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Trends in mortality due to motor vehicle traffic accident injuries between 1987 and 2011 in a Spanish region (Comunitat Valenciana)

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ABSTRACT

Objective: To analyse the time evolution of the rates of mortality due to motor vehicle traffic accidents (MVTA) injuries that occurred among the general population of Comunitat Valenciana between 1987 and 2011, as well as to identify trend changes by sex and age group.

Methods: An observational study of annual mortality trends between 1987 and 2011. We studied all deaths due to MVTA injuries that occurred during this period of time among the non-institutionalised population residing in Comunitat Valenciana (a Spanish Mediterranean region that had a population of 5,117,190 inhabitants in 2011). The rates of mortality due to MVTA injuries were calculated for each sex and year studied. These rates were standardised by age for the total population and for specific age groups using the direct method (age-standardised rate – ASR). Joinpoint regression models were used in order to detect significant trend changes. Additionally, the annual percentage change (APC) of the ASRs was calculated for each trend segment, which is reflected in statistically significant joinpoints.

Results: For all ages, ASRs decrease greatly in both men and women (70% decrease between 1990 and 2011). In 1990 and 2011, men have rates of 36.5 and 5.2 per 100,000 men/year, respectively. In the same years, women have rates of 8.0 and 0.9 per 100,000 women/year, respectively. This decrease reaches up to 90% in the age group 15–34 years in both men and women. ASR ratios for men and women increased over time for all ages: this ratio was 3.9 in 1987; 4.6 in 1990; and 5.8 in 2011. For both men and women, there is a first significant segment ($p < 0.05$) with an increasing trend between 1987 and 1989–1990. After 1990, there are 3 segments with a significant decreasing APC (1990–1993, 1993–2005 and 2005–2011, in the case of men; and 1989–1996, 1999–2007 and 2007–2011, in the case of women).

Conclusion: The risk of death due to motor vehicle traffic accidents injuries has decreased significantly, especially in the case of women, for the last 25 years in Comunitat Valenciana, mainly as of 2006. This may be a consequence of the road-safety measures that have been implemented in Spain and in Comunitat Valenciana since 2004. The economic crisis that this country has undergone since 2008 may have also been a contributing factor to this decrease.

Despite the decrease, ASR ratios for men and women increased over time and it is still a high-risk cause of death among young men. It is thus important that the measures that helped decrease the risk of death are maintained and improved over time.

1. Introduction

Traffic accident (TA) injuries are currently a major public health problem at a global, national and regional level, as they cause a great number of deaths and disabilities.

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In 2004, this cause of death was responsible for more than 1.27 million deaths at a global level, which represented about 2.2% of total deaths. This cause of death was ranked as the 9th leading cause of death (WHO, 2009). It is estimated that it could become the 5th leading cause of death by 2030, accounting for 3.6% of total deaths (2.4 million deaths) (WHO, 2009). It affects the general population, but particularly young people. It is the first cause of death among the age group 15–29 years, the second one among the age group 5–14 years, and the third one among the age group 30–44 years (WHO, 2009). In 2011, it was the first cause of death for age group 15–34 years in Spain. Furthermore, it is one of the causes of death with a greater number of premature deaths in men, after lung cancer and cardiac ischemia (Instituto de Salud Carlos III, 2013).

Even if 90% of the deaths due to TA take place in developing countries, it is still a major cause of death in developed countries. Although it has decreased or stabilised for the last few years in the latter countries (for instance, according to the Spanish Statistics National Institute, Spain's TA mortality rates have decreased from 20.6 deaths per 100,000 inhabitants/year in 1990 to 4.6 deaths per 100,000 inhabitants/year in 2011), further steps should be taken to continue to lower the number of deaths (WHO, 2009).

Around 40,000 premature deaths due to transport accidents occur each year, most of these accidents are caused by traffic (OECD, 2012). This cause of death has been included as a preventable cause of death in the different lists of avoidable mortality since 1991 (Holland, 1991; Nolte and McKee, 2004; Gispert et al., 2006), which gave rise to the implementation of global and national policies (OPS, 2004; WHO, 2009; Comisión Europea, 2003, 2010; Dirección General de Tráfico, 2005, 2011. The decrease of traffic-related deaths is also a key aim of the different health plans and reports developed at a global and regional level (OMS, 1998; Conselleria de Sanitat, 2011).

As a cause of morbidity, traffic accidents are estimated to cause between 20 and 50 million non-fatal injuries, which are a major cause of disability, at a global level each year. Additionally, they cause a considerable pressure on national health systems, particularly in terms of hospital-bed occupancy, health professionals and economic resources. The economic resources devoted to traffic accidents account for 1.00–3.00% of the Gross Domestic Product (GDP) of a country (WHO, 2009). In Spain, these costs represented around 1.04% of the GDP in 2011 (Dirección General de Tráfico, 2012).

For the last 5 years, most countries have endorsed the recommendations of the World report on road traffic injury prevention, which gives guidance on how countries can implement measures in order to ensure a comprehensive approach to improving road safety and reducing the number of road fatalities due to TA (WHO, 2009).

In Spain, the regulations on traffic and motor vehicles fall exclusively within the competence of the State, because traffic is considered as a supra-regional matter. Therefore, the country needs a standard regulation, as well as uniform safety conditions for all passengers, pedestrians, drivers and everybody involved.

For the last 2 decades, many legislative changes have been enacted in Spain and significant steps have been taken to improve road safety. In this regard, a new Law on Traffic, Motor Vehicles and Road Safety (Real Decreto Legislativo 339 de 2 de marzo, 1990) came into force in Spain in 1990, which replaced the existing law of 1934. This law was amended in 2001 and 2003. At the same time, the new General Road Traffic Regulations, which replace the existing regulations of 1992, were approved. In 2004, the Spanish government decided to make road safety a priority. For this purpose, some actions were developed: the Special Measures for Road Safety 2004–2005 and the Strategic Programme for Road Safety 2005–2008, aimed to reduce the number of deaths by 40% between 2005 and 2008 (taking 2003 as the base year), in line with the European objective of reducing the number of fatalities due to TA by 50% by 2010 (Comisión Europea, 2003). Some other relevant events are, for instance, the entry into force of the penalty-points driving licence, the amendment of the text of the Law on Traffic, Motor Vehicles and Road Safety in 2006, the amendment of the Criminal Code concerning Road Safety in 2007, the introduction of the compulsory civil liability insurance for motor vehicles in 2008, the introduction of the new General Regulations on Drivers in 2009, and the speed limit reduction for cars and motorcycles on motorways and expressways in 2011.

Spain is geographically and administratively divided in 17 autonomous regions. Comunitat Valenciana (CV) is one of these regions. In 2005, CV prepared its 1st comprehensive Road Safety Programme, which established some directives to be implemented without a time-limit, such as the increase of the number of high-capacity road kilometres, the upgrading of conventional networks, a programme to remove obstacles from roadsides, a complete review of traffic signs, etc. (Conselleria de Infraestructuras y Transporte, 2005).

In light of the different legislative regulations, traffic accident prevention programmes, regulations on motor vehicles and road-safety measures introduced in Spain and CV, the aim of this study is to analyse, by sex and age group, the temporal evolution of the rates of mortality due to motor vehicle traffic accident (MVTA) injuries among the general population residing in CV between 1987 and 2011, as well as to identify trend changes and the way they relate to the regulations and measures that have been taken to improve road safety.

2. Methods

2.1. Design, unit of analysis and population studied

This is an observational study on annual mortality trends during the period 1987–2011. All the subjects studied resided in CV. This region is located in the east of the country, on the Mediterranean coast. Its resident population was 5,117,190 in 2011, according to the Spanish Statistics National Institute.

2.2. Information sources

All deaths due to motor vehicle traffic accident (MVTA) injuries that occurred between 1987 and 2011 in CV have been studied. The data about deaths used in this study were provided by the mortality register of CV (MRCV). For the purposes of the analysis, we selected the deaths of residents in CV whose basic cause of death had been MVTA injuries during the years studied.

Table 1
Codes used for mortality due to motor vehicle traffic accident injuries.

Codes ICD-9	Codes ICD-10
E810–E819	V02–V04.1.9, V09.2. V12–V14 .3.4.5.9, V19.4.5.6, V20–V28.3.4.5.9, V29.4.5.6.9, V30–V38.4.5.6.7.9, V39.4.5.6.9, V40–V48.4.5.6.7.9, V49.4.5.6.9, V50–58.4.5.6.7.9, V59.4.5.6.9, V60–V68.4.5.6.7.9, V69.4.5.6.9, V70–V78.4.5.6.7.9, V79.4.5.6.9, V80.3.4.5, V81.1, V82.1, V83.0.1.2.3, V84.0.1.2.3, V85.0.1.2.3, V86.0.1.2.3, V87.0.1.2.3.4.5.6.7.8, V89.2

Table 2
Number of deaths (n) and age-standardised rates (ASR)* due to ATVM injuries, by year, sex and age group. 1987–2011. Comunitat Valenciana, Spain.

Men	Total		0–14		15–34		35–64		≧65	
Year	n	ASR	n	ASR $_{0-14}$	N	ASR $_{15-34}$	n	ASR $_{35-64}$	n	ASR$_{\geq 65}$
1987	483	26.0	19	4.4	247	41.6	147	23.4	70	38.7
1988	540	29.1	14	3.0	285	48.3	152	24.3	89	49.8
1989	612	32.9	18	4.2	337	56.8	173	27.8	84	48.0
1990	679	36.5	26	5.5	374	63.4	181	29.0	98	57.0
1991	626	31.7	26	6.5	317	50.0	192	29.3	91	43.7
1992	565	28.3	17	4.3	292	46.4	165	25.1	91	41.2
1993	445	22.7	7	1.6	195	31.1	153	23.1	90	42.5
1994	456	23.1	15	3.9	210	33.1	143	22.0	88	40.1
1995	431	21.9	19	4.4	205	32.5	137	20.8	70	33.8
1996	406	19.3	6	1.8	176	26.6	137	19.5	87	34.4
1997	425	20.2	12	3.4	176	26.7	139	19.9	98	38.7
1998	447	21.0	14	4.3	200	30.5	148	20.6	85	31.9
1999	424	20.3	11	3.4	198	29.9	145	20.8	70	27.6
2000	404	18.2	8	2.3	186	28.5	139	18.0	71	24.6
2001	405	17.9	5	1.6	189	28.4	140	18.0	71	23.0
2002	390	16.4	8	2.3	170	24.8	127	15.2	85	27.4
2003	409	16.9	7	2.2	182	26.3	153	17.5	67	20.6
2004	378	15.5	6	1.7	164	24.2	131	14.8	77	23.4
2005	376	15.0	7	1.9	156	22.5	146	15.5	67	20.4
2006	353	13.8	5	1.4	159	22.5	141	14.6	48	13.8
2007	287	10.8	4	1.1	122	17.0	103	10.2	58	16.6
2008	244	8.8	4	1.1	94	12.7	94	8.9	52	13.8
2009	187	6.7	0	0.0	61	8.3	79	7.4	47	11.8
2010	175	6.4	4	1.0	54	8.0	79	7.4	38	9.8
2011	149	5.2	1	0.3	44	6.4	68	6.1	36	8.7
Women	**Total**		**0–14**		**15–34**		**35–64**		**≧65**	
Year	n	ASR	n	ASR $_{0-14}$	N	ASR $_{15-34}$	n	ASR $_{35-64}$	n	ASR$_{\geq 65}$
1987	140	6.7	10	2.4	60	10.1	29	4.2	41	15.2
1988	149	7.3	9	2.1	64	10.9	36	5.6	40	15.0
1989	189	9.4	15	3.8	75	12.9	51	7.9	48	17.5
1990	162	8.0	11	2.5	65	11.1	39	6.0	47	18.4
1991	167	7.5	15	3.9	75	12.0	35	4.9	42	12.7
1992	145	6.5	4	1.1	60	9.8	33	4.8	48	15.1
1993	136	6.3	7	2.0	50	8.1	33	4.9	46	15.2
1994	115	5.3	7	1.8	45	7.2	29	4.3	34	10.9
1995	115	5.3	4	0.9	47	7.5	33	4.8	31	9.9
1996	114	5.0	5	1.5	41	6.4	32	4.6	36	9.9
1997	103	4.4	5	1.6	36	5.6	28	3.8	34	9.5
1998	139	5.8	5	1.6	60	9.5	28	3.7	46	12.4
1999	122	5.4	5	1.5	34	5.3	44	6.1	39	10.7
2000	114	5.1	10	3.5	45	7.2	28	3.6	31	7.9
2001	107	4.5	5	1.8	41	6.5	31	3.9	30	7.0
2002	108	4.2	5	1.6	39	5.9	30	3.5	34	7.2
2003	112	4.4	6	1.9	45	7.2	26	2.9	35	7.9
2004	103	3.9	2	0.6	36	5.8	27	3.1	38	8.4
2005	66	2.5	7	2.1	11	1.8	20	2.3	28	6.1
2006	83	3.1	1	0.3	34	5.1	23	2.4	25	6.0
2007	75	2.9	5	1.5	27	4.5	18	1.9	25	5.4
2008	62	2.2	3	0.8	15	2.6	21	2.0	23	4.2
2009	48	1.5	3	0.8	5	0.8	16	1.5	24	4.9
2010	44	1.5	2	0.6	10	1.5	20	1.9	12	1.9
2011	30	0.9	1	0.3	7	1.2	7	0.6	15	2.6

* ASRs are ×100,000 person/year.

For the period 1987–1998, the basic causes of death were codified according to the International Classification of Diseases 9th revision (ICD-9) (OPS, 1981). On the other hand, for the period 1999–2011, the basic causes of death were codified according to the International Classification of Diseases and Related Health Problems 10th revision (ICD-10) (OPS, 1999). Table 1 shows the codes used to codify the different basic causes of death used in this study.

Due to the lack of a single source of information in Spain throughout the 25 year study period, the data about the population of CV used to calculate the indicators were obtained from the Population and Housing Census (1991), the Municipal Register of Inhabitants (1986, 1996), and the Ongoing Register of Inhabitants (1998–2011), provided by the Valencian Statistics Institute. The total population was disaggregated by sex and age.

2.3. Data analysis

Age-standardised rates (ASR) of mortality due to MVTA injuries were calculated using the direct method for each sex and year studied (Rué and Borrell, 1993). These rates were calculated for the total population and for the age groups (0–14, 15–34, 35–64 and ≧65 years). The European population, together with its standard errors, was used as the standard population (Segi, 1960). ASR ratios were calculated on a men vs. women basis. A joinpoint regression analysis was used to determine time segments and time points in mortality trends for each sex, age group and for all ages. Each joinpoint

Table 3
Trend segments and annual percentage change (APC), obtained using joinpoint regression models, for the age-standardised rates, by sex and age group. Period 1987–2011. Comunitat Valenciana, Spain.

	Trend segment 1		Trend segment 2		Trend segment 3		Trend segment 4		Trend segment 5	
	Period	APC IC 95%	Period	APC IC 95%	Period	APC IC 95%	Period	APC IC 95%	Period	APC IC 95%
Men										
Total	1987–1990	12.4 5.7, 19.4	1990–1993	−14.0 −23.4,−3.4	1993–2005	−3.4 −4.3, −2.5	2005–2011	−16.8 −19.5 −14.1		
Age 0–14	1987–2011	−7.0 −9.8, −4.07								
Age 15–34	1987–1990	15.5 6.8, 24.9	1990–1993	−19.6 −30.9, −6.4	1993–2006	−2.9 −4.1, −1.8	2006–2011	−23.9 −29.2, −18.2		
Age 35–64	1987–1989	11.4 −10.3, 38.3	1989–2005	−3.9 −4.8, −3.0	2005–2011	−14.4 −18.3, −10.4				
Age ≧ 65	1987–2004	−5.0 −6.2, −3.7	2004–2011	−12.6 −17.8, −6.9						
Women										
Total	1987–1989	17.4 −6.9, 48.0	1989–1996	−8.9 −12.5, −5.1	1996–1999	6.1 −18.1, 37.5	1999–2007	−8.4 −12.0, −4.7	2007–2011	−22.1 −32.7, −10.0
Age 0–14	1987–2011	−4.5 −7.0, −1.9								
Age 15–34	1987–2011	−5.7 −7.4, −4.0								
Age 35–64	1987–1999	−2.0 −4.8, 0.8	1999–2011	−9.68 −12.6, −6.4						
Age ≧ 65	1987–2011	−6.2 −7.3, −5.1								

(if any) showed a significant change in trend, and an annual percentage of change (APC) of the ASRs, and the corresponding confidence interval at 95% (CI 95%) was computed from each trend segment. A negative APC indicated a decreasing trend, whereas a positive APC indicated an increasing trend. The analysis began with the minimum number of 0 joinpoints to a maximum of 4 joinpoints and tested whether one or more joinpoints were significant. In order to build the model, the freeware Joinpoint Regression Program V 4.1.0 (National Cancer Institute, 2013) was used, under the usual assumption that ASRs were normally distributed, because the high numbers for numerators and denominators of rates, and heteroscedastic variances for the ASRs. The weighted least square method was used to estimate the model. The APCs were calculated using the logarithmic transformation. The Monte Carlo permutation test (Kim et al., 2000) was used to prove the existence of statistically significant joinpoints ($p < 0.05$). This test is usually used in studies of ASRs trends.

3. Results

The total number of deaths of residents in CV during the period studied was 906,616; 36,978 of which were due to external causes (4.1% of the total) and 13,044 were due to MVTA injuries (1.4% of total deaths and 35.3% of the deaths due to external causes). The percentage represented by deaths due to MVTA injuries within the group of deaths due to external causes varies depending on the different periods studied. The highest value can be found at the beginning of the period and the lowest value in the final year of the period: variations from 48.0% to 42.0% between 1987 and 1992; from 40.0% to 35.9% between 1993 and 2000; from 35.2% to 24.3% between 2001 and 2007; from 22.3% to 15.1% between 2008 and 2011.

Table 2 shows the number of deaths and ASRs by sex and age group per year.

Table 3 shows trend segments detected using the joinpoint regression model and the APC of ASRs in the different trend segments for each age group, together with their confidence intervals at 95%.

Figs. 1–3 show the time evolution of ASRs.

The ASR ratio between men and women for all ages studied was 3.9 in 1987, 4.6 in 1990, and 5.8 in 2011. For the same years and divided by age groups, this indicator was respectively 4.1, 5.7 and 5.3 for the age group 15–34 years; 5.6, 4.8 and 10.2 for the age group 35–64 years; and 2.5, 3.1 and 3.3 for the age group ≧65 years.

3.1. Results in men

Between 1987 and 2011, the total number of deaths due to MVTA injuries for men was 10,296. Men represent 77.5–83.2% of the total deaths due to MVTA injuries for both sexes. 47.1% of the deaths occur in the age group 15–34 years, 32.7% in the age group 35–64 years, 17.8% in the age group ≧65 years, and the remaining percentage, 2,4%, in the age group 0–14 years. Between 1990 and 2011, ASRs decreased by almost 70% for all ages studied (from 36.5 deaths per 100,000 men/year to 5.2 deaths per 100,000 men/year). The age group 15–34 years reached a decrease of 90% (the ASR was 63.4 in 1990, and 6.4 in 2011).

For all ages, ASRs show 4 trend segments during the whole period studied. The first one is an increasing segment between 1987 and 1990, with an APC of ASRs of 12.4% ($p < 0.05$). All the other ones are decreasing segments during the periods 1990–1993, 1993–2005 and 2005–2011, with statistically significant APCs of ASRs ($p < 0.05$). The last period has the highest APC (−16.8%). In the age group 15–34 years, the pattern of ASRs is very similar to the one of the whole population, with 4 trend segments; the first one has an increasing APC, while the other 3 have a decreasing APC. All of them are statistically significant ($p < 0.05$), but the highest APC is the one for the period 2006–2011 (−23.9%). In the age group 35–64 years, there are only three trend segments; the first one is an increasing segment between 1987 and 1989, while the other ones are decreasing segments (1989–2005 and 2005–2011). All the APCs of ASRs are statistically significant ($p < 0.05$). All the other age groups show linear decreases of the ASRs from the first period studied, with negative and significant APCs of ASRs ($p < 0.05$).

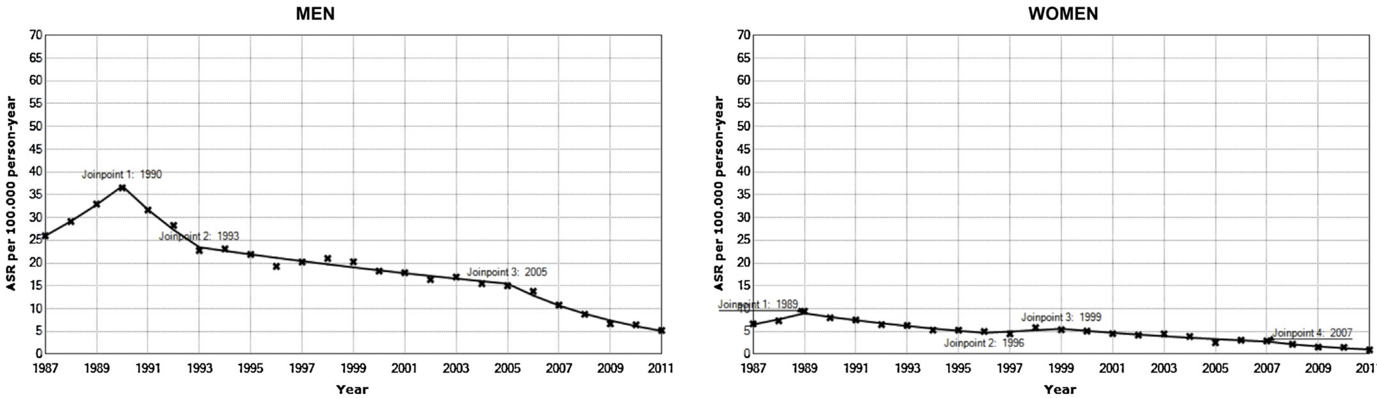

Fig. 1. Age standarized mortality rates (ASR), joinpoints and trends by sex. All ages. Comunitat Valenciana, Spain. Period 1987–2011

3.2. Results in women

The total number of deaths due to MVTA injuries studied was 2748 between 1987 and 2011. Women represent 16.8–22.5% of total deaths due to MVTA injuries for both sexes each year. The age group 15–34 years accounts for 37.4% of total deaths, the age group ≧65 years for 31.0%, and the age group 35–64 years for 26.1%. For the total population, the ASR decreased by almost 90% between 1990 and 2011. During this period, the ASR decreased from 8.0 to 0.9 deaths per 100,000 women/year. A similar change occurred in the age group 15–34 years during the aforementioned period: the ASR decreased from 11.1 to 1.2 deaths per 100,000 women-year.

For the total population, ASRs have 5 trend segments. During the period 1987–1989, there is an increasing trend; the APC of ASRs is 17.4%. There are decreasing trends during the other 4 periods. During the periods 1989–1996, 1999–2007 and 2007–2011, the APCs of ASRs are statistically significant ($p < 0.05$). The last segment has the highest APC of ASRs (−22.1%).

Most age groups show a linear decrease of the ASRs during the 25 years studied, with statistically significant APCs of ASRs ($p < 0.05$). The age group 35–64 years has the highest APC of the ASRs during the period 1999–2011 (−9.7%).

4. Discussion

This study has revealed an increase of the risk of death due to MVTA injuries in Comunitat Valenciana during the late 1980s, which decreased gradually for both sexes from the beginning of the

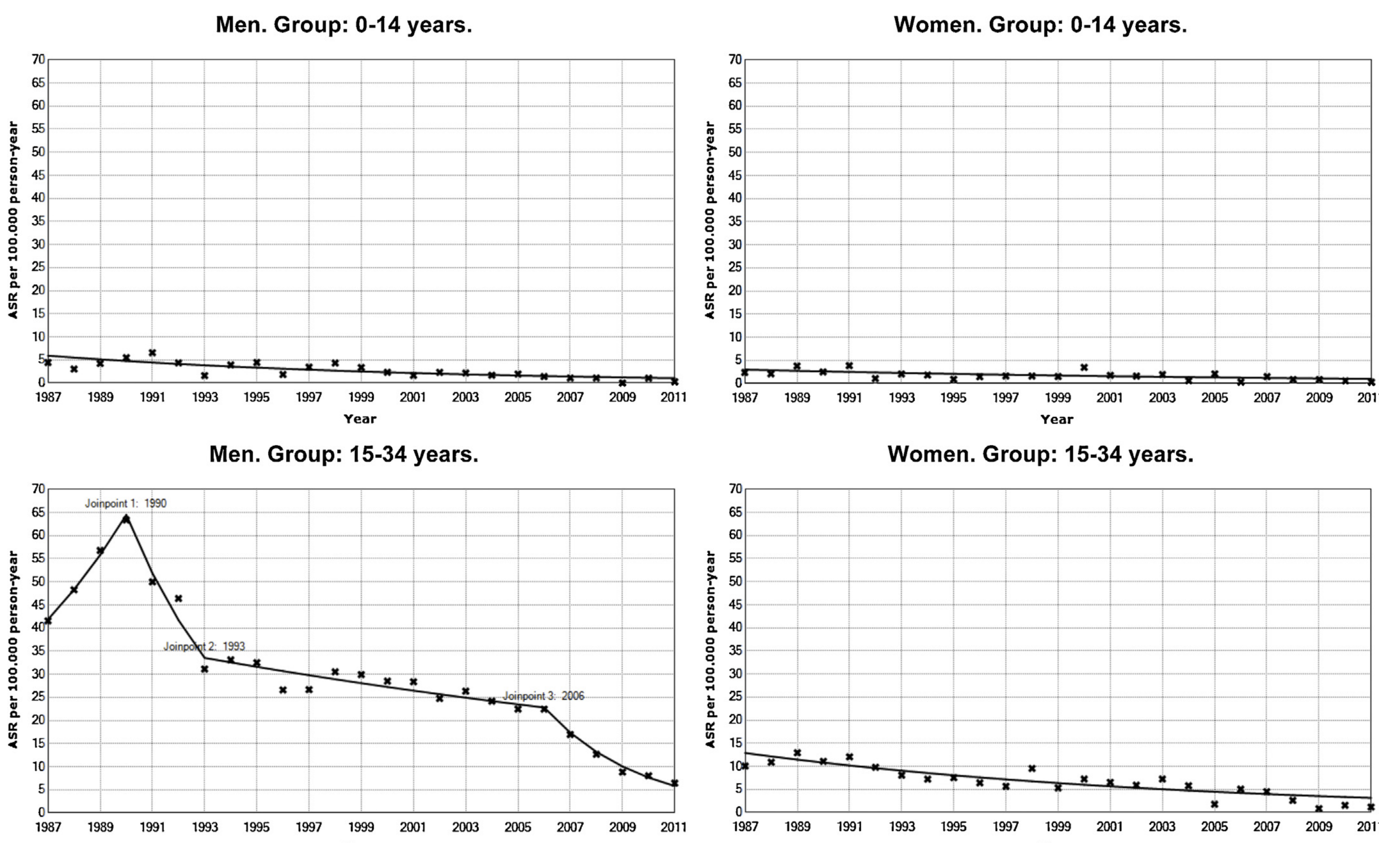

Fig. 2. Age-standarized mortality rates (ASR), joinpoints and trends by sex. Age Groups: 0–14 and 15–34 years. Comunitat Valenciana, Spain. Period 1987–2011

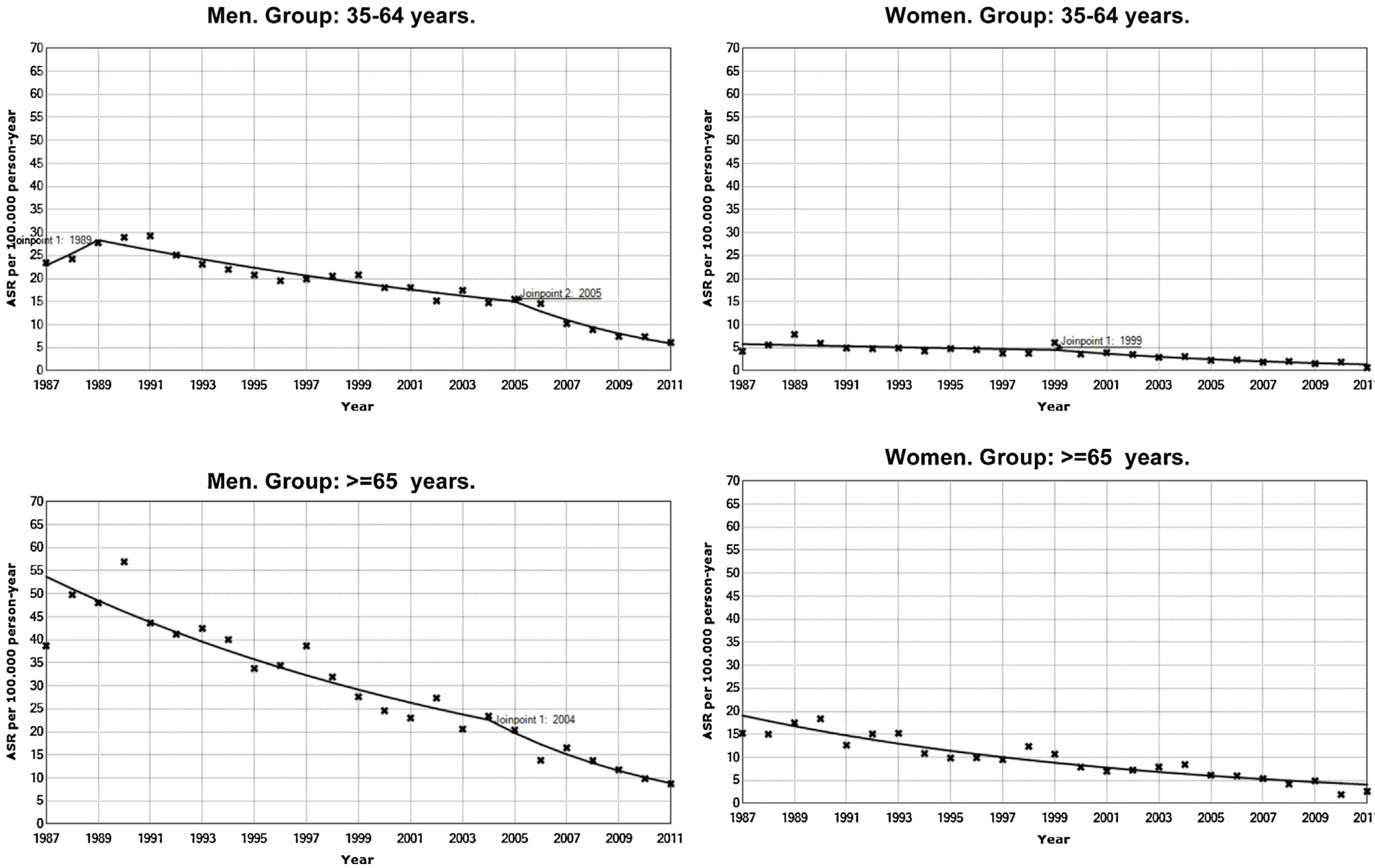

Fig. 3. Age standarized mortality rates (ASR), joinpoints and trends by sex. Age Groups: 35–34 and ≧65 years. Comunitat Valenciana, Spain. Period 1987–2011

1990s to the present. This decrease differs over time; there was a very sharp decrease during the first half of the 1990s, then it became moderate until the first half of the 2000s, and again very sharp from 2006 to the present. The population group where this pattern is clearer is 15- to 34-year-old men, although, in general, this group still has higher mortality rates compared to other age and sex groups.

Mortality rates suggest that the pattern of evolution of the last 25 years in CV is similar to the one in other countries, such as Finland, France or Australia (Lapostolle et al., 2009; Korhonen et al., 2011; Gargett et al., 2011). Mortality rates also increased in Spain, Greece and Portugal (Van Beeck et al., 2000; Redondo et al., 2000; Regidor et al., 2002) and some other Spanish autonomous regions (Giné, 1992; Ruiz et al., 2004) until 1990, although this phenomenon took place earlier in most Western European countries, during the 1970s (Van Beeck et al., 2000). Some of the reasons for this increase may be the economic recovery in Spain between 1986 and 1989 (Redondo et al., 2000; Söderlund and Zwi, 1995), and the regulations on traffic and road safety established in the Highway Code of 1934 and the existing road safety measures, which were obsolete and weakly complied with and enforced (Villabí and Pérez, 2006).

As of 1990, there was a turning point in mortality with a change of trend of the ASRs. For the first years of this decade, there was an important decrease that coincided with some events in Spain. Some of these events were: The Law on Traffic, Motor Vehicles and Road Safety came into force in 1990; the General Road Traffic Regulations were enacted in 1992, these regulations established the obligation to use safety belts in motor vehicles on urban roads and in rear seats, and to use motorcycle helmets on interurban roads (also by moped users), as well as the prohibition to drive under the influence of a specific blood alcohol level by establishing strict punitive measures in case of infringement; in 1993, the General Roads Plan of 1988 was reinforced; in 1994, a plan to aid customers to purchase new vehicles began (RENOVE Y PREVER), the regulations on vehicle inspections of 1985 were updated, and new safety electronic devices (Airbag, ABS, EPS . . .) were incorporated on a non-mandatory basis, which led to a general improvement of safety in new vehicles. During this decade, the healthcare of the victims of accidents also improved, as a result of the development of the health system and emergency system, which provide urgent care in the place where the accident occurred. Another contributing factor is the advertising campaign launched by the DGT (Directorate-General for Traffic) on the use of safety belts, helmets, alcohol, etc. The gradual, positive effect of these measures may be a major cause of the decrease of the number of deaths during this period (Villabí et al., 2006; Castillo-Manzano et al., 2010 Castillo-Manzano et al., 2010). CV started to draw up some successive road-safety plans in 1991, which aimed to eliminate black spots in the region's road network. As the conditions of this road network improved, the mitigating road-safety policies changed to preventive road-safety policies (Conselleria de Infraestructuras y transportes, 2005).

ASRs also decreased in most EU countries between 1995 and 2007. This decrease was greater in Austria, Denmark, France and Germany, and smaller in other countries such as Portugal and Greece, where this indicator was higher than the European average in 2007, which was 8.6 deaths per 100,000 inhabitants (The London School Economics and Political Science, 2010).

The actions which had been contributing to a downward trend in ASRs until 2004 were reinforced with some later political decisions. As of 2006, there is a greater decrease of ASRs in CV than the one that had occurred in the early 1990s. This decrease coincides with the decision made by the government to make road safety a political priority in 2004 with a view to reducing the number of deaths by 40% between 2005 and 2008 (taking 2003 as the base year), in line with the European objective of reducing the number of fatalities due to TA by 50% by 2010 (Comisión Europea, 2003). This decreasing trend, by almost 50%, in the number of deaths during the early 2000s also took place in some other European countries, such as Luxemburg, France, Portugal, Latvia and Spain as a whole, in line with the recommendations of the European Commission in this area (Pérez, 2009). Novoa et al. (2011a) proved that the rate of deaths due to TA injuries within 24 h after the accident decreased by 12.5% in Spain between 2004 and 2006. The main reason for this is the consideration of road safety as a priority as of 2004. It decreased by 11.5% in the case of men and by 16.1% in the case of women. The penalty-points driving licence was implemented in July 1st 2006 (PPS), followed by some amendments of the Criminal Code regarding Road Safety in 2007, and the General Road Traffic Regulations.

Several studies have highlighted the positive effect of the penalty-points driving licence on the decrease of deaths due to TA in Spain (Novoa et al., 2010; Pulido et al., 2010; Castillo-Manzano et al., 2010). Aparicio et al. (2011) concluded that its implementation had a very positive effect on the decrease of the number of fatalities after more than 24 h on interurban roads, and that this effect has continued to the present. The key to this success was a combination of: the implementation of the penalty-points driving licence, the gradual strengthening of surveillance measures and sanctions, and the advertising campaigns on road safety matters launched through the media. Montoro et al. (2008, 2009),) reported a moderate change of drivers' behaviour after the penalty-points driving licence had been implemented, particularly regarding speed violations and the inadequate use of mobile phones. This change was greater among infringing drivers. 40% of drivers stated to be more aware of TA. Furthermore, they assessed the penalty-points driving licence in Spain positively, they considered that the main aim of this measure was to raise awareness and improve road safety rather than to sanction and raise money. The effect of the implementation of the penalty-points driving licence on the reduction of the risk of death due to MVTA injuries varies depending on the different European countries, especially due to police action strategies and the existing legislation on road safety in the country where the penalty-points driving licence is implemented, and the behaviour of drivers and passengers regarding safety belts (Butler et al., 2006; Zambon et al., 2007; Farchi et al., 2007; Zambon et al., 2008). Some studies by sex show that the penalty-points driving licence is more effective in men than in women (Zambon et al., 2008).

Concerning the effect of the amendment of the regulations on sanctions in the Criminal Code, Aparicio et al. (2011) suggest a great decrease of the number of deaths because of the positive effect of this measure. Novoa et al. (2011b) estimated that the number of deaths due to MVTA injuries in men decreased significantly between 2000 and 2009, before and after the amendment of sanctions. By age group, young people and young adults benefited most (decrease of serious injuries and fatalities by 19.2% and 17.8%, respectively). This measure did not result in a significant reduction of the total deaths in women at a global level.

On the other hand, although effective road safety policies are the main contributing factor to the decrease of mortality (OECD, 2012), it also acknowledged that economic crises help reduce mortality due to transport accidents, most of which are traffic accidents. In this regard, Novoa et al. (2011b) proves that the number of kilometres covered on interurban roads decreased during the period 2008–2009 in Spain, which naturally affected the risk of death.

All the positive effects of the aforementioned measures, taken as of 2004, are compatible with the evolution of the mortality ASRs with statistically significant APCs (−16.8% between 2005 and 2011 in men; and −22.1% between 2007 and 2011 in women).

By age group, mortality ASRs are generally greater in men than in women. The age group 15–34 years in men has the highest ASR, this result coincides with the published literature (Butler et al., 2006; Lapostelle et al., 2009 Clarke et al., 2010; Spoerri et al., 2011). On the other hand, it is worth highlighting that men aged 65 or older also have high mortality ASRs. However, the paediatric age group in both sexes has very sharp decreases of mortality ASRs, reaching 0.3 deaths per 100,000 children. This result is similar to the one presented by Parkkari et al. in Finland (Parkkari et al., 2012). The descending pattern by age group is similar to the one in France, with similar traffic accident prevention measures (Lapostolle et al., 2009).

4.1. Strengths and limitations

The main strength of this study is the completeness of the mortality data. The Mortality Register of the CV has codified the basic cause and registered all the deaths occurred to residents in CV for more than 20 years. This means that the codification and registration criteria and the working team have not changed during the period studied.

One of the limitations of this study may be the use of two different classifications (CIE-9 and CIE-10) to codify and select the basic cause of death in the period studied. Nonetheless, two studies at a national level verified that the use of both classifications did not cause mortality due to traffic accidents to change (Cano-Serral et al., 2006; Cirera et al., 2006).

Another limitation for the analysis of mortality due to traffic accidents is that the individual exposure to traffic on the road of each socio-demographic group and type of transport is not taken into account. In general, male population spend more time and cover more kilometres on public and private transport. The difference of exposure may partially explain that mortality is higher in men than in women. Some age groups also have a higher level of exposure to traffic risks, particularly middle-aged population, which includes most of the working population (Spoerri et al., 2011).

Another limitation of the study is that MVTA could not be classified depending on the type of deceased person (driver, passenger, motorcyclist, moped driver, cyclist, pedestrian). Thus, the decrease of the ASRs depending on the type of deceased person could not be analysed. The fourth digit of the CIE-9 and CIE-10 could not be analysed in order to indicate the type of deceased person, because this description was not always available in the Statistical Death Bulletin.

The Joinpoint regression model used in this article can be viewed as "a single case of linear regression spline with variable knots" (Kim et al., 2000). Other models such as Bayesian methods for change-point modelling, non-parametric smoothing methods, or nonlinear models for change-point modeling, could have been used. Although results could have differed, we think that this model is appropriate when the number and location of joinpoints is unknown, and has allowed adequately summarize trends and annual percentages of change. Furthermore, this method is frequently used in the analysis of trend changes on standardized mortality rates.

5. Conclusions

The risk of death due to MVTA injuries has significantly decreased for the last 25 years in CV. This decrease has been particularly important during the second half of the 2000s in both sexes. The reason for this might be the implementation of some road-safety measures in Spain as of 2004, such as the decision made by the government to make road safety a priority during that year, the implementation of the penalty-points driving licence, the amendment of the Criminal Code concerning Road Safety, the increase in the number of radars, losses of licence, alcohol and drug checks, and road safety advertising campaigns. The severe economic crisis that this country has undergone since 2008 may have contributed to this decrease.

Despite the decreases, age-standardised rate ratios for men and women increased over time and this cause of death still has a high risk among young men and it is important to maintain and improve the measures that led to such reduction in the risk of death.

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