Gender and Age Distribution of Motorcycle Crashes in Spain

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This study analyzed motorcycle crashes in Spain. Ninety nine thousand three hundred and four motorcycle crash reports filed in the years 2006–2011 were extracted from the Directorate General of Traffic database of crashes with victims. These data were analyzed in terms of gender, age groups, trip purpose, type of crash, speed violation, day of the week, harm caused, use of helmet and psychophysical conditions of the driver to study the characteristics of motorcycle crashes in Spain and to assess the differences between male and female motorcycle drivers in these crashes. Significant differences were found in all the variables considered in the study, which implies gender differences in the profile of the injured motorcycle driver. The severity of motorcycle crashes suffered by male drivers is higher than that of women. These results corroborate the need to develop measures differentiated by gender, based on their profile.

Keywords: road safety; gender differences; age groups; motorcyclists; power-two-wheelers safety

Introduction

Spain is currently a leader among countries with the lowest mortality rate in traffic crashes, with a total of 3.7 deaths per 100,000 inhabitants (World Health Organization, 2015).

The efforts made in Spain, both by the Directorate General of Traffic (Dirección General de Tráfico, DGT) and other entities working to reduce traffic crashes, have paid off in recent decades and have made Spain one of the countries of the Organisation for Economic Cooperation and Development (OECD) with the greatest improvement in road safety indicators, with a reduction in the mortality rate in this type of crash exceeding 75% in the last 20 years (OECD, 2013).

However, the severity of traffic crashes in Spain during the last few years has not decreased homogeneously among the occupants of the different types of vehicles

that compose the national fleet. For the drivers and the passengers of passenger cars, mortality has been reduced by more than 75% from 2000 to 2014; however, among motorcycle riders and their passengers, mortality has only been reduced by 26.79%. This is the lowest recorded reduction in mortality across all motor vehicles (DGT, 2015a). In addition, the number of injured motorcyclists hospitalized as a result of crashes has increased by almost 20% in this period, while injuries resulting from different types of vehicle crashes have become less severe.

This situation is not unique to Spain because in the vast majority of countries, the reduction in the number of fatalities in traffic crashes in recent years has been higher among passenger vehicle occupants than among motorcycle occupants (ITF, 2015).

Since the mid-1990s, there has been a significant increase in motorcycles in the mobile fleet of numerous countries (Blackman and Haworth, 2013; Jamson and Chorlton, 2009). They are an attractive alternative to cars (especially in large urban centers) because they are an economically practical means of transport (both in terms of their acquisition and maintenance), are faster in increasingly congested cities and towns, and are easier to find parking for near the destination (Van Elslande and Elvik, 2012). There has also been a significant increase in the size of the motorcycle fleet in Spain, from 1,445,644 motorcycles registered in 2000 to 2,972,165 in 2014 (DGT, 2015b).

The increase in motorcycle fleets, together with the increased vulnerability of motorcycle riders and passengers in the event of an crash (even at relatively low speeds), means that motorcyclists are 9 to 30 times more likely to be killed in a traffic crash than the drivers of a car for the same number of kilometers traveled (Van Elslande et al., 2014).

Among the factors that have been identified as causes of motorcycle crashes (state of the vehicle, road, adverse weather conditions, etc.), it is the human factor that

has been most frequently identified as the cause of traffic crashes (Evans, 1996; Petridou and Moustaki, 2000).

Male drivers are involved in more fatal crashes than are female drivers (Li, Baker, Langlois and Kelen, 1998; Martin, Lafont, Chiron, Gadegbeku and Laumon, 2004; Roudsari, Sharzei and Zargar, 2004; Tavris, Kuhn and Layde; 2001). Ulfarsson and Mannering (2004) noted that differences at both the behavioral level and the physical level could be behind the differences in the severity of traffic crash injuries between men and women. Regarding the behavioral element, gender is a powerful predictor of risky driving, with men being more prone to risk-taking behavior while driving than women (Harré, Brandt and Dawe, 2001; Oltedal and Rundmo, 2006; Rhodes and Pivik, 2011; Santamariña-Rubio et al., 2009). As for the physical element, Evans and Gerrish (2001) found that faced with the same physical impact, the risk of dying was higher among women than among men.

Youth is another of the risk factors identified among motorcycle riders (Rutter and Quine, 1996; Yeh and Chang, 2009). Younger drivers are more likely to suffer a traffic crash per kilometer traveled (Mullin, Jackson, Langley and Norton, 2000).

Young male motorcycle riders show a greater propensity to risky behaviors, which is associated with a higher probability of being involved in an crash (Chang and Yeh, 2007; Lin, Chang, Pai and Keyl, 2003). Rutter and Quine (1996) found an association between motorcycle crashes and a pattern of behavior consisting of the inclination to break the law and violate safety regulations. Young drivers exhibit more dangerous behavior and less safe attitudes when driving motorcycles (Bjørnskau, Nævestad and Akhtar, 2012).

Methods

The objective of this study is to analyze the characteristics of motorcycle crashes that

occurred in Spain from 2006 through 2011 and to further examine the differences between men and women in both the frequency of crashes and their severity.

The data used for this study comes from the DGT database of crashes with victims corresponding to the period from 2006 through 2011. These data were provided by the DGT.

The information in the records included in this database is collected directly by the agents in charge of the surveillance and control of traffic at the time of the crash through a statistical questionnaire in which the crash data, the vehicles involved and the people who were observed to be involved are recorded.

The database included 99304 crashes in which a total of 102676 motorcycle drivers were involved.

The variables studied were age, sex, trip purpose (reason for travelling), severity, type of crash, day of the week, violations related to speed and helmet use.

Descriptive analyses of the motorcycle crashes for the total sample and chi-square tests were carried out to analyze the differences stratified by the sex of the driver. The fatality index in the different variables included in the study was also calculated as an indicator of the severity of the crash, dividing the number of deaths by the total number of victims. This fatality rate is frequently used by the DGT to assess the relative severity of traffic crashes.

Results

Descriptive analyses

During the six years analyzed in this study, 102676 motorcycle drivers were involved in traffic crashes of varying severity in Spain (see Table 1).

Table 1. Frequency and percentage distributions in motorcycle accidents, 2006–2011.

	Frequency	%
Gender		
Men	91767	89.4
Women	10250	10.0
Unknown	659	0.6
	102676	
Age groups		
16-24	10514	10.2
25-34	37289	36.3
35-44	28919	28.2
45-54	15551	15.1
55-64	5088	5.0
>65	1109	1.1
Unknown	4206	4.1
Trip purpose		
During the work day	7582	7.4
Going to or returning from work	5725	5.6
Leaving for or returning from vacation	153	0.1
Leaving for or returning from weekends and holidays	317	0.3
Emergencies	236	0.2
Leisure	23783	23.2
Other	14629	14.2
Unknown	50251	48.9
Type of crash		
Head-on collision of vehicles in motion	2559	2.5
T-bone collision of moving vehicles	27250	26.5
Side collision of moving vehicles	13924	13.6
Rear-end collision of moving vehicles	16434	16.0
Multiple vehicle collision or caravan of moving vehicles	4626	4.5
Roll-over on the road	7412	7.2
Collision with obstacle in the road	2002	1.9
Run over pedestrian	3727	3.6
Run over animal	481	0.5
Left exit with collision	2019	2.0
Left exit without collision	1355	1.3
Right exit with collision	3674	3.6
Right exit without collision	7231	7.0
Another type of accident	9982	9.7
Speed violation		
Inappropriate speed for existing conditions	9586	9.3
Exceeding the established speed	1521	1.5

Slow speed slowing down circulation	67	0.1
None	59988	58.4
Unknown	31514	30.7
Weekdays /weekend		
Weekday	77748	75.7
Weekend	24928	24.3
Harm caused		
Death	2162	2.1
Seriously injured	15907	15.5
Slightly injured	77307	75.3
Unscathed	4482	4.4
Unknown	2818	2.7
Use of helmet		
Yes	85024	82.8
No	6892	6.7
Unknown	10760	10.5
Psychophysical conditions		
Apparently normal	80100	78.0
Alcohol without breathalyzer	228	0.2
Alcohol with breathalyzer	983	1.0
Drugs	33	0.0
Sudden illness	44	0.0
Sleepiness or drowsiness	43	0.0
Fatigue	41	0.0
Concern	137	0.1
Unknown	21067	20.5

Three out of four crashes (75.3%) caused the driver of the motorcycle to be slightly injured (fewer than 24 hours of hospitalization).

Men (91767) and women (10250) accounted for 89.4% and 10% of drivers involved in crashes, respectively. The average age of male drivers in crashes was 36.7 years (SD = 10.73), while that of women was 36.49 (SD = 10.58).

Of motorcycle riders involved in crashes during this period, 74.7% were under 44 years old, with the age group between 25 and 34 years being distinctive for representing 36.3% of the total number of drivers.

Leisure was the most common trip purpose at the time of the crash, accounting for 23.2% of crashes.

The most common type of crash was the T-bone collision of vehicles in operation, which accounted for 26.5% of motorcycle crashes, followed by rear-end collisions with 16%.

In most crashes (58.4%), the driver of the motorcycle crash did not commit any type of speed violation.

A total of 75.7% of motorcycle crashes took place on weekdays, and 82.8% of motorcycle drivers wore helmets at the time of the crash.

Comparison analysis

In all the variables studied, significant differences were found between genders (Table 2).

Table 2. Comparisons of percentage distribution in motorcycle accidents by gender, 2006–2011.

	Men	Women	*P* [a]
Age groups			<0.001
16-24	9454 (10.7%)	1049 (10.5%)	
25-34	32848 (37.2%)	4407 (44.3%)	
35-44	25877 (29.3%)	3002 (30.2%)	
45-54	14305 (16.2%)	1235 (12.4%)	
55-64	4861 (5.5%)	218 (2.2%)	
>65	1069 (1.2%)	36 (0.4%)	
Reason for displacement			<0.001
During the work day	6718 (13.8%)	740 (22.2%)	
Going to or returning from work	5247 (10.8%)	451 (13.5%)	
Leaving for or returning from vacation	142 (0.3%)	9 (0.3%)	
Leaving for or returning from weekends and holidays	302 (0.6%)	14 (0.4%)	
Emergencies	223 (0.5%)	12 (0.4%)	
Leisure	22576 (46.4%)	1117 (33.5%)	

Other	13495 (27.7%)	992 (29.7%)	
Type of crash			<0.001
Head-on collision of vehicles in motion	2396 (2.6%)	147 (1.4%)	
T-bone collision of moving vehicles	24428 (26.6%)	2685 (26.2%)	
Side collision of moving vehicles	11854 (12.9%)	2002 (19.5%)	
Rear-end collision of moving vehicles	14488 (15.8%)	1873 (18.3%)	
Multiple vehicle collision or caravan of moving vehicles	3963 (4.3%)	540 (5.3%)	
Roll-over on the road	6748 (7.4%)	637 (6.2%)	
Collision with obstacle in the road	1824 (2.0%)	143 (1.4%)	
Run over pedestrian	3282 (3.6%)	370 (3.6%)	
Run over animal	469 (0.5%)	10 (0.1%)	
Left exit with collision	1972 (2.1%)	43 (0.4%)	
Left exit without collision	1300 (1.4%)	53 (0.5%9	
Right exit with collision	3535 (3.9%)	122 (1.2%)	
Right exit without collision	6570 (7.2%)	644 (6.3%)	
Another type of accident	8938 (9.7%)	981 (9.6%)	
Weekdays /weekend			<0.001 [b]
Weekday	68459 (74.6%)	8773 (85.6%)	
Weekend	23308 (25.4%)	1477 (14.4%)	
Speed violation			<0.001
Inappropriate speed for existing conditions	9319 (14.8%)	244 (3.1%)	
Exceeding the established speed	1487 (2.4%)	29 (0.4%)	
Slow speed slowing down circulation	61 (0.1%)	5 (0.1%)	
None	52143 (82.8%)	7527 (96.4%)	
Harm caused			<0.001
Death	2117 (2.4%)	41 (0.4%)	
Seriously injured	15134 (16.9%)	719 (7.2%)	
Slightly injured	68026 (76.1%)	9022 (90.0%)	
Unscathed	4116 (4.6%)	239 (2.4%)	
Use of helmet			<0.001
Yes	76145 (92.4%)	8662 (94.4%)	
No	6283 (7.6%)	515 (5.6%)	

[a] Pearson chi-square test.
[b] Fisher exact test.

In relation to the differences by age groups, in both men and women, the age group that had the highest number of crash victims was 25-34 years of age, although women represented a greater proportion of victims.

In the variable trip purpose, men were involved in a higher percentage of crashes in travel for leisure reasons, while women were more often involved for work reasons (especially on the way to and from work).

The percentage of injured drivers having committed a speed violation is much higher in men.

The number of drivers who were killed or seriously injured (more than 24 hours of hospitalization) was also higher in males.

Helmet use was high in both cases, although higher among women.

For both genders, the most common crash during this period was the T-bone collision; in the case of women, the second most common type of crash was the side collision, while for men, it was the rear-end collision.

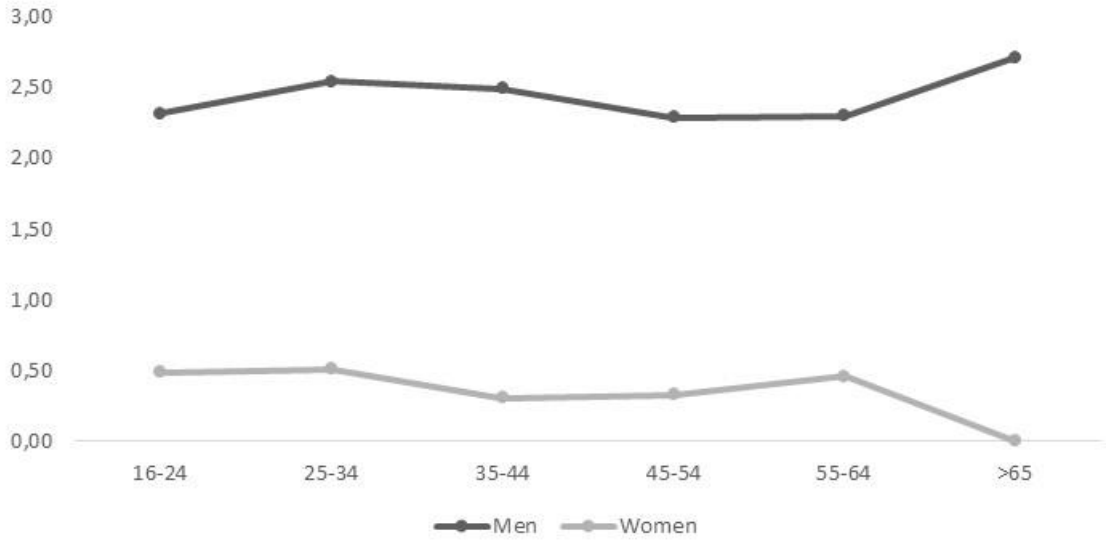
Analysis of severity

To analyze the severity of the crashes, it was decided to calculate a fatality index for each of the comparison groups, men and women: fatality index of men (men killed among the total number of male crash victims) and fatality index of women (women killed among the total number of female crash victims).

The fatality index of male motorcycle drivers is 2.37 deaths per 100 victims (see Figure 1), while that of women is 0.41 deaths per 100 victims. Among male drivers, the highest fatality index was observed in the group over 65 years of age (2.72), while the 45 to 54 (2.29) and 55 to 64 (2.30) age groups have the lowest fatality indices. In the female group, the 25 to 34 (0.51) age group had the highest fatality index in this period,

while there was not a single motorcycle driver mortality in the age group of 65 years and over.

Figure 1. Fatality index by sex and age groups, 2006-2011.



In relation to the trip purpose at the time of the crash, the crashes that occurred during the workday were associated with less severity (0.93), while those crashes that took place during the departure to or return from holidays had the highest fatality index (9.33).

As for the type of crash, exiting the lane with collision, both on the left side (11.46) and on the right side (10.45), and head-on collision with another vehicle (10.08) presented the greatest severity. On the other hand, hitting pedestrians (0.26), rear-end collision (0.70) and side collision (0.93) were the types of crashes with the lowest fatality rates among motorcycle drivers.

Crashes that occurred over the weekend (4.29) had a higher fatality index than those that occurred during the week (1.48).

Regarding speed violations, the violation with the highest fatality index (19) was exceeding the speed limit. In those crashes in which there was no type of speed violation, the fatality index dropped to 0.76.

Finally, in regard to the use of helmets among drivers involved in crashes, surprisingly, the fatality rate was slightly higher among those motorcycle drivers who did wear a helmet (2.29) compared to those who did not use one (2.19).

Discussion

The objective of this study was to study the characteristics of motorcycle crashes in Spain and to assess the differences between male and female motorcycle drivers in these crashes.

The average age of the motorcycle driver involved in crashes in this period is 36.7 years for men and 36.49 years for women, which does not initially align with the scientific literature analyzed. The literature indicates that older drivers and younger drivers are at greater risk of being involved in traffic crashes (Augenstein et al., 2003; Li et al., 2003; Kim et al., 2013; Lyman et al., 2002; Newgard, 2008; Ridella et al., 2012). In the specific case of motorcycle drivers, several authors also point to youth as a risk factor (Hawworth and Smith, 1998; Mullin et al., 2000; Rutter and Quine, 1996; Ulleberg, 2003; Yeh and Chang, 2009). However, due to the impossibility of relating the number of drivers who are crash victims to the total number of motorcycle drivers, it is not possible to analyze the risk of each age group. The fact that some age groups during this period appear to have more crashes than others may simply reflect a greater number of drivers, not necessarily riskier drivers. Regarding severity in terms of age, at least in the case of male motorcycle drivers, the results found in this work are in agreement with those of Nunn (2011) and Savolainen and Mannering (2007), who indicate that older motorcycle drivers are more often involved in serious or fatal

crashes. The higher severity among older people in traffic crashes would be related to their inherent physical intolerance to the biomechanical stress of crashes (Newgard, 2008).

Regarding gender, the majority of motorcycle drivers involved in traffic crashes during the period analyzed were males (89.4%), which agrees with the findings of Lin et al. (2003). However, similar to the situation with age, it is not possible to analyze the number of victims by gender relative to the number of male and female motorcycle riders; therefore, even though males have been involved in more crashes while riding motorcycles, we cannot say that their level of risk is higher than the female drivers of this type of vehicle. One possible explanation for the higher fatality index in men versus women is the higher propensity of men for risky behaviors (Chang and Yeh, 2007; Harris, Jenkins and Glaser, 2006), which could result in more serious crashes.

Speeding is one of the most common driving-related behaviors, despite being one of the most significant concurrent factors both in causing traffic crashes and in the severity of their consequences in general (Ellison and Greaves, 2015; Elvik et al., 2004) and, specifically, as pertains to the crash rate of two-wheeled vehicles (Lardelli-Claret et al., 2005; Steg and Brussel, 2009). Several authors have noted how speed greatly influences the severity of motorcycle crash injuries (Lin, Chang, Pai and Keyl, 2003; Savolainen and Mannering, 2007; Shibata and Fukuda, 1994). The results of this research are in accordance with the scientific literature, in that the fatality rate of motorcycle drivers who suffered an crash while driving with excessive speed, as well as those who had an crash at an unsuitable speed for driving conditions, is much higher than drivers involved in a traffic crash who did not commit any type of speed-related violation.

The fatality rate obtained in crashes occurring during vacation or leisure trips is greater than that observed in work-related trips. This may be because work-related trips, both during the workday itself and the to-and-from, tend to be short journeys through urban areas where it is less likely to suffer serious injuries in the event of an crash. In addition, during leisure trips, there may be a greater consumption of alcohol among drivers, a factor associated with an increased risk of fatal crashes among moped and motorcycle drivers (Kasantikul, Ouellet, Smith, Sirathranont and Panichabhongse, 2005; Lin and Kraus, 2009; Longthorne, Varghese and Shankar, 2007; Zambon and Hasselberg, 2006). Alcohol may also explain the greater severity of crashes occurring on weekends, compared to those occurring on weekdays.

As for the type of crash, those that present a greater severity are those in which there may be a greater speed reduction due to the collision, known as Delta-V, which are head-on collision and collision route exits. Also, collisions with objects (exiting the lane with collision) result in more severe injuries (Lin et al., 2003; Savolainen and Mannering, 2007).The most surprising result is the greater severity found among motorcycle drivers wearing helmets. Although the difference is not very high this result contradicts several investigations that indicate how the use of this safety device reduces the risk of head and face injuries as well as death in crashes (Liu et al., 2008; Moskal et al., 2008; Rice, Troszak, Oullet, Erhardt, Smith & Tsai, 2016; Rowland et al., 1996). One hypothesis would be that the crashes of those who were wearing the helmet occurred outside of urban areas and at a higher speed, that is, the use of the helmet would be associated with circumstances that cause more serious crashes. Of course, this result does not mean that the use of the helmet causes more serious injuries in case of accident. Donate-Lopez et al. (2010) obtained a similar result in a study designed to separate the association of age, sex and helmet use with the risk of death for occupants

of two-wheeled motor vehicles involved in crashes with victims in Spain from 1993 to 2007, when they found that female sex and non-helmet use seemed to be associated with crashes of lower severity. They proposed the hypothesis that helmet use seemed to be a marker associated with crashes of higher severity. Therefore, it is necessary to collect and analyze more data to explain this result.

The main strength of this study is the completeness of data. The data cover all the motorcycle accidents with victims that occurred in Spain during a prolonged period of time, wich means that the results obtained represent the reality of the crash rate in Spain during that period. Another strength is the novelty of the topic, since, as has been pointed out in the introduction, there is very few research on the analysis of motorcycle crash rate in Spain.

On the contrary, an important limitation has to do with the type of data used. Police crash data may are incomplete and biased, due to the level of under-reporting non-fatal casualties compared to fatal casualties (Amoros, Martin & Laumon, 2006). Many of the variables in the DGT database of crashes with victims have a significant number of "unknown". Also, the DGT database does not distinguish the type of motorcycle, which prevents further comparative analysis. Some studies have found a relation between the type of motorcycle and the probability of risk behaviors or the severity of the accident (Teoh & Campbell, 2010).

Conclusion

Identifying risk groups is one of the most necessary measures when studying traffic crashes. Knowing the characteristics of these groups and the risk of harm to them is essential information that decision makers must assess when planning, implementing and developing the necessary measures to reduce crashes on our roads.

In this study, the differences between male and female motorcycle riders who were involved in 102676 traffic crashes in Spain from 2006 through 2011 were analyzed. Significant differences were found in all the variables considered in the study, which implies gender differences in the profile of the injured motorcycle driver. These results indicate the need to develop informational, awareness and prevention campaigns for motorcycle crashes with different objectives and content for men and women, based on their profile.

No less important is the finding that the severity of motorcycle crashes suffered by male drivers is higher than that of women. Once again, these data corroborate the point made in the previous paragraph, the need to develop measures differentiated by gender.

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