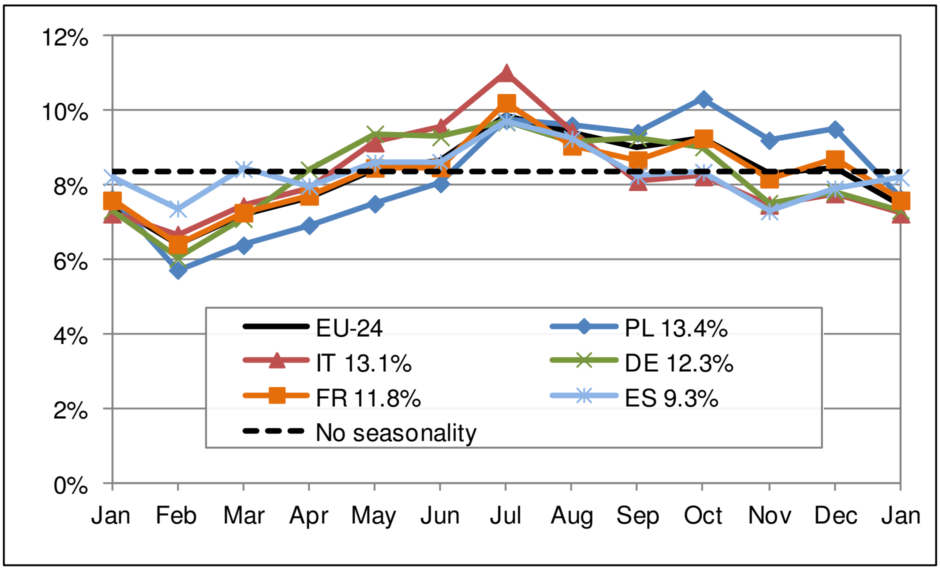

Figure 2 – The proportion of fatalities by month in the EU-24 and 5 Member States, 2005-2009

A simple index of seasonality for each country is obtained by dividing the standard deviation of the twelve monthly fatality averages by their mean. Seasonality is below average in several Western European countries, and above average in several Central European countries.

The seasonality of fatality distributions is likely to be the result of many factors. The principal factor is probably the changing pattern of travel during the year with, for example, many more trips being made for leisure and recreation during the summer than the winter. Accident risk also varies seasonally with changing weather conditions and hours of daylight. The relative harshness of winters in Northern and Central Europe is likely to contribute to the greater seasonality for several of these countries.

SEASONALITY, WEATHER AND HOURS OF DAYLIGHT

Variations through the year in weather and the hours of daylight are likely to contribute to the seasonality that has been seen, and these also vary across Europe. In the EU-19 countries over the whole year, 61% of fatalities occurred in daylight (includes twilight), but the percentage was below 46% between November and February. The great majority (85%) occurred in dry conditions, and this was still at 75% in December.

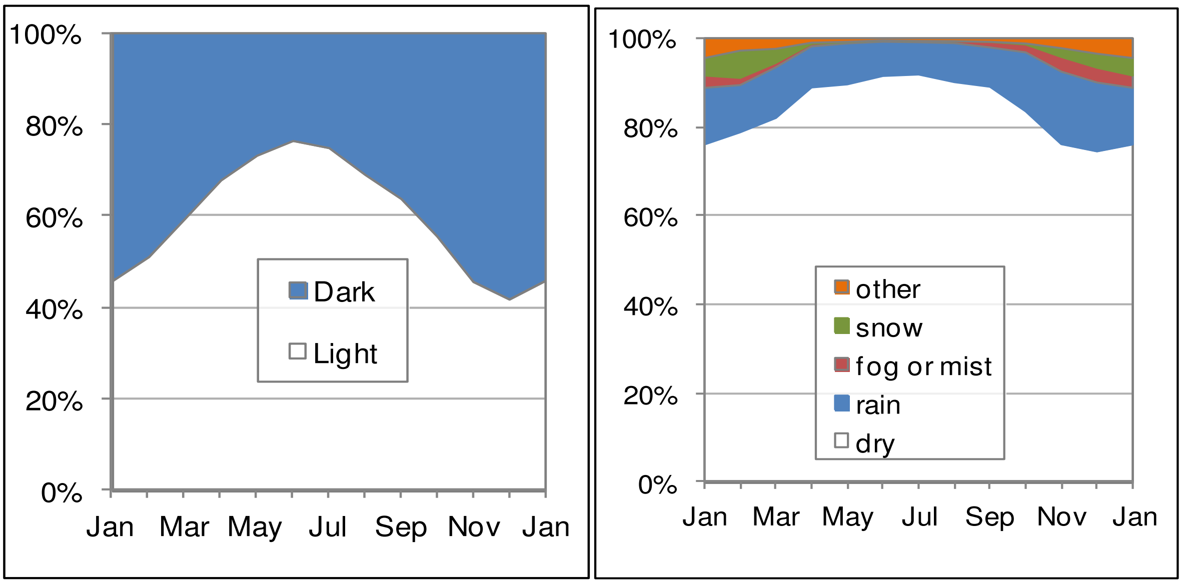

Figure 3 – Monthly proportion of fatalities by light and weather condition, EU-19, 2005-2009

The geographic variation of the proportion of fatalities occurring in daylight is examined in Figure 4, choosing countries from across Europe and combining the three Scandinavian countries (DK, FI, SE). The variation is greatest in the three Scandinavian countries and least in Greece, but differences cannot be explained simply by day length. This is depends on latitude but, for example, there are fewer fatalities in daylight in the UK than in the Scandinavian countries during the winter despite the UK's greater day length in winter that results from its more southerly location.

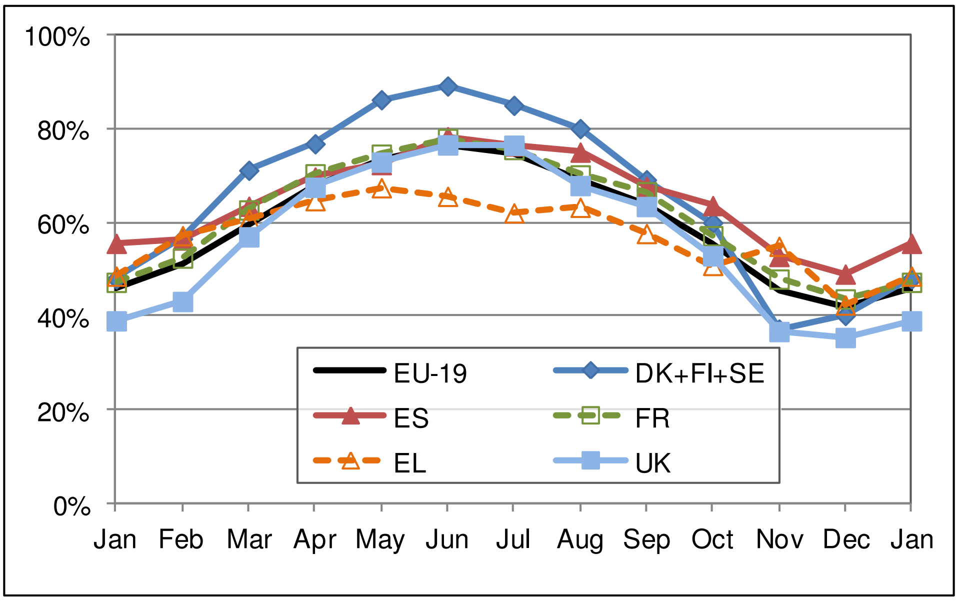

Figure 4 – Monthly proportion of fatalities in daylight, by country, 2005-2009

More detailed analysis of geographic variation in the CARE accident data requires a different form of presentation. This is illustrated in the case of weather condition by Figure 5, which compares the distributions in Spain and the three Scandinavian countries. Spain is selected to represent the South of Europe, the Scandinavian countries to represent the North (a different selection might yield results that differed slightly in detail).The proportion of fatalities in dry conditions is only slightly greater in Spain (85% compared with 83%), but the proportion in snow is predictably much lower.

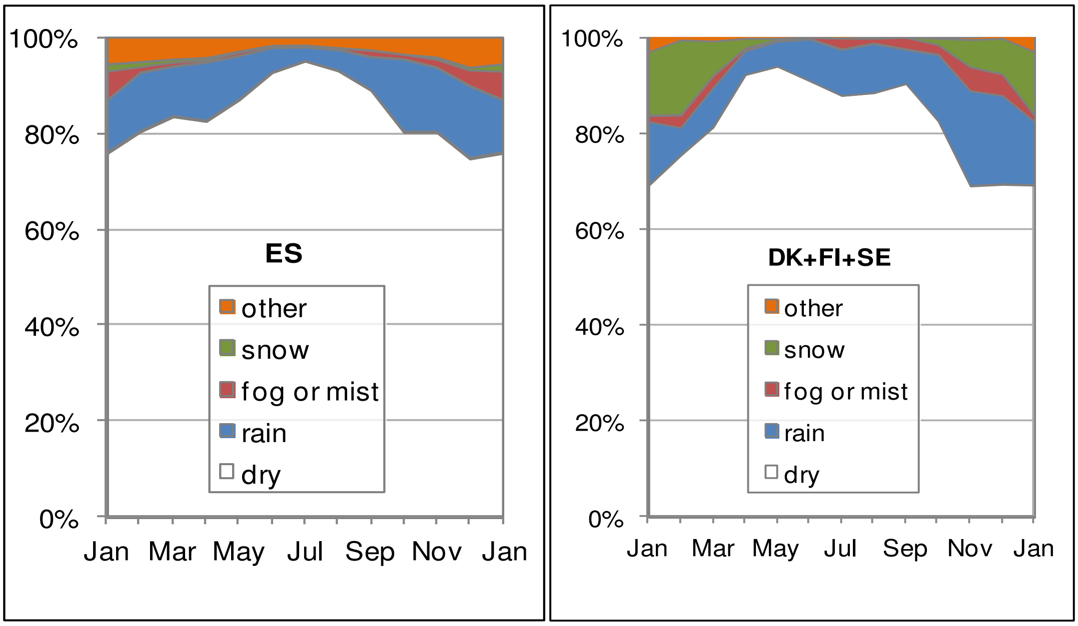

Figure 5 – Monthly proportion of fatalities by weather and country, 2005-2009

DISTRIBUTION BY MODE OF TRANSPORT AND TYPE OF ROAD

An important way of grouping casualties is by their mode of transport. Figure 6 shows that the seasonality for several groups differs clearly from the overall pattern. Relatively many motorcyclists are killed in the summer, and relatively few in the winter, while deviations from the overall pattern are similar but less for moped riders and pedal cyclists. These variations are probably the result of the preference by riders of two-wheeled vehicles to travel when the weather is better. The reason for the increase in pedestrian fatalities from 6.3% of the annual total in June to 12.4% in December is probably more complex. In Figure 6, the group ‘others’ consists mainly of occupants of goods vehicles, buses and coaches.

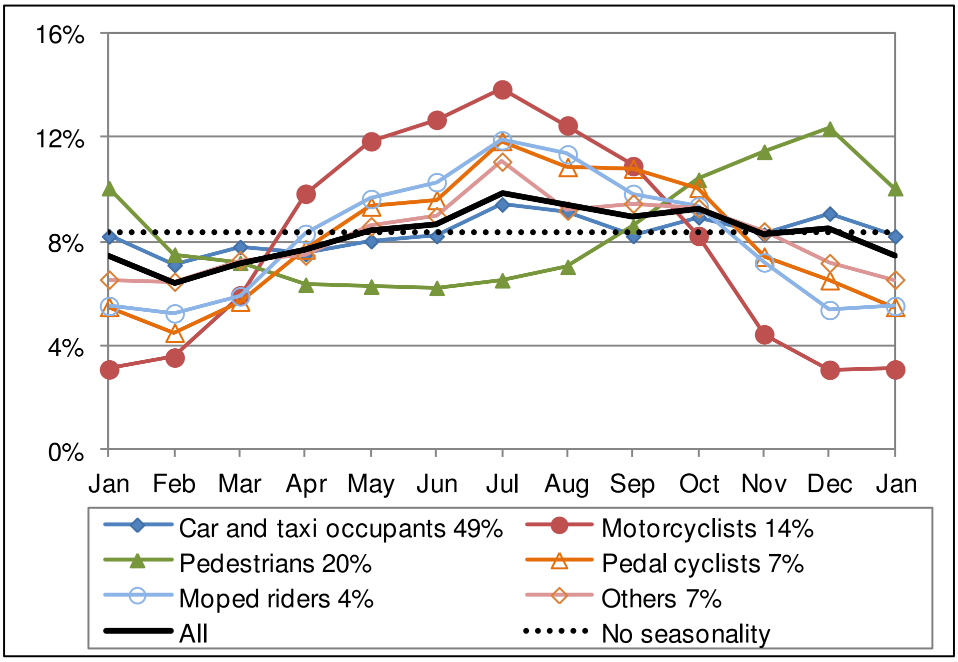

Figure 6 – Monthly proportion of fatalities by mode of transport, EU-24, 2005-2009

The geographic range of the seasonality of fatalities by mode of transport is illustrated in Figure 7, which compares the distributions in Spain and the three Scandinavian countries. The Spanish fatality proportions show limited variation by month, except for the minor mode of pedal cycling. By contrast, the Scandinavian proportions vary considerably by month, especially for pedestrians and motorcyclists.

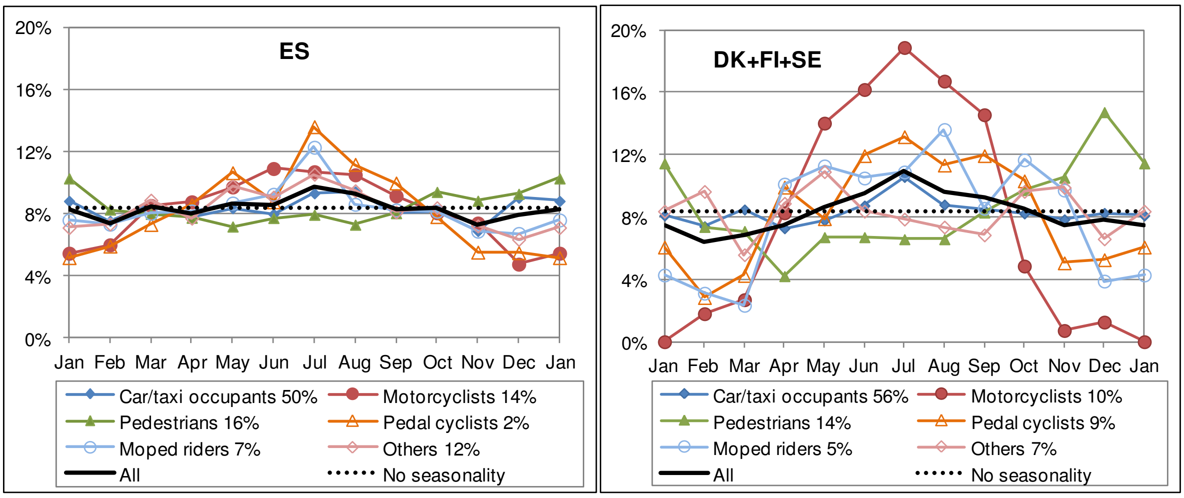

Figure 7 – Monthly proportion of fatalities by mode of transport and country, 2005-2009

Figure 8 compares seasonality on the three types of road that can be distinguished in the CARE accident data: motorways, rural roads (excluding rural motorways) and urban roads (excluding urban motorways). There are minor differences, as seasonality is less observed on urban roads than on rural roads and motorways.

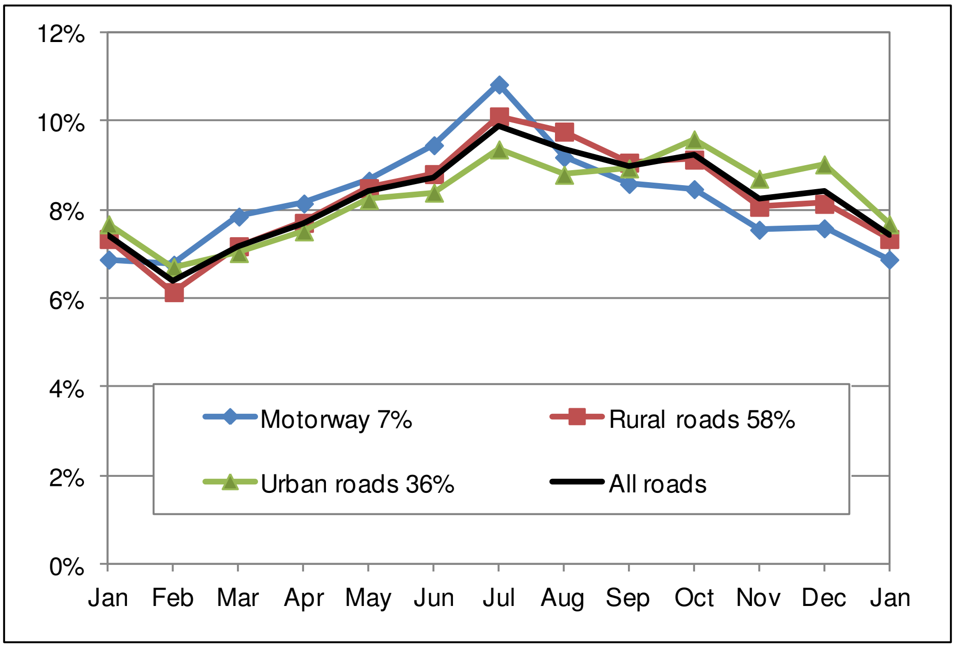

Figure 8 – Monthly proportion of fatalities by type of road, EU-24, 2005-2009

DISTRIBUTION BY DIFFERENT ROAD SAFETY PARAMETERS

Classification by time of day and day of week

Figure 9 compares the fatality proportions in four periods of the day. For example, it shows the proportions of the fatalities that occurred between 10pm and 4am over the five years. Seasonality is greatest in this period, and least for the 4am-10am period. There is a clear peak in July for the 10pm-4am period, while there is a steady increase from February to December for the 4pm-10pm period.

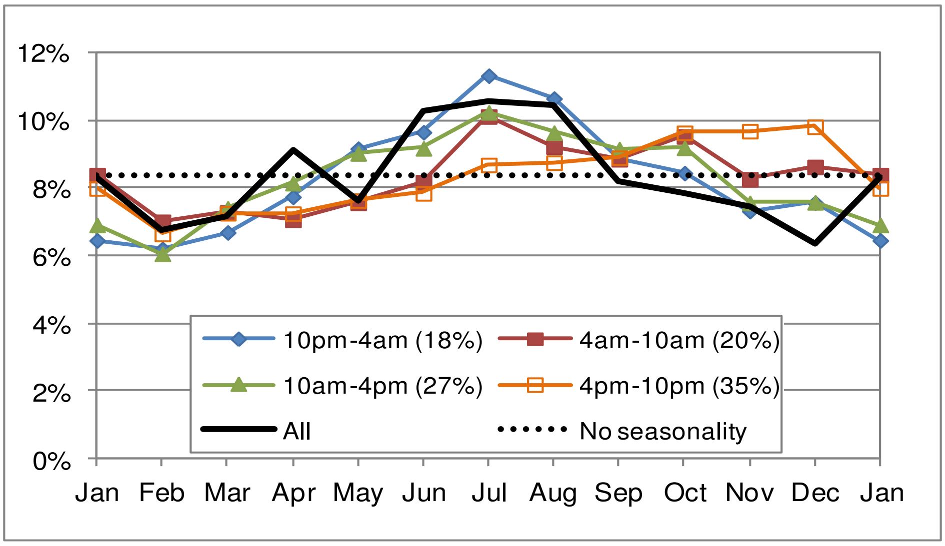

Figure 9 – Monthly proportion of fatalities by time of day, EU-23, 2005-2009

The geographic range of the seasonality of fatalities by time of day is illustrated in Figure 10, which compares the distributions in Spain and the three Scandinavian countries. The Spanish fatality proportions show limited variation by month about the overall trend. The Scandinavian proportions vary considerably by month, however, especially in the late evening (10pm-4am).

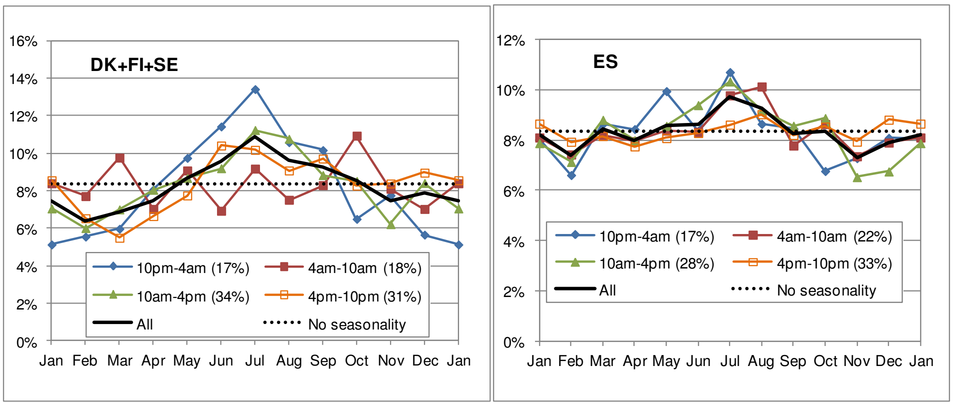

Figure 10 – Monthly proportion of fatalities by time of day and country, 2004-2008

Seasonality on each day of the week is similar to overall seasonality. The main difference concerns Sunday: there are relatively many fatalities on Sundays between March and August, and relatively few between November and January.

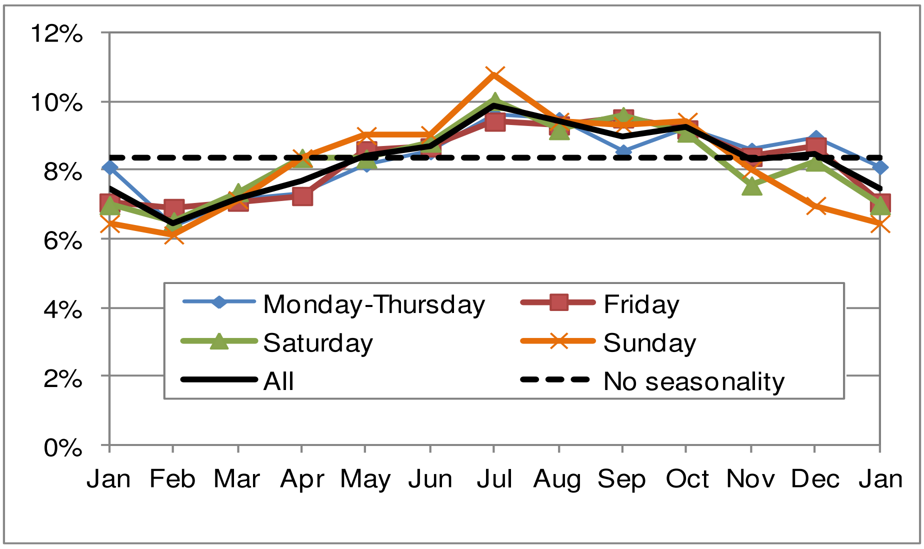

Figure 11 – Monthly proportion of fatalities by day of week, EU-24, 2005-2009

Classification by age and gender

Figure 12 compares seasonality of female and male fatalities by age range. Both male and female fatalities have their minimum values in February; male fatalities peak in July whilst female fatalities peak in July, October and December. There are also clear differences by age range. There is a pronounced peak for 0-17 year old fatalities in July and August, whereas the number of 65+ year old fatalities rises fairly steadily from February to December, especially for women.

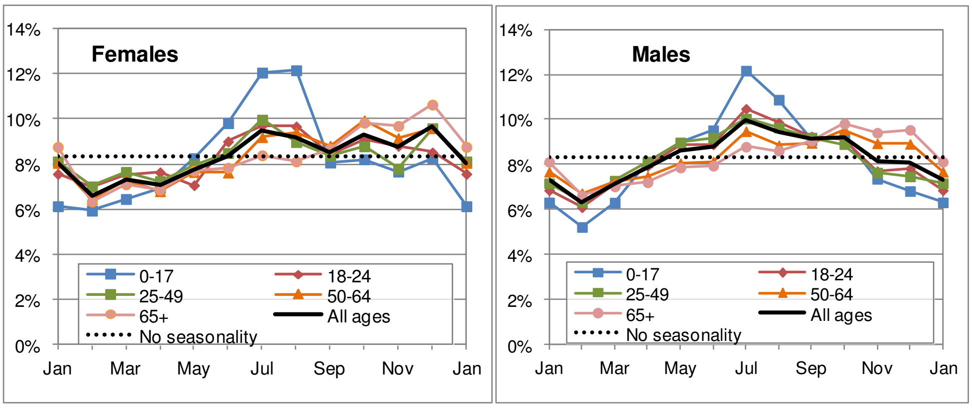

Figure 12 – Monthly proportion of fatalities by age and sex, EU-24, 2005-2009

Figure 13 illustrates the range of patterns of seasonality by age around Europe (male and female fatalities combined). There are limited variations about the overall distribution in the UK, but clear differences in Italy and Romania. There are relatively few fatalities aged 65+ during spring and summer in each of the four countries, and a peak in the autumn/winter.

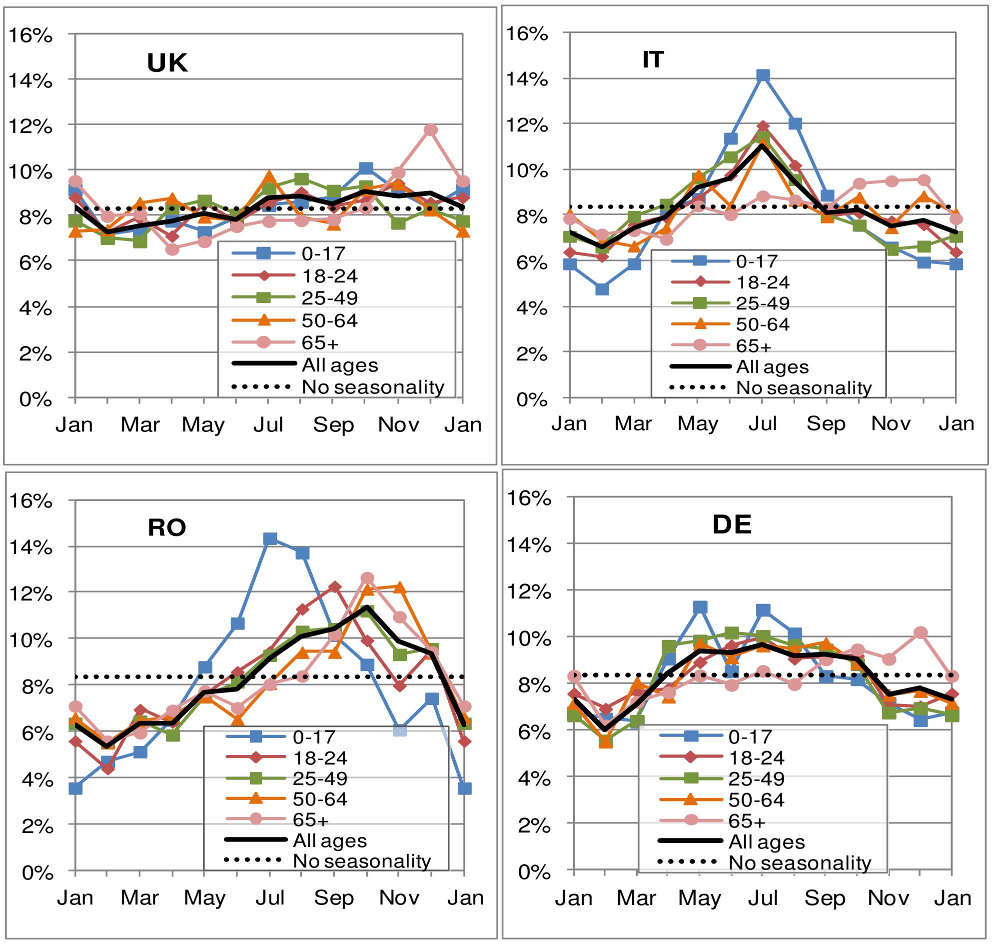

Figure 13 – Monthly proportion of fatalities by age and gender in selected countries, 2005-2009

The clear differences in the seasonal variation of fatalities by age and gender seen in Figure 13 are likely to be influenced by the different travel patterns of the national populations.

CONCLUSION

The answer to the question of the reasons for the observed seasonal and monthly distribution of road accidents is complicated, as it depends on a variety of factors which also have seasonal and monthly variation. They include weather characteristics, road conditions, duration of darkness and visibility, alcohol consumption, annual rhythm of spending the leisure time, etc.

Although the annual number of people who were killed in road accidents in Europe has fallen over many years, the distribution of the annual number by month has scarcely changed. The distribution of fatalities by month tends to vary most in Central Europe and least in Western Europe and mode of transport, motorcycling is the mode of transport with the most seasonal fatality distribution, while seasonal variation is less on urban roads than on rural roads and motorways. Moreover, seasonal variation is found to be greater for fatalities occurring between 10pm-4am and least during the 4am-10am period, and also greater on Sundays than on other weekdays. Finally, seasonal variation of fatalities by age and gender seems to be different across Europe.

The results of the analysis allow for an overall assessment of the road safety level in the European road network in relation to to seasonal parameters, 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 (i.e. traffic volumes, veh-kms and person-kms travelled by month). Furthermore, the macroscopic analysis presented in this paper could in the future be combined with in-depth analysis providing a better insight into the causes and impacts of seasonality on accidents.

ACKNOWLEDGMENT

This paper is based on work carried out within the scope of the SafetyNet (The European Road Safety Observatory) and DaCoTA (Data Collection Transfer and Analysis) projects of the 6th and 7th (respectively) Framework Programs for Research, Technological Development and Demonstration of the European Commission.

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