# ON THE EFFECTS OF COMPULSORY CYCLE HELMET IN SPAIN

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***Abstract:*** *Cycle helmets are compulsory in Spain on non-urban roads since 2004, whereas they are not compulsory inside urban areas. We analyze the evolution of the number of killed and seriously injured cyclist in Spain during the period 1993-2010. It is shown that there are not significant differences between the evolution of these figures before and after 2004, nor inside and outside urban areas. We also analyze the probabilities of being killed or seriously injured for helmeted and non-helmeted cyclists inside and outside urban areas. We found that these probabilities became very similar inside urban areas during recent years, probably as a consequence of the increase of urban cycling in Spain, induced by the active policies of promotion developed in many Spanish cities.*

## 1.- INTRODUCTION

Early analyses of the effect of helmets on the safety of cycle traffic [Dorsch-1987, Thompson-1989] reported a dramatic reduction in head injuries for helmeted cyclists. Following those early analysis, some countries approved regulations enforcing cyclists to wear helmets. Thus, in the nineties, Australia, New Zealand and some provinces of Canada introduced regulations enforcing the use of helmets for all cyclist and, following this wave, other countries introduced regulations enforcing the use of helmets for some specific categories of cyclists (for instance children), or in some specific roads (for instance outside urban areas). However, none of the leader countries in cycling mobility, such as The Netherlands, Denmark or Germany, have introduced such kind of regulations. Instead, most Dutch experts, for instance, focus on developing specific infrastructures and campaigns in order to make cycling safer [CROW-2007] and disregard compulsory helmet regulations because they can discourage cycling, which is considered as an inherently healthy activity [de-Hartog-2010]. Moreover some studies, e.g. [Jacobsen-2003], have reported that safety of cyclists increases with the level of cycling, a concept called “safety in numbers” [Jacobsen-2003], and that compulsory helmet laws discourage cycling, e.g. [Robinson-2006], giving a net negative effect on cycle traffic safety. For this reason, the European Cyclist's Federation (ECF) actively opposes to compulsory helmet regulations [Küster-2010], and favor policies that improve cyclists safety without discouraging cycling or promoting a false perception of cycling as a risky activity.

Even if it is admitted that personal safety of cyclists is improved by the use of helmet, it is not apparent that compulsory cycling helmet regulations also improve overall cycling safety. The Netherlands, Denmark, Germany and most countries with high levels of cycling also have the lowest rates of cycling fatalities without any resource to such regulations [Pucher-2008, ECMT-2004], and there is no clear evidence of improved safety of cycle traffic in countries with compulsory cycling helmet regulations [Robinson-2006, Dennis-2013]. Moreover, at difference of driving a car or a motorbike, massive cycling is a healthy activity which contributes to improve public health [de-Hartog-2010]. Therefore, the discouraging effect of enforcing cyclists to wear helmets may affect the level of cycling and, therefore, have a negative impact on public health that may overcome its eventual positive impact on personal cyclists safety [Jacobsen-2003, de-Jong-

2012]. This effect would be even more negative for modern bike-sharing systems, whose users could be very effectively discouraged by compulsory helmet regulations [Fishman-2012, Rojas-Rueda-2011].

In Spain, cycle helmets became mandatory outside city boundaries in 2004, after a reform in the traffic code which also compelled using reflective clothes at night, as well as other minor measures aimed to the self-protection of cyclists against motorized traffic. It has been, therefore, a long period of time since then, wide enough to develop a meaningful analysis of the effects of such regulation on cyclists safety. Moreover, since helmet was not mandatory in urban zones, the effect of compulsory cycle helmets in non-urban roads can be compared with the evolution of cycling safety inside localities, in order to differentiate for the specific effects (if any) of helmet regulation and other measures aimed to cycling protection and/or promotion. The main aim of this paper is to develop such comparative analysis, which may add new evidence to the cycle helmet debate. This analysis becomes even more meaningful after the announcement made by the Spanish Minister of Internal Affairs about the possibility of making cycle helmet mandatory also in Spanish urban areas.

## 2.- METHODOLOGY

Traffic crashes involving cyclists, including the number of helmeted and non-helmeted cyclists inside and outside urban areas are well documented in Spain. The “Dirección General de Tráfico” (DGT) has continuously compiled a computerized database that contains information recorded by the traffic police at the scene of each crash occurred throughout the country since 1993, including information about damages, injuries, kind of vehicle and use of helmet, among other relevant features. The database includes all traffic crashes happened in roads subjected to traffic regulation, involving one or more injured people or material damages of any kind, and with at least one moving vehicle involved[1]. This database will be the main source of data for our analysis.

Along this analysis we will examine the evolution of pre- and post-law rates of Killed and Seriously Injured (KSI) cyclists inside and outside urban areas in Spain. Post-law changes in the evolution of the total number of KSI cyclists are expected if some effectiveness is assumed for compulsory helmet regulations. Moreover, since such regulation only applies outside urban boundaries, different post-law trends for KSI cyclists inside and outside these boundaries can be expected as a consequence of this difference. Since these changes may also depend on a general change of trend in the overall safety of traffic (as a consequence, for instance, of other regulations introduced during the same period), the trend for KSI cyclists should be compared with the trends for other users of the road before to reach any conclusion. Specifically, we will compare the trends for KSI cyclists and KSI car occupants (driver and passengers), which are the main group of traffic victims in Spain. In order to double check our conclusions, the analysis will be performed for all kind of injuries and for head injuries only.

Since helmets are not intended to prevent crashes, but its worse consequences, an useful tool in order to analyze helmet's effectiveness is the probability of being KSI for cyclists already involved in a crash. These probabilities can be computed for helmeted, P(c-h-KSI), and non-helmeted, P(c-nh-KSI), cyclists as:

$$P(c\text{-}h\text{-}KSI) = N(c\text{-}h\text{-}KSI)/N(c\text{-}h)\ ; \quad P(nh) = N(c\text{-}nh\text{-}KSI)/N(c\text{-}nh) \qquad (1)$$

where N(c-h-KSI) and N(c-nh-KSI) are the total number of helmeted/non-helmeted KSI cyclists and N(c-h)/N(c-nh) the total number of helmeted/non-helmeted cyclists involved in a crash. If helmets have some measurable statistical effect P(c-h-KSI) and P(c-nh-KSI) should be different

1 Orden de 18 de Febrero de 1993. Boletín Oficial del Estado 24 de febrero de 1993.

along a meaningful series of years and for the different scenarios.

Some authors have argued that helmeted cyclists may have a false perception of safety, a phenomenon known as “risk compensation” [Adams-2001], although the validity of this concept for Spanish cyclists has been questioned [Lardelli-Claret-2003]. Others have reported that motorists may behave in a different way when they approach helmeted and non helmeted cyclists, and that this different behavior increases the risks for helmeted cyclists [Walker-2007]. There are no, as far as we know, any scientific paper reporting a lower probability of being involved in a crash for helmeted cyclists than for non-helmeted cyclists. Therefore, we should admit that the probability of suffering a traffic crash for helmeted cyclists, P(c-h), should be high or, as less, equal to the probability of suffering a crash for non-helmeted cyclists, P(c-nh). Therefore, the ratio between the probabilities of being KSI for helmeted and non-helmeted cyclists already involved in a crash, P(c-h-KSI)/P(c-nh-KSI), should be a lower limit of the overall probability of being KSI for helmeted and non-helmeted cyclists P(h-KSI)/P(nh-KSI):

$$P(h\text{-}KSI)/P(nh\text{-}KSI) = P(c\text{-}h)/P(c\text{-}nh) \cdot P(c\text{-}h\text{-}KSI)/P(c\text{-}nh\text{-}KSI) \geq P(c\text{-}h\text{-}KSI)/P(c\text{-}nh\text{-}KSI) \quad (2)$$

Since compulsory helmet regulations are based on the assumption of a lower probability of being KSI for helmeted cyclists than for non helmeted cyclists, a necessary condition for the effectiveness of such laws is:

$$1 > P(c\text{-}h\text{-}KSI)/P(c\text{-}nh\text{-}KSI) \quad (3)$$

## 3.- RESULTS

The data series about the total number of helmeted and non-helmeted cyclist involved in the different kind of crashes during the period 1993-2010, as it comes out from the DGT database, are shown in the Appendix. The most salient feature is a steady decline of the number of KSI cyclists, regardless of the period (after and before 2004) and of the location (inside or outside urban areas). This steady decline is also apparent for KSI cyclists with head injuries, regardless of the period and the location of the crash. The increase in the rate of crashed helmeted cyclists outside urban areas can be attributed to the effect of the compulsory helmet law, although it is remarkable the high number of non-helmeted cyclists many years after the law was passed. Another salient feature of the data is the fast growth of the number of minor accidents inside urban areas during last years, mainly after 2006. This growth can be related to an increase of urban cycling as a consequence of the active policies of urban cycling promotion which have been taken place in many Spanish cities[2]. It is also remarkable the relatively small number of non-helmeted KSI cyclists with head injuries inside urban areas during the last years (about two tens each year). Since they are the main target of the announced new helmet regulation in Spain, it is worthy to point out this fact.

Following our methodology, we first analyze the evolution of the number of KSI cyclists inside and outside urban areas, and compare such evolution with this evolution for other meaningful users of the road. For this purpose we choose car occupants (drivers and passengers) which are the main group of traffic crash victims in Spain. Fig.1 shows in arbitrary units (1993=100)[3] the number of KSI cyclists inside and outside urban areas, as well as th number of KSI car occupants outside urban areas during the period 1993-2010.

2 The city of Sevilla has been recently scored as the fourth bike friendly city in the world by http://copenhagenize.eu/ and Barcelona was rated as the third most bike friendly city in the previous index (2011). Other Spanish cities with successful active policies of urban cycling promotion are San Sebastián, Vitoria, Valencia, Alicante and Zaragoza, among others.

3 The starting actual numbers in 1993 are: KSI cyclists outside urban areas 631, KSI cyclists inside urban areas 485, KSI car occupants outside urban areas: 3321

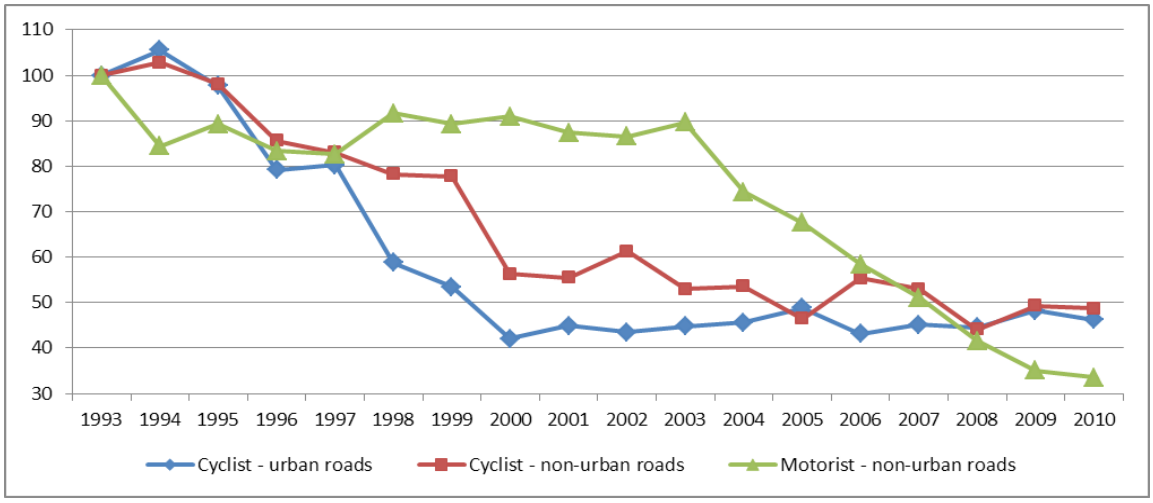


Fig. 1: Total numbers of KSI cyclists in urban and non urban areas, and total number of KSI car occupants outside urban areas in Spain. Absolute units (1993=100).

As it can be seen in the Figure, there is no a clear change in the trend for KSI cyclists outside urban areas after the helmet law was passed (2004). Moreover, there are not many differences between the trends for KSI cyclists inside and outside urban areas after this date. These features are in sharp contrast with the evolution of KSI car occupants, which show a salient change of slope after 2004. This change of slope can be attributed to other measures included in the reform of the traffic code (the "Reglamento General de Circulacion") which also takes place in 2004, such as more restrictive regulations for safety belts, maximum alcohol rates, driving license by points, etc... We can conclude that the introduction of compulsory cycle helmets outside urban areas in 2004 has not shown positive effects on the safety of cyclists comparable to those shown by other contemporary reforms intended to improve the safety of car occupants.

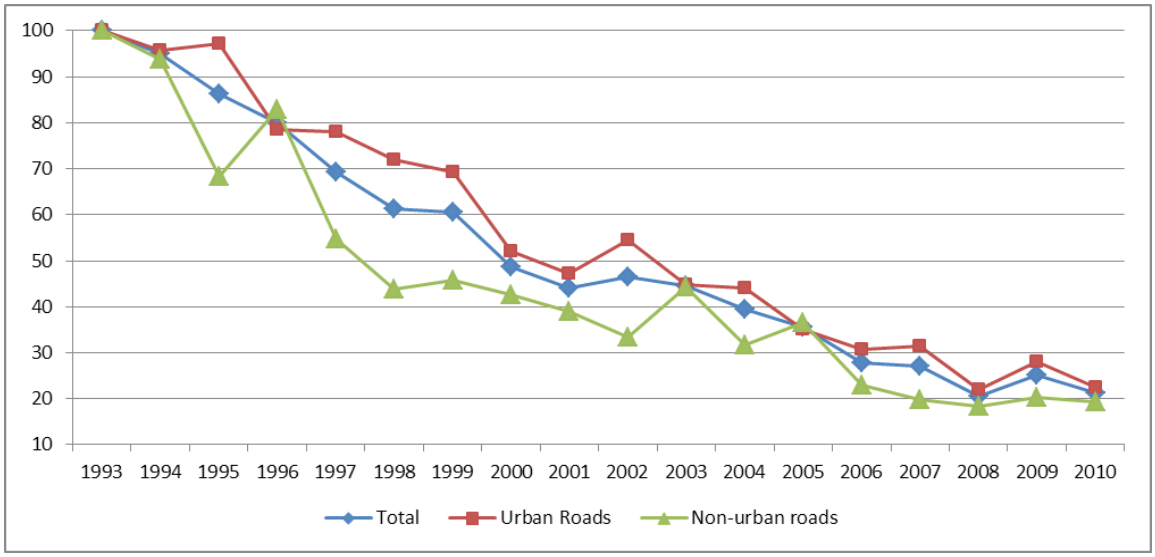


Fig. 2: Numbers of KSI cyclists with head injuries in all roads and in roads inside and outside urban areas. Arbitrary units (1993=100)

Since cycle helmets are mainly intended to the prevention of head injuries, it is worthy to analyze the evolution of the number of KSI cyclists with such kind of injuries involved in traffic crashes, and compare these numbers for roads outside urban areas, where helmet is compulsory, with such number in roads inside urban areas, where helmet is not compulsory. This comparison is shown in Fig. 2, where the evolution of the absolute numbers of KSI cyclists with head injuries inside and

outside urban areas is shown in arbitrary units (1993=100)[4]. The general conclusion arising from the graphics of this Figure is fully consistent with the conclusions drawn from the analysis of the previous Figure. It can not be observed any empirical evidence of any substantial change in the trend for the number of KSI cyclists with head injuries after and before 2004. Moreover, there are not substantial differences for these trends inside and outside urban areas in the whole period 1993-2004.

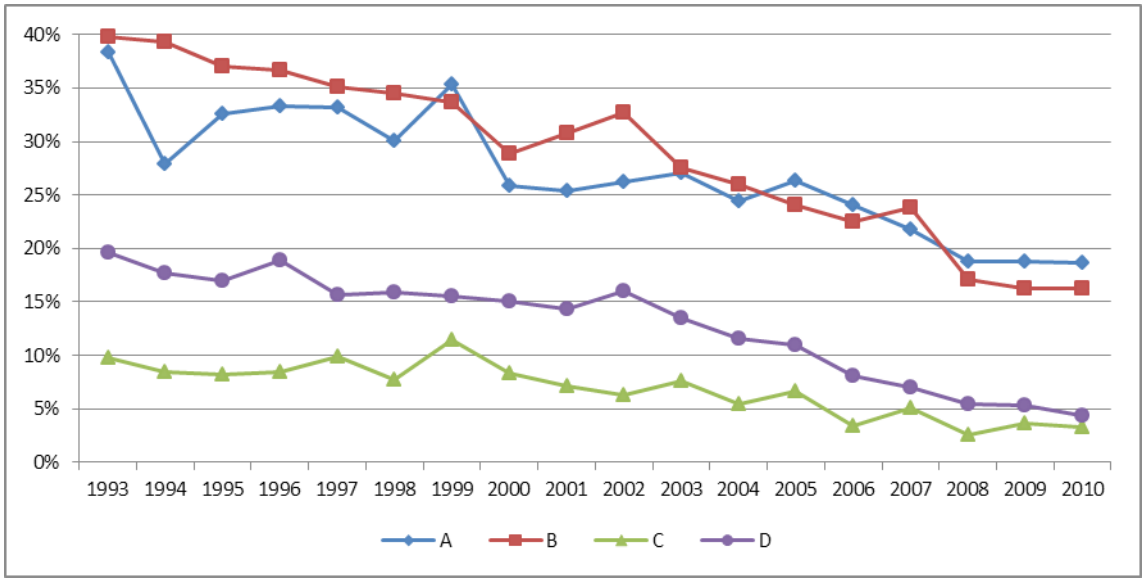


Fig. 3: All roads: Percent of helmeted KSI cyclists over the total number of helmeted cyclists involved in a crash (A). Percent of non-helmeted KSI cyclists over the total number of non-helmeted cyclists involved in a crash (B). Percent of helmeted KSI cyclists with head injuries over the total number of helmeted cyclists involved in a crash (C). Percent of non-helmeted KSI cyclists with head injuries over the total number of helmeted cyclists involved in a crash (D).

Let us move now to the determination of the probabilities P(c-h-KSI) and P(c-nh-KSI) defined in the previous section. The evolution of the probability of being killed or seriously injured for helmeted P(c-h-KSI) and non-helmeted P(c-nh-KSI) cyclists already involved in a traffic crash is shown in Fig. 3 as the percent of KSI cyclists over the total number of crashed cyclists. The figure include data about KSI cyclists and about KSI cyclists with head injuries. The evolution of the probabilities is very similar, with a common decline to lower values. For all kind of KSI cyclists (graphics A and B) there is almost no difference between helmeted and non-helmeted cyclists, except for some peaks at the beginning of the series. For head injured KSI cyclists, however, there is a big difference at the early years in favor oh helmeted cyclists, which monotonically decline to negligible values in recent years.

It is worthy to disaggregate the data shown in Fig. 3 for urban and non urban roads. The data for non urban roads are shown in Fig. 4 while the data for urban roads are shown in Fig. 5. The data in Fig. 4 show an almost constant difference in favor of helmeted cyclists, P(c-h-KSI)<P(c-nh-KSI), for both categories of all injured KSI and head injured KSI cyclists. However, the data of Fig. 5 show that this difference only appears at the beginning of the series, and then monotonically declines to the meaningless values of recent years. This behavior can be related with the efforts recently made in many Spanish cities in order to promote safer cycling by the implementation of bike paths and traffic calming, which are useful for both helmeted and non-helmeted cyclists. As it was already mentioned, these efforts could have caused a fast growth in the number of urban cyclists and, accordingly to the “safety in numbers” concept [Komanoff-2001, Jacobsen-2003],

4 The starting numbers in 1993 are: All roads 512, non urban roads 320, urban roads 192.

safer cycling conditions. These safer cycling conditions may have made helmets statistically irrelevant for the safety of urban cycling, as it is shown in Fig. 5 for the most recent years.

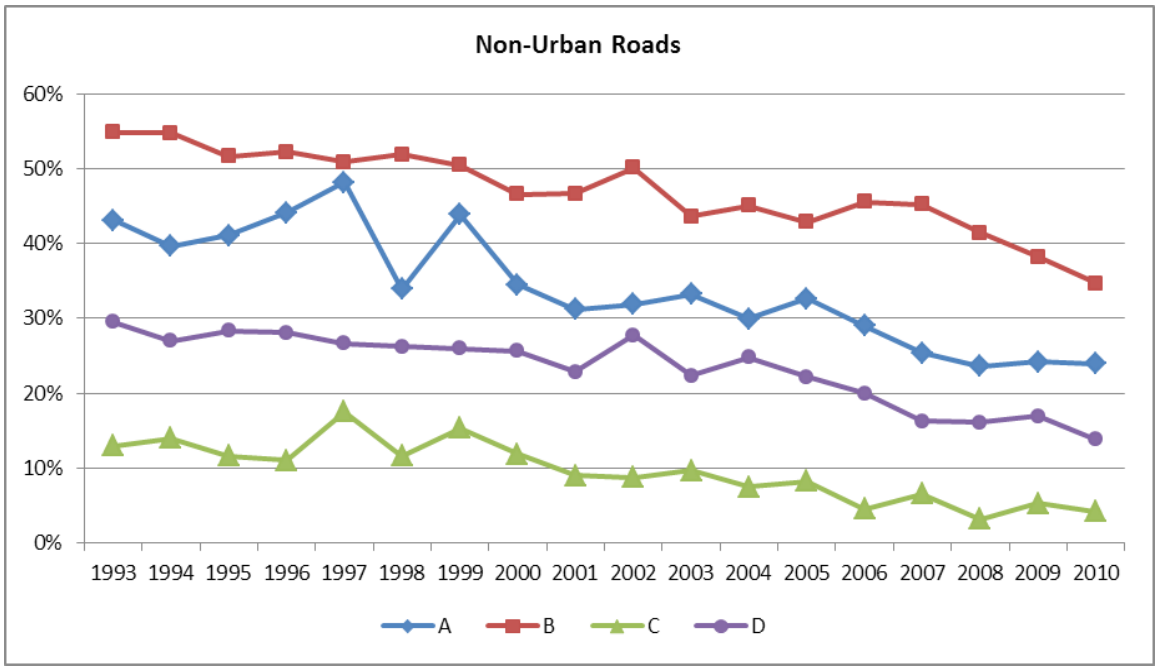


Fig. 4: Non urban roads: Percent of helmeted KSI cyclists over the total number of helmeted cyclists involved in a crash (A). Percent of non-helmeted KSI cyclists over the total number of non-helmeted cyclists involved in a crash (B). Percent of helmeted KSI cyclists with head injuries over the total number of helmeted cyclists involved in a crash (C). Percent of non-helmeted KSI cyclists with head injuries over the total number of helmeted cyclists involved in a crash (D).

Regarding compulsory helmet regulation, the previous analysis only justifies its application in non urban roads, because only in such roads Eq. 3 is fulfilled[5], as it is shown in Fig. 4. Inside urban areas, the probability of suffering any kind of serious accident, including a serious head accident, is presently the same for helmeted and non-helmeted cyclists (see Fig. 5), and therefore there is no justification for making helmets compulsory. In fact, it can be asked if, without compulsory helmets in non urban roads, cycle crashes would not have evolved in a similar way as in urban roads, turning helmets irrelevant for cycling safety and making compulsory helmet regulation uneffective.

## CONCLUSIONS

Cycle helmet are compulsory in non urban Spanish roads since 2004, while they are not compulsory inside urban areas. In order to elucidate the effects of this regulation we have analyzed the evolution of the total number of cyclists which have been killed or have suffered serious injuries as a consequence of traffic crashes in Spain during the period 1993-2010. The analysis has been developed for all kind of killed or seriously injured (KSI) cyclists, and for KSI cyclist with head injuries only. In both cases we have not observed any empirical evidence of any positive effect of this regulation beyond the baseline trend showing a monotonically decline of the total number of KSI cyclists. Specifically, we have not observed any meaningful difference in this decline rate for non urban roads after and before helmets became compulsory (2004). This behavior is in sharp contrast with the behavior of the total number of KSI car occupants, which shows a clear change of

5 This statement, however, neglects other meaningful considerations, derived from the discouraging of cycling coming from compulsory helmet regulations and their subsequent negative effects on public health, which may overcome the possible positive effects on cycle traffic safety [de-Jong-2012].

slope in 2004, which can be interpreted as a consequence of the introduction of more restrictive regulations affecting car drivers in 2004 and after. Moreover, we have not observed any meaningful difference between the aforementioned decline rates for cyclists in non-urban roads (where helmets are compulsory) and in urban roads (where helmets are not compulsory), nor before nor after 2004.

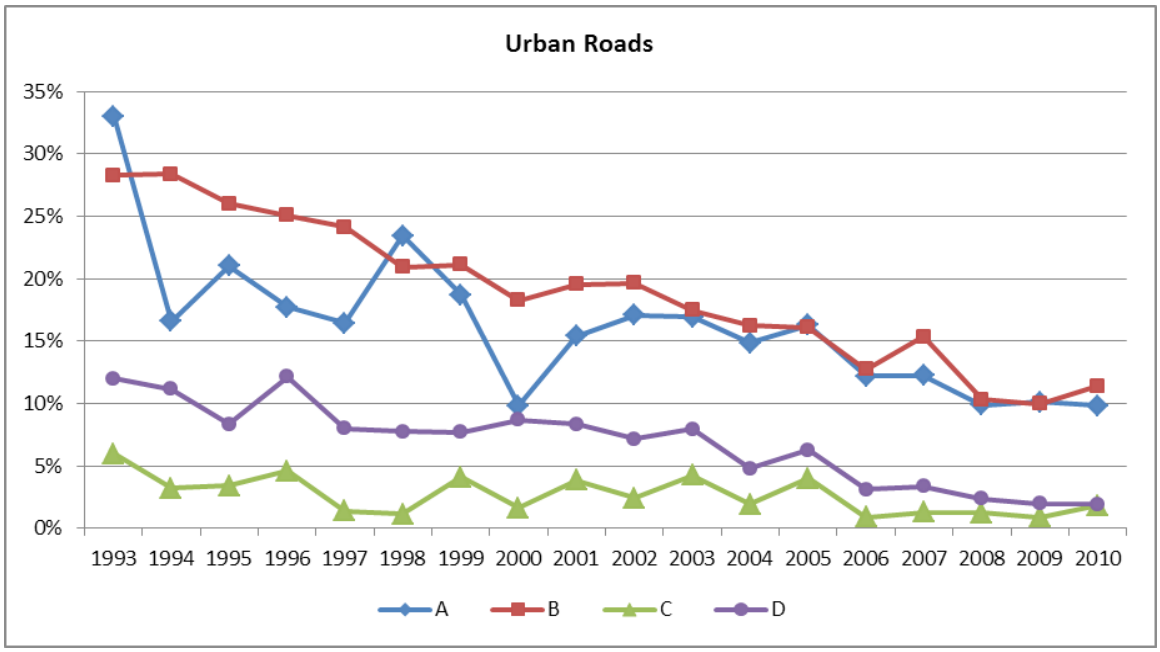


Fig. 5: Urban roads: Percent of helmeted KSI cyclists over the total number of helmeted cyclists involved in a crash (A). Percent of non-helmeted KSI cyclists over the total number of non-helmeted cyclists involved in a crash (B). Percent of helmeted KSI cyclists with head injuries over the total number of helmeted cyclists involved in a crash (C). Percent of non-helmeted KSI cyclists with head injuries over the total number of helmeted cyclists involved in a crash (D).

We have also analyzed the percent of helmeted and non-helmeted cyclists which have been killed or have suffered serious injuries (all kind of injuries and head injuries only) over the total number of helmeted and non-helmeted cyclists involved in traffic crashes. This percent can be interpreted as the “probability” of being filled or seriously injured for a cyclist already involved in a crash. From this analysis follows that in non-urban roads there is an almost constant lower probability of being killed or seriously injured for helmeted cyclists than for non-helmeted cyclists. However, in urban areas this difference between helmeted and non-helmeted cyclists shows a monotonically decline towards meaningless values during last years. We interpret this behavior as a consequence of the efforts made in many Spanish cities in order to promote urban cycling making it safer. These efforts seem to have substantially increased the number of urban cyclists as well as the safety of cycling for both helmeted and non-helmeted cyclist, thus making the use of helmets statistically irrelevant for cycling safety. We feel that our result question the usefulness of compulsory helmet regulations, mainly in urban areas, where other policies, such as building of cycling infrastructure or traffic calming, can provide similar or higher protection without discouraging cycling.

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# APPENDIX

| | | Cyclists involved in a traffic crash | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Non-Urban Roads | | | | Urban Roads | | | |
| | TOTAL | Total | Helmeted | Non-Helmeted | Unknown | Total | Helmeted | Non-Helmeted | Unknown |
| 1993 | 3045 | 1191 | 116 | 994 | 81 | 1854 | 100 | 1294 | 460 |
| 1994 | 3259 | 1239 | 179 | 943 | 117 | 2020 | 187 | 1315 | 518 |
| 1995 | 3209 | 1259 | 241 | 931 | 87 | 1950 | 176 | 1237 | 537 |
| 1996 | 2860 | 1094 | 254 | 749 | 91 | 1766 | 175 | 1005 | 586 |
| 1997 | 2873 | 1063 | 245 | 720 | 98 | 1810 | 219 | 1024 | 567 |
| 1998 | 2609 | 1106 | 301 | 706 | 99 | 1503 | 175 | 904 | 424 |
| 1999 | 2400 | 1038 | 333 | 620 | 85 | 1362 | 171 | 833 | 358 |
| 2000 | 2207 | 873 | 336 | 468 | 69 | 1334 | 183 | 773 | 378 |
| 2001 | 2294 | 875 | 311 | 478 | 66 | 1419 | 182 | 671 | 522 |
| 2002 | 2364 | 923 | 333 | 519 | 71 | 1441 | 205 | 683 | 553 |
| 2003 | 2382 | 861 | 310 | 479 | 72 | 1521 | 189 | 756 | 576 |
| 2004 | 2624 | 922 | 441 | 420 | 61 | 1702 | 256 | 818 | 628 |
| 2005 | 2482 | 834 | 435 | 329 | 70 | 1648 | 276 | 783 | 589 |
| 2006 | 2647 | 1025 | 555 | 356 | 114 | 1622 | 230 | 841 | 551 |
| 2007 | 2866 | 1099 | 623 | 345 | 131 | 1767 | 237 | 866 | 664 |
| 2008 | 3132 | 999 | 593 | 273 | 133 | 2133 | 324 | 969 | 840 |
| 2009 | 3665 | 1196 | 714 | 301 | 181 | 2469 | 445 | 1052 | 971 |
| 2010 | 3828 | 1246 | 832 | 260 | 154 | 2582 | 489 | 993 | 1089 |

Table I: Total number of helmeted and non-helmeted cyclists involved in a traffic crash inside and outside urban areas in Spain.

| | | Killed +Seriously Injured (KSI) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Non-Urban Roads | | | | Urban Roads | | | |
| | TOTAL | Total | Helmeted | Non-Helmeted | Unknown | Total | Helmeted | Non-Helmeted | Unknown |
| 1993 | 1116 | 631 | 50 | 545 | 36 | 485 | 33 | 366 | 86 |
| 1994 | 1161 | 649 | 71 | 516 | 62 | 512 | 31 | 373 | 108 |
| 1995 | 1093 | 619 | 99 | 481 | 39 | 474 | 37 | 322 | 115 |
| 1996 | 924 | 540 | 112 | 391 | 37 | 384 | 31 | 252 | 101 |
| 1997 | 913 | 524 | 118 | 366 | 40 | 389 | 36 | 247 | 106 |
| 1998 | 779 | 494 | 102 | 366 | 26 | 285 | 41 | 189 | 55 |
| 1999 | 750 | 491 | 146 | 313 | 32 | 259 | 32 | 176 | 51 |
| 2000 | 559 | 355 | 116 | 218 | 21 | 204 | 18 | 141 | 45 |
| 2001 | 568 | 350 | 97 | 223 | 23 | 218 | 28 | 131 | 56 |
| 2002 | 598 | 387 | 106 | 260 | 21 | 211 | 35 | 134 | 42 |
| 2003 | 551 | 334 | 103 | 209 | 22 | 217 | 32 | 132 | 53 |
| 2004 | 559 | 338 | 132 | 189 | 17 | 221 | 38 | 133 | 50 |
| 2005 | 530 | 293 | 142 | 141 | 10 | 237 | 45 | 126 | 66 |
| 2006 | 558 | 349 | 161 | 162 | 26 | 209 | 28 | 107 | 74 |
| 2007 | 553 | 334 | 158 | 156 | 20 | 219 | 29 | 133 | 57 |
| 2008 | 494 | 278 | 140 | 113 | 25 | 216 | 32 | 100 | 84 |
| 2009 | 545 | 311 | 173 | 115 | 23 | 234 | 45 | 105 | 84 |
| 2010 | 531 | 307 | 199 | 90 | 18 | 224 | 48 | 113 | 63 |

Table II: Total number of helmeted and non-helmeted KSI cyclists involved in a traffic crash inside and outside urban areas in Spain.

| Head | | Killed +Seriously Injured (KSI) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Non-Urban Roads | | | | Urban Roads | | | |
| | TOTAL | Total | Helmeted | Non-Helmete | Unknown | Total | Helmeted | Non-Helmete | Unknown |
| 1993 | 512 | 320 | 15 | 293 | 12 | 192 | 6 | 155 | 31 |
| 1994 | 486 | 306 | 25 | 254 | 27 | 180 | 6 | 147 | 27 |
| 1995 | 442 | 311 | 28 | 264 | 19 | 131 | 6 | 103 | 22 |
| 1996 | 410 | 251 | 28 | 210 | 13 | 159 | 8 | 122 | 29 |
| 1997 | 355 | 250 | 43 | 192 | 15 | 105 | 3 | 82 | 20 |
| 1998 | 314 | 230 | 35 | 185 | 10 | 84 | 2 | 70 | 12 |
| 1999 | 310 | 222 | 51 | 161 | 10 | 88 | 7 | 64 | 17 |
| 2000 | 249 | 167 | 40 | 120 | 7 | 82 | 3 | 67 | 12 |
| 2001 | 226 | 151 | 28 | 109 | 9 | 75 | 7 | 56 | 12 |
| 2002 | 238 | 174 | 29 | 144 | 1 | 64 | 5 | 49 | 10 |
| 2003 | 228 | 143 | 30 | 107 | 6 | 85 | 8 | 60 | 17 |
| 2004 | 202 | 141 | 33 | 104 | 4 | 61 | 5 | 39 | 17 |
| 2005 | 182 | 112 | 36 | 73 | 3 | 70 | 11 | 49 | 10 |
| 2006 | 142 | 98 | 25 | 71 | 2 | 44 | 2 | 26 | 16 |
| 2007 | 139 | 101 | 41 | 56 | 4 | 38 | 3 | 29 | 6 |
| 2008 | 105 | 70 | 19 | 44 | 7 | 35 | 4 | 23 | 8 |
| 2009 | 129 | 90 | 38 | 51 | 1 | 39 | 4 | 21 | 14 |
| 2010 | 109 | 72 | 35 | 36 | 1 | 37 | 9 | 19 | 9 |

Table III: Total number of helmeted and non-helmeted KSI cyclists with head injuries[6] involved in a traffic crash inside and outside urban areas in Spain.

6 Excluding neck and face injuries.

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