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ORIGINAL ARTICLE

Targeted prevention of road traffic deaths in Greece: a multifactorial 5-year census-based study

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Abstract

Background Between 2012 and 2016**,** Greece suffered yearly more than 800 deaths from road traffic incidents (RTIs), holding one of the worst performances in the European Union for RTI-related deaths per population. Our primary aim is to identify risk factors associated with mortality to set a targeted policy framework on road safety.

Methods This is a retrospective analysis of data collected prospectively from Traffic Police. A correlation of 29 factors with adult drivers' mortality was made, applying multivariate logistic regression models. At a second stage, a scoping literature review identified the best possible targeted prevention measures.

Results A total of 93,019 drivers with a mean age of 42.2 ± 0.1 years were recorded, of which 2772 (3%) died. Age above 65 (aOR 3.1, $p < 0.001$), non-use of seatbelt (aOR 8.2, $p < 0.001$) or helmet (aOR 2.85, $p < 0.001$) and alcohol consumption (aOR 3.3 for cars, 4 for motorbikes, $p < 0.001$) were the driver-related parameters with the strongest correlation with a fatal outcome. Drivers' behavior with specific high-risk maneuvers increased odds of death 2–4 times, depending on vehicle type. One-lane, rural road network was the environmental factor with the most significant impact. Based on the results of the analyses, our scoping review identified and suggested 23 specific measures for the Greek government and policymakers to examine.

Conclusion Human-related factors were the parameters with the strongest impact on mortality after an RTI in Greece. These findings demonstrate an educational gap that must be primarily addressed with the introduction of missing road safety education in schools and an intensified and innovative population awareness campaign.

Keywords Road traffic incident · Accident prevention · Mortality · Road safety

Introduction

Trauma is a leading cause of death worldwide [1]. In Greece, road traffic incidents (RTIs) and falls almost equally account for as much as 75% of trauma [2]. RTIs, however, cause 60% of severe injuries (Injury Severity Score > 15), the majority of patients dead on arrival (DOA) [3] and have a large socioeconomic impact, affecting a much younger group of the population compared to falls. Reports suggest that more than half of RTI deaths occur within the first 1.5 h from the incident [4, 5]. Therefore, injury prevention is an integral part of road safety provision and campaigns in European countries have helped to reduce the burden from RTI-related trauma deaths.

Greece has made substantial steps in the road safety provision and managed to gradually improve from 18.1 deaths per 100,000 population in 1991 to a death rate of 7.6 per 100,000 inhabitants in 2016. However, this performance

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is still far from desirable, as Greece remains within the top five of the list of RTIs fatalities' rate per population among the 28 EU countries (Fig. 1). This downward trend reached a plateau the last few years with an 8% decrease in the number of incidents but a small mortality increase of 0.5%. Currently, Greece does not have a trauma system with an associated registry and injury prevention program [6]. In the absence of these, RTI data to support the need for injury prevention can only be accessed by the Traffic Police (TP). To date, these data have never been analyzed in-depth and the characteristics of those involved in RTIs in Greece are currently unknown. Furthermore, the key factors associated with mortality after an RTI are unreported and it is not clear which parameters (human, road/environmental or vehicle-related) require urgent targeted prevention interventions (Fig. 2).

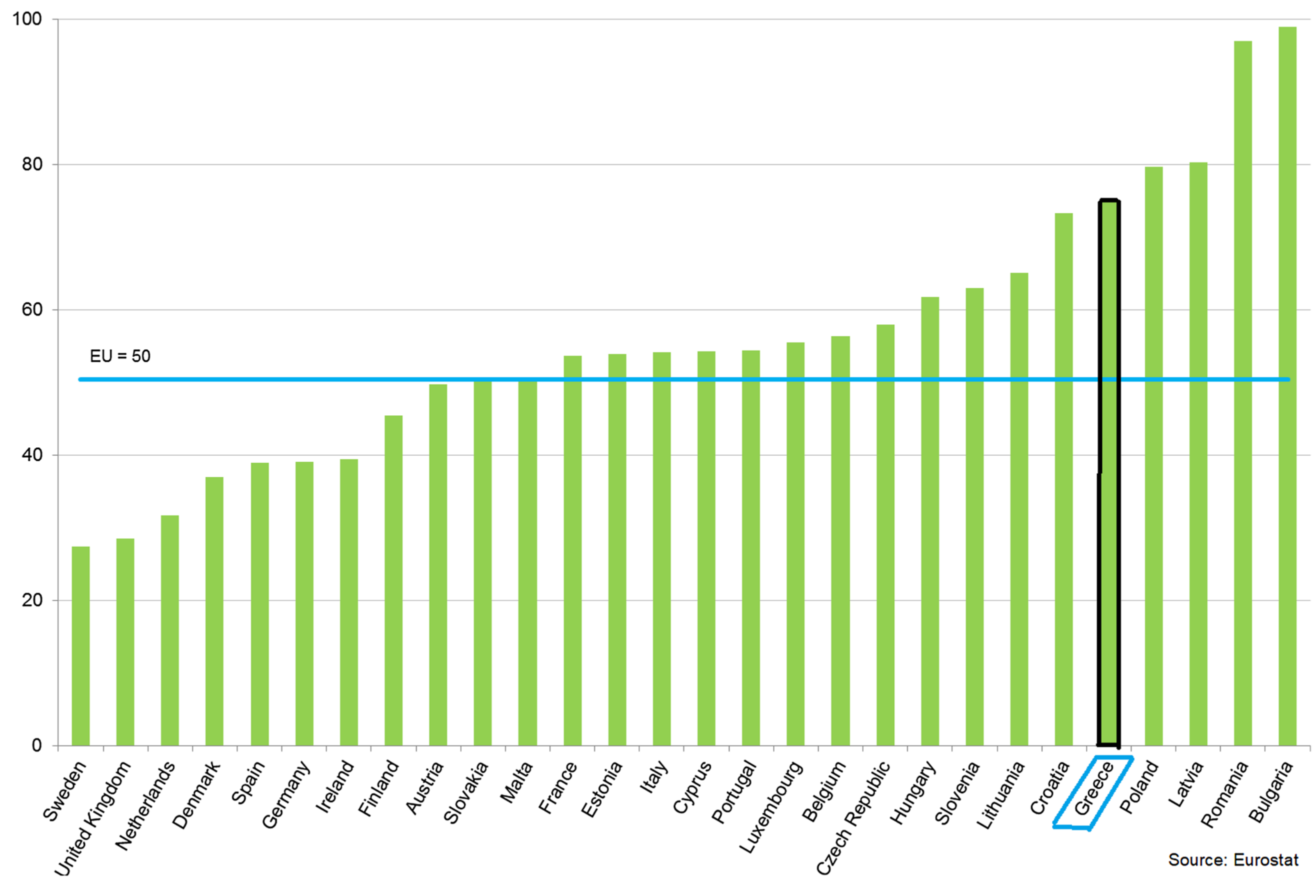
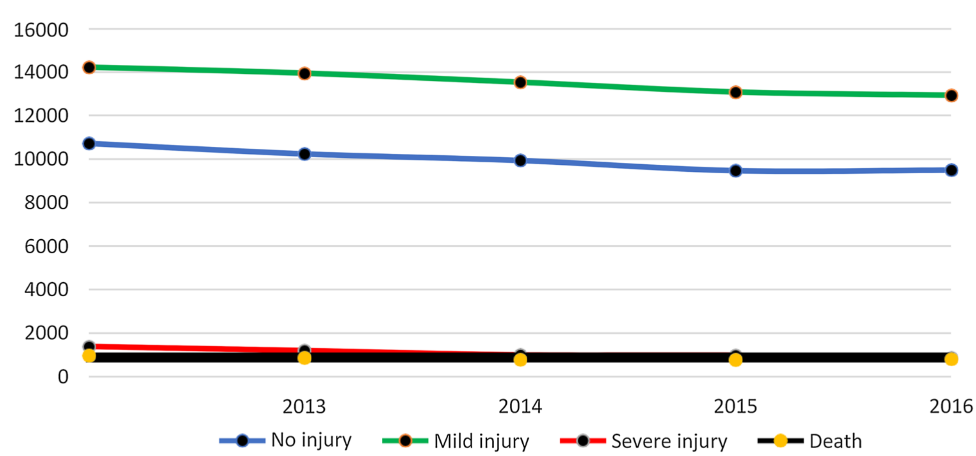


Fig. 1 Road traffic fatalities per million inhabitants in the EU member states, 2016. (Source: Eurostat)

Fig. 2 Severity of outcome of participants in all officially recorded RTIs in Greece between 2012 and 2016 [7]



The primary aim of this study, therefore, is to utilize the census data to describe the demographics and epidemiological characteristics of the driving population involved in an RTI in the Greek region during the 5-year period (2012–2016). Secondly, to identify those risk factors that are associated with increased RTI mortality to plan targeted prevention with changes in laws, policies and traffic controls, as well as enhanced public education and awareness.

Materials and methods

Data sources

Raw data regarding the total of RTIs from 2012 to 2016 in the Hellenic region were granted with a special permission from the Hellenic Statistical Authority (ELSTAT) [7]. This is the most up-to-date 5-year period available, as 2017 data were not yet published at the study planning stage. All data are based on standardized forms collected prospectively and systematically on the scene from the TP and are subject to a 30-day follow-up of injured participants' health status without a distinction between on-scene and delayed deaths within TP records.

Every driver involved in an RTI is included in this database, irrespective of the outcome. Exceptions were low energy incidents that may have caused no injuries and minor or no vehicle damage and for which TP was not present on-scene. Injuries are classified by the TP as mild or severe (which required hospitalization), with no clinical criteria recorded.

The dataset contained 58,955 incidents, including 100,043 vehicles. The 29 variables included were grouped into the human, vehicle, road and environmental/crash factors. The outcome was 30-day mortality. Weekend was defined as Friday from 18:00 to Sunday at 23:59 and seven national holidays throughout the year were included. We chose to use a zero-tolerance level of blood alcohol with concentrations varying widely in participants. Therefore, a BAC of 0.01 was considered as a positive test, while laws currently enforce a limit at 0.05.

Statistical analysis

Excel spreadsheets were entered and merged in the STATA 15 statistical package and each variable examined for missing data and errors. Chi-squared and ANOVA tests were used for categorical and continuous variables respectively. Post hoc analyses with adjusted residuals were used to determine which categories of a variable were mostly responsible for its p value. The level of significance was set at 0.01 due to the very large number of observations which could lead to amplification of insignificant effects (Type I error).

Multivariate logistic regression analyses were performed to correlate the independent factors with death in adult drivers. Participants with missing data were excluded from the multivariate analysis. All variables were initially entered into each model for car and motorbike drivers ("Appendix"). We then excluded those factors showing little or no association in a stepwise manner. A significance level of 0.1 for inclusion and 0.05 for exclusion from the logistic regression model was used. After each exclusion or addition, models were compared to each other with likelihood-ratio tests and Akaike and Bayesian information criterion (AIC/BIC) to establish goodness of fit and minimization of information loss [8]. Separate analyses were run for car and 2-wheel vehicle drivers.

This was a retrospective study of prospectively collected data, approved by ELSTAT ethics committee. All data are anonymous with unique identification numbers that cannot be matched to individuals. Website and less important references can be found in the bibliography in the "Appendix".

Results

During this 5-year period, there were 93,019 driver-related RTIs recorded. Mean age was 42.2 years old for all drivers and those who died were older by 4 years. In a subgroup analysis, people aged 65 years or greater had a threefold probability of a fatal outcome (aOR 3.1, 2.1–4.6, 99%CI) compared to the 18–35 age group. 4 out of 5 were males, nine out of ten had a Hellenic nationality. Cars accounted for more than half of RTIs (55%) and motorbikes for a third (35%). Compared to cars, bicycles and motorcycles > 116 cc had a fivefold and threefold probability for a fatal outcome respectively. Approximately one-quarter of all cars involved in an RTI each year were manufactured prior to 2000.

Overall mortality was low at 3.0%, almost half of the cohort had no injuries (48.4%), whilst 44.8% had mild injuries and severe injuries affected 3.8%. Regarding modifiable human factors, almost a tenth of the population were positive for alcohol (8%), only two-thirds of motorcyclists wore helmets and 87% of car drivers had fastened a seatbelt, but with high unknown rates (around 40%) (Tables 1, 2, 3).

The strongest risk factors for crude mortality were non-use of seatbelts (RR 13.2, OR 15.2) or helmets (RR 4.4, OR 4.8) and a positive test for alcohol consumption (RR 7.1, OR 7.5). These factors remained the most significant determinants in multivariate analysis, with non-seatbelt use carrying an eightfold increased risk (aOR 8.2, 5.6–12.2, 99%CI) (Table 4). Alcohol consumption presented a threefold to fourfold risk for different categories, worse for 2-wheel drivers. Subgroup analysis of Blood Alcohol Content (BAC) showed that levels between 0.01% and 0.1% raised the probability of death by almost half ($p = 0.03$), while BAC

Table 1 Comparison of the driver-related characteristics of the two groups (alive vs fatally injured drivers) under investigation after an RTI in Greece (2012–2016)

Independent variables	Alive drivers	Fatally injured drivers	*p* value*	Fatal (%)	Crude RR
Number of participants (drivers only)	90,247	2772		3.0	
	N [%]	*N* [%]			
Driver-related factors					
Age	42.1 ± 0.1	**46.1 ± 0.7**	< 0.001		
Gender					
Male	74,313 [82.3]	**2594 [93.6]**	< 0.001	3.4	
Female	15,929 [17.7]	*178 [6.4]*		1.1	0.3
Seatbelt use					
Yes (for car drivers alone)	27,377 [88.6]	304 [33.8]	< 0.001	1.1	
No use	3525 [11.4]	**596 [66.2]**		14.5	13.2
Unknown	26,284	463		1.7	
Helmet use					
Yes (for motorbike drivers)	15,142 [71.1]	352 [33.9]	< 0.001	2.3	
No use	6157 [28.9]	**687 [66.1]**		10.0	4.4
Unknown	10,920	280		2.5	
Result of alcohol test					
Positive (> 0.1 g/lt)	4922 [7.5]	**321 [37.9]**	< 0.001	6.1	7.1
Negative	60,278 [92.5]	526 [62.1]		0.9	
Not performed	25,042	1925		7.1	
Nationality					
Hellenic	81,056 [89.8]	2472 [89.2]	0.27	3.0	
Foreign	9191 [10.2]	300 [10.8]		3.2	1.1
Left-hand drive country origin					
Yes	749 [0.8]	33 [1.2]	0.04	4.2	1.4
No	89,493 [99.2]	2739 [98.8]		3.0	
Tourist					
Yes	7548 [8.4]	**457 [16.5]**	< 0.001	5.7	2.1
No	82,699 [91.6]	2315 [83.5]		2.7	
Foreign tourist					
Yes	1401 [1.6]	**63 [2.3]**	0.003	4.3	1.5
No	88,846 [98.4]	2709 [97.7]		3.0	
Vehicle-related factors					
Vehicle type			< 0.001		
Car	50,368 [55.8]	*1182 [42.6]*		2.3	
Bus	1253 [1.4]	*3 [0.1]*		0.2	
Lorry/truck	5564 [6.2]	178 [6.4]		3.1	
Bicycle	903 [1.0]	**71 [2.6]**		7.3	
Moped/Motorbike < 115 cc	7316 [8.1]	**313 [11.3]**		4.1	
Motorcycle > 116 cc	24,000 [26.6]	**935 [33.7]**		3.7	
Other	843 [0.9]	**90 [3.2]**		9.6	
Car engine's cubics capacity ≥ 2000 cc	2354 [5.4]	54 [5.2]	0.84	2.2	1.0
< 2000 cc	41,570 [94.6]	982 [94.8]		2.3	
Year of vehicle release before 2000	19,246 [25.1]	**813 [34.5]**	< 0.001	4.1	1.6
Year after 2000	57,581 [74.9]	1546 [65.5]		2.6	

Fatal (%): fatality rate; percentage of deaths among all drivers in each category

Adjusted residuals z values are used to see which cells are contributing the most to the p value. Categories with a z value greater than $|2.54|$ ($p < 0.001$) are presented in bold (observed frequency greater than expected) and in italic for (less than expected)

*p value for t-test (age) or chi-squared test

Table 2 Comparison of the environmental and road-related factors of the two groups (alive vs fatally injured drivers) under investigation after an RTI in Greece (2012–2016)

Independent variables	Alive drivers	Fatally injured drivers	*p* value*	Fatal (%)	Crude RR
Environmental factors					
Year of incident			0.09		
2012	18,768 [20.8]	**630 [22.7]**		3.2	
2013	18,546 [20.6]	559 [20.2]		2.9	
2014	18,124 [20.1]	523 [18.9]		2.8	
2015	17,518 [19.4]	528 [19.0]		2.9	
2016	17,291 [19.2]	532 [19.2]		3.0	
Season					
June–September (summer)	32,698 [36.2]	1073 [38.7]	0.03	3.2	
November–February (late autumn/winter)	26,903 [29.8]	804 [29.0]		2.9	
October and March–May (autumn-spring)	30,641 [34.0]	895 [32.3]		2.8	
Weekend & holidays	28,332 [31.4]	**1113 [40.2]**	< 0.001	3.8	1.5
Working days	61,915 [68.6]	1659 [59.8]		2.6	
Hour of day			< 0.001		
12:00–17:59	34,536 [38.3]	*804 [29.0]*		2.3	
18:00–23:59	25,454 [28.2]	741 [26.7]		2.8	
00:00–05:59	8093 [9.0]	**528 [19.0]**		6.1	
06:00–11:59	22,164 [24.6]	699 [25.2]		3.1	
Non-optimal weather conditions	7147 [7.9]	**337 [12.2]**	< 0 .001	4.5	1.6
Clear weather	83,100 [92.1]	2435 [87.8]		2.8	
Non-optimal road surface conditions	7698 [8.5]	**366 [13.2]**	< 0.001	4.5	1.6
Dry surface	82,549 [91.5]	2406 [86.8]		2.8	
Non-optimal light conditions	5176 [5.7]	**528 [19.0]**	< 0.001	9.3	3.6
Daylight or sufficient artificial light	85,066 [94.3]	2244 [81.0]		2.6	
Road-related factors					
Street type			< 0.001		
Urban road	68,984 [76.4]	*929 [33.5]*		1.3	
New national road—highway	2779 [3.1]	**182 [6.6]**		6.1	
New national road—not highway	3066 [3.4]	**327 [11.8]**		9.6	
Old national road	5753 [6.4]	**468 [16.9]**		7.5	
County road	8324 [9.2]	**713 [25.7]**		7.9	
Communal/rural road	1341 [1.5]	**153 [5.5]**		10.2	
Not a built-up area/uninhabited	14,927 [16.5]	**1460 [52.7]**	< 0.001	8.9	5.2
Inhabited	75,320 [83.5]	1312 [47.3]		1.7	
One- or two-way street					
Two-way	74,621 [82.7]	2630 [94.9]	< 0.001	3.4	3.8
One-way	15,626 [17.3]	*142 [5.1]*		0.9	
Lanes number			< 0.001		
1 lane	49,764 [55.1]	**1936 [69.8]**		3.7	
2 lanes	26,746 [29.6]	*584 [21.1]*		2.1	
≥ 3 lanes	13,737 [15.2]	*252 [9.1]*		1.8	

Fatal (%): fatality rate; percentage of deaths among all drivers in each category

*p value for Chi-squared or Wilcoxon-Mann–Whitney test (lanes number)

levels > 0.1% had a sevenfold increase in death, compared to being completely sober.

The summer period contained the most RTIs (36.5%) and driver deaths (38.7%), but the winter period and weekend raised adjusted risk for 2-wheel drivers (Appendix). Two-thirds of incidents took place between midday and midnight, however, the 00:00–06:00 period (9% of all incidents, 19% of fatal) increased risk, especially for

Table 3 Comparison of crash-related factors of the two groups (alive vs fatally injured drivers) after an RTI in Greece (2012–2016)

Independent variables	Alive drivers	Fatally injured drivers	*p* value*	Fatal (%)
Crash-related factors				
Crash type			< 0.001	
Head-to-side	43,706 [48.4]	*664 [24.0]*		1.5
Head-on	4937 [5.5]	**304 [11.0]**		5.8
Side-to-side	8709 [9.7]	*102 [3.7]*		1.2
Rear-end	10,393 [11.5]	*192 [6.9]*		1.8
Collision with obstruction	4549 [5.0]	**486 [17.5]**		9.7
Vs pedestrian/animal	9212 [10.2]	*24 [0.9]*		0.3
Lost control/off-road	5201 [5.8]	**742 [26.8]**		12.5
Miscellaneous/other	3540 [3.9]	**258 [9.3]**		6.8
Maneuver			< 0.001	
On normal route	14,988 [16.6]	445 [16.1]		2.9
Entering traffic flow	3508 [3.9]	81 [2.9]		2.3
Entering opposite traffic flow	7890 [8.7]	**561 [20.2]**		6.6
Leaving traffic flow without control	1494 [1.7]	**279 [10.1]**		15.7
Overtaking	2329 [2.6]	73 [2.6]		3.0
Crossing violating priority	4309 [4.8]	*54 [1.9]*		1.2
Turning	10,034 [11.1]	*247 [8.9]*		2.4
Parking/braking/decelaration maneuvers	5360 [5.9]	*73 [2.6]*		1.3
Lane change	3374 [3.7]	*47 [1.7]*		1.4
Speeding	3602 [4.0]	**416 [15.0]**		10.4
Red light/STOP sign violation	23,264 [25.8]	*202 [7.3]*		0.9
Other	10,095 [11.2]	294 [10.6]		2.8

Fatal (%): fatality rate; percentage of deaths among all drivers in each category

Adjusted residuals z values are used to see which cells are contributing the most to the p value. Categories with a z value greater than $|2.54|$ ($p < 0.001$) are presented in bold (observed frequency greater than expected) and in italic for (less than expected)

*p value for t test, Chi-squared or Wilcoxon-Mann–Whitney test

2-wheel drivers if lighting conditions were insufficient (aOR 1.80, $p < 0.001$). Regarding road type and characteristics, uninhabited areas were associated with more than half of fatal accidents (aOR 4.54, $p < 0.001$ for cars). This was more evident in one-lane, old national or county road network and non-highway parts of new national roads with no division wall.

Head-to-side collision was the most common type of crash occurring in one in two incidents, but higher probability of a fatal outcome was associated with collision with obstruction (aOR 3.54, $p < 0.001$) and lost control/off-road (aOR 2.85, $p < 0.001$). Responsible maneuvers analysis showed that one in four incidents was due to a STOP sign/red light violation, but most dangerous ones were entering opposite traffic flow (overtaking) and losing control of vehicle (Table 4). Excessive speeding was associated with a threefold risk of death for motorbike drivers (aOR 3.17, $p < 0.001$), but not for those in cars.

Discussion

This is the first large-scale study to have examined risk factors associated with high mortality after an RTI in Greece. Our results indicate that particular factors were significant in all our analyses, irrespective of the type of vehicle and driver/passenger classification. Increased age, no seatbelt or helmet use, alcohol consumption and travelling in one-lane road network outside inhabited areas are all strongly associated with road deaths. Other environmental and crash-related factors were found to be key factors of poor outcome in specific categories of road users. These findings elucidate the public health issue in Greece and support the need for robust intervention. Following our original study, we continued with a scoping review of the English and Greek literature to support our findings with specific suggestions on policymaking

Table 4 Adjusted odds ratios (with 99% confidence intervals) of risk factors for a fatal outcome of (a) car drivers and (b) motorbike drivers in RTIs in Greece, derived by stepwise logistic regression analysis

Variable	aOR	(99% CI)	*p* value
(a)			
Age	**1.02**	(1.01–1.03)	**< 0.001**
No seatbelt use	**8.24**	(5.55–12.2)	**< 0.001**
Positive alcotest result (> 0.1 g/lt)	**3.34**	(2.20–5.08)	**< 0.001**
Type of road			
Uninhabited (not urban) area	**4.54**	(2.93–7.05)	**< 0.001**
National Road—not highway	**2.31**	(1.39–3.83)	**< 0.001**
Lanes number: ≥ 3 lanes	**0.46**	(0.19–1.08)	**0.019**
One-way road[a]	0.36	(0.09–1.39)	0.052
Type of crash—Maneuver responsible			
Collision with fixed object	**3.54**	(2.06–6.08)	**< 0.001**
Lost control/off-road	**2.85**	(1.75–4.64)	**< 0.001**
Entering opposite traffic flow	**2.25**	(1.39–3.64)	**< 0.001**
Head-on crash	**1.69**	(0.93–3.07)	**0.025**
Reason to move: leisure, travel or tourism	**0.52**	(0.32–0.83)	**< 0.001**
Hour of day			
06:00–11:59[a]	1.36	(0.90–2.06)	0.055
07:00–07:59	**2.23**	(1.05–4.75)	**0.006**
Insufficient light conditions	**1.46**	(0.92–2.33)	**0.035**
Not clear weather conditions[a]	1.39	(0.89–2.18)	0.059
(b)			
Age	**1.03**	(1.02–1.04)	**< 0.001**
No helmet use	**2.85**	(1.97–4.13)	**< 0.001**
Positive alcotest result (> 0.1 g/lt)	**4.01**	(2.745.85)	**< 0.001**
Type of road			
Uninhabited (not urban) area	**2.62**	(1.81–3.78)	**< 0.001**
National road —Not highway	**2.18**	(1.18–4.03)	**0.001**
One-way road	**0.47**	(0.23–0.97)	**0.008**
Type of crash—Maneuver responsible			
Head-on crash	**2.32**	(1.20–4.47)	**0.001**
Leaving traffic flow (no control)	**2.16**	(1.11–4.22)	**0.003**
Overtaking	**2.14**	(1.02–4.50)	**0.008**
Entering opposite traffic flow	**1.90**	(1.07–3.36)	**0.004**
Collision with fixed object	**1.78**	(1.01–3.13)	**0.008**
Speeding (identified as primary cause)	**3.17**	(1.86–5.41)	**< 0.001**
Insufficient light conditions	**1.80**	(1.13–2.88)	**0.001**

2 log likelihood = 1762.04; $Chi^2(16) = 896.34$; $p < 0.001$

Nagelkerke Pseudo R2 = 0.352

Hosmer–Lemeshow test: 11.294 with 8 *df*, $p = 0.186$

2 log likelihood = 2043,347; $Chi^2(13) = 530.414$; $p < 0.001$

Nagelkerke Pseudo R2 = 0.223

Hosmer–Lemeshow test: 5.637 with 8 *df*; $p = 0.688$

to enhance targeted prevention in road safety. These proposals are integrated into this discussion section and presented in Table 5.

Human-related factors

Age was strongly associated with poor outcome after a RTI. It could be argued that advanced age suggests more driving experience, while the young age is associated with risky and unexperienced driving, causing incidents of worse outcome [9]. However, age also plays a huge role physiologically to the outcome of an injured person and elderly drivers may have decreased reflexes and diminished vision or hearing causing an RTI to occur [10]. Our findings confirmed other studies to show that the most elderly group of people (aged 65 years or more) is the most vulnerable [11–13].

Seatbelt non-use was most powerfully correlated with a fatal outcome in all categories. The protective effect of seatbelt use could be overestimated with low-energy incidents that cause only damage to property and would not have caused an injury whatsoever. Nevertheless, one could argue that in these incidents, an injury was prevented with seatbelt use [13]. Underreporting of property damage only (PDO) accidents could also overestimate the protective effect, while a differential misclassification could have been possible if some uninjured or mildly injured drivers were mistakenly registered as restrained, possibly for insurance coverage issues. Findings showed that seatbelt use worsened from 2012 to 2016, in young males, rural regions, winter months and nighttime hours (00:00–06:00). These findings warrant further investigation into how they could guide targeted intensification of police controls. Specific efforts are required to target younger people, for example during the compulsory military service and in schools, especially in regions with high death rates, whilst social media (YouTube, Instagram) may have a more direct effect on the 15–24 age group [14].

Almost a third of motorbike drivers did not wear a helmet at the time of incident, which is an increase from the 28% non-use reported a decade ago in 4th Hellenic Road Safety conference. Male gender, age (18–30, 65 + years old), alcohol consumption, small motorbikes and rural regions were all factors that lowered the probability of helmet use. Helmet use varies widely, and it may not be consistent even for the same individual [15]. Summer season, after hours (00:00–06:00) and weekends diminish the probability of helmet use, both for social reasons, limitation of the feeling of freedom, increased temperatures or higher alcohol consumption [16]. Alcohol not only lowers safety equipment use but impairs driving ability [17]. For people aged 15–29 in Europe, driving under the influence is one of the main causes of mortality [18]. Alcohol use was strongly associated with male gender, motorbikes < 115 cc, weekends, the 00:00–06:00 h, winter months and rural regions. Matching these findings with the current socioeconomic reality, DUI seems to be chosen over increased night rates of taxis due to non-existence of public transport during late hours [19].

Table 5 Targeted RTI prevention suggestions for road safety strategy in Greece

Target of prevention	Problem identification	Suggestion
(A) Not using passive safety devices (seatbelt/helmet)	Worst age group 18–35, esp. males	1. This underlines the lack of road safety education at middle and high schools. Introduction of road safety as a subject twice, first in elementary school to inculcate the basics of using the road safely as a pedestrian, plus the importance of seatbelt and helmet use when being passengers and later in high school with concepts of safe driving. Informative speeches from experts and videos can enhance this experience
		2. The target group of young males can be informed and positively influenced during the compulsory military service without any cost. In cooperation with the Hellenic Army General Staff, road safety speeches from military doctors and other experts could help
		3. A road safety campaign could be initiated officially and have a name to assist with the spread of the problem to the public and the effort to deal with it with a fresh start. TV advertising alone can't target at this group efficiently enough. Hashtags (#) containing this name could be used with the participation of popular social media users (YouTube, Instagram etc.) having the potential to influence the crucial 15–24 age group
		4. Driving schools and instructors should underline as much as possible the importance of passive safety devices and use them themselves all the time
	Worst time of day 00:00–06:00	5. Target existing police controls during the 00:00–06:00 afterhours. Visible police presence discourages non-use of seatbelt or helmet or driving under influence of alcohol
		6. Positive reinforcement. Rewards system with coupons or giveaways for young drivers (below 25) with no violations during the control
		7. New graduated drivers could be restricted from driving during 23:00 and 06:00 for a minimum learning period of 12 months. Moreover, new drivers should have only one non-family member under 18 years old in the vehicle
		8. Introduce law for implication and shared responsibility by 50% of the driver or occupant of a vehicle that is not responsible for causing a RTI but does not use a passive safety device
	High cost of helmet	9. Subsidy for the first helmet purchase after driving school graduation. Taxation-free sales for helmets
	Discomfort esp. during summer when wearing a helmet	10. Driving schools and road safety education at schools have to teach both theoretically and practically that all helmets are not for everyone, offering a variety of helmets to be worn and tested. Open face helmets, lightweight and helmets with good velocity-flow ventilation offer comfort even during summer months. These, often more expensive helmets, have to be more accessible to buyers through subsidies or tax-free sales
(B) Driving under the influence (DUI)	Repeat offenders	11. Ignition interlocks for all repeat offenders or high BAC offenders for a minimum period of 6 to 12 months. If found DUI with an interlock (someone else has blown), suspension of driver's license and jail sentence

Table 5 (continued)

Target of prevention	Problem identification	Suggestion
	Young people that go out at night prefer DUI from using an expensive taxi service	12. Extension of central and key lines of public transport timetable with hourly or ideally half-hourly services, during Friday and Saturday night. Athens subway service (metro) could offer just 6 additional half-hourly services for each of the two lines and cover the existing gap
		13. Zero tolerance limit for drivers below 21 years old or new drivers
		14. Development of a mobile phone application (like SaferRide) that helps drunk drivers choose a safer way of transport. It will use existing taxi apps and would reward confirmed users with discounts or coupons
	Alcohol companies do not develop enough alcohol-impaired driving countermeasures	15. Enact different taxation policies and counter-marketing media campaigns for drinking and driving. Suggest active engagement of alcohol companies to safe driving campaign instead of taxation increase, which is considerably low compared to EU countries with high road safety (e.g. UK, Sweden). Alcohol companies often advertise during popular sports events -with a sensitive target group of young males- without enough countermeasures and clear "don't drink and drive" messages
(C) Rural road network	Worst seatbelt/helmet use percentages. Disregard of the law/local police reluctant to issue tickets	16. Local police officers are often unwilling to record violations for social or interpersonal reasons. Creation of dedicated traffic police teams that have the jurisdiction to patrol in nearby cities and counties would help encounter this issue
		17. Electronic ticketing with connection to a central station would help eliminate the phenomenon of tickets being cancelled due to interpersonal relationships
		18. Combination of the above-enhanced law enforcement with low-cost, local media promoting safe driving behavior, mainly through radio, would have a greater benefit
	Insufficient lighting/faded road markings	19. Road lighting installations can't be placed along the whole length of a road and are not cost-effective, but should be placed at all intersections and dangerous curbs and turns
		20. Even if road surface is not optimal, newly painted road markings (lining) at the edge has been shown to decrease traffic incidents, esp. highly fatal off-road and head-on crashes. Luminescent road lines could be a near-future alternative to road lighting
(D) Dangerous traffic violations	Illegal or risky overtaking causes head-on or off-road crashes with high mortality	21. Underline the extreme risk of risky or illegal overtaking in road safety education and awareness campaign, which is most of the times unnecessary compared to the time gain. An overtaking at a one lane, two-way road, depending on the speed limit of the road, can save around 30 to 60 s per 10 km

Table 5 (continued)

Target of prevention	Problem identification	Suggestion
	Not enough police enforcement for speeding control	22. Installation of speed cams at targeted high-risk segments. Since the ban of speed cam detection apps may not be feasible, an official app could use this concept in the advantage of road safety. It will further warn the driver to slow down and be alert at known accident blackspots and school locations or then through inhabited segments of high-speed roads could prove beneficial
	Not respect for speed limits of national roads' inhabited segments	23. Placing speed humps/bumps when entering an inhabited area and at school crosswalks

At the same time, instead of increasing taxes on alcohol, government could propose alcohol companies to invest in the awareness and education campaign as a countermeasure.

Vehicle-related factors

In 2016, Greece earned a disheartening first place among all 28 EU countries in the death rate per population of motorbike drivers, 24 deaths per million inhabitants, more than three times the average in the Union. Our regression analysis revealed a fivefold and threefold risk of death for bicycle and any kind of motorcycle driver, respectively, when compared to cars. High fatality could be attributed in a number of factors, but predominately user's exposed position and non-helmet use. Amongst two-wheeled vehicles, bicycle riders were the most vulnerable users. Designated bicycle lanes are scarce throughout the country; however, bike riders rarely wear protective equipment and tend to jump red lights or STOP signs. It is, therefore, apparent that new infrastructure would not be enough, but road safety education is also needed.

Whilst the age of the vehicle was not strongly associated with the outcome, it may explain the reduced seatbelt use in a quarter of the population. As fewer cars released before 2000 are in circulation, modern vehicle construction will hopefully diminish this factor. Similarly, large engine capacity was not correlated with adverse outcome. Locally, it is suggested that the recent economic crisis in Greece has caused a substantial proportion of vehicles to be badly maintained, and as a result, a mechanical problem or tyre failure could be the cause of a serious accident. No detailed information on the maintenance level of the vehicles could be accessed, however, at the time of the accident, around 6% of the vehicles had not been through MOT testing.

Environmental and crash-related factors

There was a regional variation for the high death rates associated with RTIs in Greece. Attica (Athens metropolitan area) experiences nearly at five deaths per 100,000 population per year, whilst many rural regions including islands of south Aegean and Crete, Epirus, Central and Western Greece exceed ten deaths per 100,000 population per year [6]. Our findings confirmed some previous reports of increased alcohol consumption in these regions, poor seatbelt and helmet use, as well as specific characteristics of the road network [6, 20]. One-lane county, communal or old national roads with insufficient lighting conditions during night hours were associated with increased deaths. Older people may also be at increased risk if situated outside urban centers especially after retirement [21]. A study by Hasselberg et al. in 2005 suggested that education levels, lower-income and social status also raise the risk for traffic violations and more serious incidents in these regions [22].

From an environmental perspective, motorbike drivers may face an increased risk of an RTI during the winter season, not only due to a slippery surface but also decreased daytime illumination and increased alcohol consumption [13]. Poor weather and road surface conditions did not have a significant effect in this study, possibly due to speed adjustments and an increased state of alert under adverse conditions [23]. The 00:00–06:00 period had a higher probability for a fatal outcome for all-drivers, but this was a stronger association for 2-wheel drivers, together with the 07:00–08:00 rush hour. This confirms the findings of an increased rate of traffic violations in a previous study, as drivers may not be fully alert yet or hurry not to be late at work or school [24].

Overtaking, excessive speeding and losing control of vehicle were the most probable maneuvers or errors to cause a fatality, while collision with fixed obstruction and head-on were strongly associated with alcohol consumption. All the above dangerous maneuvers and errors explain why driving in a one-lane, high-speed road deserves a heightened level of alertness for anyone driving in the regional and rural road network.

Limitations of study

Whilst this retrospective study is based on data gathered by thousands of different observers, not every incident was recorded which may result in a potential overestimation of the effect of some risk factors. Furthermore, variability may exist in the completion of the standardized forms with more severe incidents drawing more attention and detailed recording [25]. This database does not contain clinical information, therefore, we were unable to examine clinical variables which may be associated with outcome. We had no information about distraction from mobile phones or sleepiness as a possible cause of RTI. No distinction is made between DOAs and later deaths, as no time to death confirmation was available. Moreover, the lack of additional data of risk exposure and performance indicators, the results of the analyses can only ensure correlation and not causation.

One of the major limitations of this study is the unknown percentage of seatbelt and helmet use. The Police did not record the information in more than 40% and 30% for car and motorbike drivers respectively, with comparable traffic studies recorded 20–30% rates of non-reporting [13, 23]. This may suggest that information is reported only if the observer is absolutely sure, certifying the validity of complete data. However, we were able to analyse the remaining proportion of seatbelt and helmets, with strong associations found with non-use. A high proportion of fatalities did not have results reported on alcohol consumption, possibly due to it not being tested by regional forensic services or the non-reporting back to the Police. Our findings have shown that where available, alcohol presence had a significantly deleterious effect, therefore, serious RTIs should be ideally investigated by a dedicated Forensic Crash Unit [23] as part of a wider, national injury prevention strategy.

Conclusion

These findings that derived from the official data of RTIs in Greece over the last 5 years indicate that human factors play a predominant role in the high mortality rates observed. In terms of preventive initiatives, the key may be to change people's attitudes. Educational campaigns to raise awareness in schools, intensified in high-risk regions, could help to empower children to alter parental road safety behavior. At the same time, road traffic education will hopefully make future drivers, better drivers. Traffic Police controls should be denser during weekends and after hours and emphasize on high-risk regions until road network improvement is gradually accomplished. Future studies would ideally draw clinical information on the participants from a national trauma registry. Until then, targeted prevention strategy is readily available and should aim to further decrease the number of lives lost on the civilian battlefield of the road network.

Data availability statement

Application for provision of data from Hellenic Statistical Authority was made on Oct 18th and approved by the ethics committee on Nov 19th with protocol number ΓΠ—529/21.11.2018. Forms regarding the "Contract on access to confidential data for research purposes" have been signed, which declare that raw data cannot be published.

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Compliance with ethical standards

Conflict of interest We have no conflict of interest to declare.

Appendix

See Tables 6 and 7.

Table 6 Adjusted odds ratios (aOR) for car drivers with all variables included in the logistic regression analysis

Independent variables	Total *N* [%]	Alive drivers *N* [%]	Fatally injured[d] *N* [%]	Fatal (%)	aOR [Lower–upper]	CI 99%
No. of participants (car drivers only)	51,545	50,363	1182	2.3		
Driver-related						
Age[b]	44.5 ± 0.1	44.4 ± 0.1	48.3 ± 1.1		**1.02**	[1.02–1.03]
Gender						
Male[a]	38,024 [73.8]	36,970 [73.4]	**1054 [89.2]**	2.8	1.00	
Female	13,521 [26.2]	13,393 [26.6]	*128 [10.8]*	0.9	**0.74**	[0.53–1.03]
Seatbelt use						
Yes[a]	25,200 [88.2]	24,916 [89.7]	*284 [35.7]*	1.1	1.00	
No use	3361 [11.8]	2850 [10.3]	**511 [64.3]**	**15.2**	**6.32**	[4.95–8.09]
Result of alcohol test						
Positive (> 0.1 g/lt)	3109 [8.4]	2956 [8.1]	**153 [40.5]**	**4.9**	**2.54**	[1.73–3.73]
Negative	33,941 [91.6]	33,716 [91.9]	*225 [59.5]*	0.7	1.00	
Nationality						
Hellenic (Greek)[a]	46,815 [90.8]	45,739 [90.8]	1076 [91.0]	2.3	1.00	
Foreign	4730 [9.2]	4624 [9.2]	106 [9.0]	2.2	1.11	[0.70–1.75]
Left-hand drive country origin						
Yes	264 [0.5]	256 [0.5]	8 [0.7]	3.0	1.43	[0.35–5.77]
No[a]	51,281 [99.5]	50,107 [99.5]	1174 [99.3]	2.3	1.00	
Tourist						
Yes	4923 [9.5]	4727 [9.4]	**196 [16.6]**	**4.0**	**0.70**	[0.51–0.91]
No[a]	46,622 [90.5]	45,636 [90.6]	986 [83.4]	2.1	1.00	
Foreign tourist						
Yes	806 [1.6]	782 [1.5]	24 [2.0]	3.0	1.00	[0.43–2.30]
No[a]	50,739 [98.4]	49,581 [98.5]	1158 [98.0]	2.3	1.00	
Vehicle factors						
Year of vehicle release before 2000	13,430 [29.1]	12,942 [28.7]	**488 [44.7]**	**3.6**	1.02	[0.80–1.30]
Year after 2000[a]	32,689 [70.9]	32,085 [71.3]	604 [55.3]	1.8	1.00	
Car engine's cubic capacity ≥ 2000 cc	2408 [5.4]	2354 [5.4]	54 [5.2]	2.2	0.86	[0.50–1.47]
< 2000 cc[a]	42,549 [94.6]	41,567 [94.6]	982 [94.8]	2.3	1.00	
Environmental factors						
Year of incident						
2012[a]	10,840 [21.0]	10,579 [21.0]	261 [22.1]	2.4	1.00	
2013	10,633 [20.6]	10,385 [20.6]	248 [21.0]	2.3	1.00	[0.71–1.43]
2014	10,339 [20.1]	10,136 [20.1]	203 [17.2]	2.0	0.90	[0.63–1.30]
2015	9926 [19.3]	9703 [19.3]	223 [18.8]	2.2	1.03	[0.72–1.49]
2016	9807 [19.0]	9560 [19.0]	247 [20.9]	2.5	1.21	[0.85–1.72]
Season						
June–September (summer)[a]	17,966 [34.8]	17,553 [34.8]	413 [34.9]	2.3	1.00	
November–February (late autumn/winter)	16,066 [31.2]	15,656 [31.1]	**410 [34.7]**	**2.6**	0.98	[0.74–1.29]
October and March–May (autumn-spring)	17,513 [34.0]	17,154 [34.1]	359 [30.4]	2.0	0.86	[0.65–1.14]
Weekend and holidays[c]	17,269 [33.5]	16,791 [33.3]	**478 [40.4]**	2.8	0.95	[0.75–1.21]
Working days[a]	34,276 [66.5]	33,572 [66.7]	704 [59.6]	2.1	1.00	
Hour of day						
12:00–17:59[a]	19,330 [37.5]	18,999 [37.7]	*331 [28.0]*	*1.7*	1.00	
18:00–23:59	14,467 [28.1]	14,171 [28.2]	296 [25.1]	2.0	1.01	[0.72–1.42]
00:00–05:59	5014 [9.7]	4783 [9.5]	**231 [19.5]**	**4.6**	**1.38**	[0.93–2.05]
06:00–11:59	12,734 [24.7]	12,410 [24.6]	324 [27.4]	2.5	**1.32**	[0.98–1.78]
Non-optimal weather conditions	4762 [9.2]	4547 [9.0]	**215 [18.2]**	**4.5**	0.92	[0.52–1.64]
Clear weather	46,783 [90.8]	45,816 [91.0]	967 [81.8]	2.1	1.00	

Table 6 (continued)

Independent variables	Total *N* [%]	Alive drivers *N* [%]	Fatally injured[d] *N* [%]	Fatal (%)	aOR	CI 99% [Lower–upper]
Non-optimal road surface conditions	5048 [9.8]	4812 [9.6]	**236 [20.0]**	**4.7**	1.45	[0.83–2.54]
Dry surface[a]	46,497 [90.2]	45,551 [90.4]	946 [80.0]	2.0	1.00	
Non-optimal light conditions	3309 [6.4]	3042 [6.0]	**267 [22.6]**	**8.1**	1.15	[0.82–1.62]
Daylight or sufficient artificial light[a]	48,236 [93.6]	47,321 [94.0]	915 [77.4]	1.9	1.00	
Road factors						
Street type						
Urban road[a]	37,945 [73.6]	37,703 [74.9]	*242 [20.5]*	*0.6*	1.00	
New national road—highway	1856 [3.6]	1752 [3.5]	**104 [8.8]**	**5.6**	**3.88**	[2.19–6.88]
New national road—not highway	2109 [4.1]	1914 [3.8]	**195 [16.5]**	**9.2**	**6.03**	[3.81–9.55]
Old national road	3848 [7.5]	3579 [7.1]	**269 [22.8]**	**7.0**	**3.39**	[2.23–5.14]
County road	5081 [9.9]	4754 [9.4]	**327 [27.6]**	**6.4**	**2.32**	[1.52–3.53]
Communal/rural road	706 [1.3]	661 [1.3]	**45 [3.8]**	**6.4**	**2.77**	[1.39–5.53]
One- or two-way street						
Two-way[a]	42,960 [83.3]	41,810 [83.0]	1150 [97.3]	2.7	1.00	
One-way	8585 [16.7]	8553 [17.0]	*32 [2.7]*	*0.4*	**0.60**	[0.30–1.17]
Lanes number						
1 lane[a]	28,682 [55.6]	27,837 [55.3]	**845 [71.5]**	**2.9**	1.00	
2 lanes	15,195 [29.5]	14,946 [29.7]	249 [21.1]	1.6	1.00	[0.74–1.36]
≥ 3 lanes	7668 [14.9]	7580 [15.0]	*88 [7.4]*	*1.1*	**0.59**	[0.36–0.99]
Not a built-up area/uninhabited	9897 [19.2]	9110 [18.1]	**787 [66.6]**	**8.0**	**1.91**	[1.38–2.64]
Inhabited[a]	41,648 [80.8]	41,253 [81.9]	*395 [33.4]*	*0.9*	1.00	
Crash-related						
Crash type						
Head-to-side[a]	25,057 [48.6]	24,834 [49.3]	*223 [18.9]*	*0.9*	1.00	
Head-on	3293 [6.4]	3119 [6.2]	**174 [14.7]**	**5.3**	**1.65**	[1.09–2.48]
Side-to-side	4232 [8.2]	4211 [8.4]	*21 [1.8]*	*0.5*	0.64	[0.29–1.41]
Rear-end	6319 [12.3]	6262 [12.4]	*57 [4.8]*	*0.9*	0.82	[0.45–1.50]
Collision with obstruction	3044 [5.9]	2775 [5.5]	**269 [22.8]**	**8.8**	**3.50**	[2.27–5.42]
Vs pedestrian/animal	5676 [11.0]	5674 [11.3]	*2 [0.2]*	*0.0*	**0.09**	[0.01–0.59]
Lost control/off-road	2961 [5.7]	2612 [5.2]	**349 [29.5]**	**11.8**	**3.70**	[2.45–5.58]
Miscellaneous/other	963 [1.9]	876 [1.7]	**87 [7.3]**	**9.0**	**3.54**	[2.00–6.28]
Maneuver responsible/driver error						
On normal route[a]	8135 [15.8]	7967 [15.8]	168 [14.2]	2.1	1.00	
Entering traffic flow	1833 [3.6]	1808 [3.6]	25 [2.1]	1.4	0.94	[0.43–2.04]
Entering opposite traffic flow	5289 [10.3]	4951 [9.8]	**338 [28.6]**	**6.4**	**1.82**	[1.16–2.86]
Leaving traffic flow without control	1039 [2.0]	900 [1.8]	**139 [11.7]**	**13.4**	1.29	[0.81–2.06]
Overtaking	1082 [2.1]	1063 [2.1]	19 [1.6]	1.8	0.90	[0.34–2.42]
Crossing violating priority	2467 [4.8]	2458 [4.9]	*9 [0.8]*	*0.4*	0.47	[0.13–1.63]
Turning	5183 [10.1]	5090 [10.1]	*93 [7.9]*	1.8	0.81	[0.49–1.34]
Parking/braking/deceleration maneuvers	2862 [5.5]	2845 [5.6]	*17 [1.4]*	*0.6*	**0.52**	[0.22–1.20]
Lane change	1757 [3.4]	1742 [3.5]	*15 [1.3]*	*0.9*	0.78	[0.31–2.00]
Speeding	2345 [4.5]	2145 [4.3]	**200 [16.9]**	**8.5**	**1.40**	[0.93–2.11]
Red light/STOP sign violation	13,986 [27.1]	13,938 [27.7]	*48 [4.1]*	*0.3*	**0.42**	[0.22–0.80]
Other	5567 [10.8]	5456 [10.8]	111 [9.4]	2.0	0.90	[0.55–1.48]

[a]Reference (base) value

[b]Age: Mean ± 2.54z (99 CI%)

[c]*aOR* Adjusted odds ratios derived from multivariate logistic regression analysis. Bold values indicate a significance at $p < 0.05$

[d]Fatally injured drivers: 30-day mortality of drivers

Table 7 Adjusted odds ratios (aOR) for motorbike drivers with all variables included in the logistic regression analysis

Independent variables	Total *N* (%)	Alive drivers *N* (%)	Fatally injured[d] *N* (%)	Fatal (%)	aOR	CI 99% [Lower–upper]
Number of participants (motorbike drivers)	32,564	31,316	1248	3.8		
Driver-related						
Age	37.3 ± 0.2	37.1 ± 0.2	40.9 ± 1		**1.02**	[1.02–1.03]
Gender						
Male[a]	30,407 [93.4]	29,194 [93.2]	1213 [97.2]	4.0	1.00	
Female	2157 [6.6]	2122 [6.8]	*35 [2.8]*	*1.6*	**0.61**	[0.36–1.01]
Helmet use						
Yes[a]	15,427 [69.7]	15,076 [71.4]	*351 [34.5]*	*2.3*	1.00	
No use	6704 [30.3]	6037 [28.6]	**667 [65.5]**	**9.9**	**3.00**	[2.44–3.68]
Result of alcohol test						
Positive (> 0.1 g/lt)	1740 [7.7]	1607 [7.2]	**133 [38.6]**	**7.6**	**2.47**	[1.74–3.52]
Negative[a]	20,853 [92.3]	20,641 [92.8]	*212 [61.4]*	*1.0*	1.00	
Nationality						
Hellenic (Greek)[a]	28,723 [88.2]	27,630 [88.2]	1093 [87.6]	3.8	1.00	
Foreign	3841 [11.8]	3686 [11.8]	155 [12.4]	4.0	1.06	[0.75–1.50]
Left-hand drive country origin						
Yes	32,105 [1.4]	439 [1.4]	20 [1.6]	3.8	0.78	[0.34–1.79]
No[a]	459 [98.6]	30,877 [98.6]	1228 [98.4]	4.4	1.00	
Tourist						
Yes	2627 [8.1]	2393 [7.6]	**234 [18.8]**	**8.9**	**1.33**	[1.02–1.72]
No[a]	29,937 [91.9]	28,923 [92.4]	1014 [81.2]	3.4	1.00	
Foreign tourist						
Yes	575 [1.8]	540 [1.7]	**35 [2.8]**	**6.1**	0.67	[0.35–1.29]
No[a]	31,989 [98.2]	30,776 [98.3]	1213 [97.2]	3.8	1.00	
Vehicle-related						
Vehicle type						
Moped/Motorbike < 115 cc[a]	7629 [23.4]	7316 [23.4]	313 [25.1]	4.1	1.00	
Motorcycle > 116 cc	24,935 [76.6]	24,000 [76.6]	935 [74.9]	3.7	**1.36**	[1.08–1.70]
Year of vehicle release before 2000	4543 [17.1]	4300 [16.9]	**243 [22.4]**	**5.3**	1.13	[0.82–1.45]
Year after 2000[a]	21,972 [82.9]	21,131 [83.1]	841 [77.6]	3.8	1.00	
Environmental factors						
Year of incident						
2012[a]	6648 [20.4]	6367 [20.4]	281 [22.5]	4.2	1.00	
2013	6670 [20.5]	6423 [20.5]	247 [19.8]	3.7	0.95	[0.72–1.27]
2014	6575 [20.2]	6324 [20.2]	251 [20.1]	3.8	1.10	[0.83–1.46]
2015	6353 [19.5]	6117 [19.5]	236 [18.9]	3.7	0.95	[0.71–1.27]
2016	6318 [19.4]	6085 [19.4]	233 [18.7]	3.7	1.06	[0.79–1.42]
Season						
June–September (summer)[a]	12,471 [38.3]	11,936 [38.1]	535 [42.9]	4.3	1.00	
November–February (late autumn/winter)	9049 [27.8]	8762 [28.0]	287 [23.0]	3.2	**1.27**	[0.99–1.62]
October and March–May (autumn-spring)	11,044 [33.9]	10,618 [33.9]	426 [34.1]	3.9	**1.20**	[0.97–1.49]
Weekend & holidays[c]	9901 [30.4]	9368 [29.9]	**533 [42.7]**	**5.4**	**1.30**	[1.08–1.58]
Working days[a]	22,663 [69.6]	21,948 [70.1]	715 [57.3]	3.2	1.00	
Hour of day						
12:00–17:59[a]	12,361 [38.0]	12,003 [38.3]	*358 [28.7]*	*2.9*	1.00	
18:00–23:59	9721 [29.8]	9364 [29.9]	357 [28.6]	3.7	1.05	[0.82–1.36]
00:00–05:59	3111 [9.6]	2851 [9.1]	**260 [20.8]**	**8.4**	**1.71**	[1.24–2.35]
06:00–11:59	7371 [22.6]	7098 [22.7]	273 [21.9]	3.7	**1.28**	[0.99–1.65]
Non-optimal weather conditions	1655 [5.1]	1587 [5.1]	**68 [5.5]**	4.1	1.18	[0.61–2.29]

Table 7 (continued)

Independent variables	Total *N* (%)	Alive drivers *N* (%)	Fatally injured[d] *N* (%)	Fatal (%)	aOR	CI 99% [Lower–upper]
Clear weather[a]	30,909 [94.9]	29,729 [94.9]	1180 [94.5]	3.8	1.00	
Non-optimal road surface conditions	1881 [5.8]	1811 [5.8]	**70 [5.6]**	3.7	0.74	[0.38–1.44]
Dry surface[a]	30,683 [94.2]	29,505 [94.2]	1178 [94.4]	3.8	1.00	
Non-optimal light conditions	1715 [5.3]	1520 [4.8]	**195 [15.6]**	**11.4**	**1.29**	[0.95–1.76]
Daylight or sufficient artificial light[a]	30,849 [94.7]	29,796 [95.2]	1053 [84.4]	3.4	1.00	
Road factors						
Street type						
Urban road[a]	27,093 [83.2]	26,479 [84.5]	*614 [49.2]*	*2.3*	1.00	
New national road—highway	650 [2.0]	589 [1.9]	**61 [4.9]**	**9.4**	**1.96**	[1.12–3.43]
New national road—not highway	667 [2.1]	565 [1.8]	**102 [8.2]**	**15.3**	**3.89**	[2.52–6.00]
Old national road	1351 [4.1]	1207 [3.9]	**144 [11.5]**	**10.7**	**2.78**	[1.96–3.94]
County road	2384 [7.3]	2100 [6.7]	**284 [22.8]**	**11.9**	**2.42**	[1.76–3.31]
Communal/rural road	419 [1.3]	376 [1.2]	**43 [3.4]**	**10.3**	**1.96**	[1.12–3.41]
One- or two-way street						
Two-way[a]	26,447 [81.2]	25,289 [80.8]	1158 [92.8]	4.4	1.00	
One-way	6117 [18.8]	6027 [19.2]	*90 [7.2]*	*1.5*	**0.56**	[0.40–0.80]
Lanes number						
1 lane[a]	17,479 [53.7]	16,663 [53.2]	**816 [65.4]**	**4.7**	1.00	
2 lanes	9905 [30.4]	9621 [30.7]	*284 [22.8]*	*2.9*	1.13	[0.88–1.44]
≥ 3 lanes	5180 [15.9]	5032 [16.1]	*148 [11.8]*	*2.9*	1.11	[0.78–1.57]
Not a built-up area/uninhabited	3377 [10.4]	2938 [9.4]	**439 [35.2]**	**13.0**	**1.63**	[1.23–2.16]
Inhabited[a]	29,187 [89.6]	28,378 [90.6]	809 [64.8]	2.8	1.00	
Crash-related						
Crash type						
Head-to-side[a]	15,707 [3.8]	15,329 [49.0]	*378 [8.8]*	*2.4*	1.00	
Head-on	1247 [48.3]	1137 [3.6]	**110 [30.3]**	**8.8**	**1.93**	[1.28–2.91]
Side-to-side	3856 [11.9]	3783 [12.1]	*73 [5.9]*	*1.9*	0.67	[0.43–1.04]
Rear-end	3003 [9.2]	2910 [9.3]	*93 [7.4]*	3.1	0.83	[0.54–1.27]
Collision with obstruction	1507 [4.6]	1328 [4.2]	**179 [14.3]**	**11.9**	**1.81**	[1.24–2.64]
Vs pedestrian/animal	2649 [8.1]	2628 [8.4]	*21 [1.7]*	*0.8*	0.40	[0.21–0.78]
Lost control/off-road	2446 [7.5]	2154 [6.9]	**292 [23.4]**	**11.9**	**1.54**	[1.09–2.16]
Miscellaneous/other	2149 [6.6]	2047 [6.5]	102 [8.2]	4.7	0.81	[0.53–1.25]
Maneuver responsible/driver error						
On normal route[a]	5653 [17.3]	5444 [17.4]	209 [16.8]	3.7	1.00	
Entering traffic flow	1333 [4.1]	1284 [4.1]	49 [3.9]	3.7	0.99	[0.57–1.70]
Entering opposite traffic flow	1887 [5.8]	1712 [5.5]	**175 [14.0]**	**9.3**	**1.53**	[1.00–2.33]
Leaving traffic flow without control	513 [1.6]	413 [1.3]	**100 [8.0]**	**19.5**	**1.89**	[1.23–2.90]
Overtaking	989 [3.0]	941 [3.0]	**48 [3.9]**	**4.9**	**1.53**	[0.89–2.63]
Crossing violating priority	1559 [4.8]	1520 [4.8]	*39 [3.1]*	2.5	1.12	[0.62–2.02]
Turning	4343 [13.3]	4218 [13.5]	*125 [10.0]*	2.9	0.86	[0.58–1.27]
Parking/braking/deceleration maneuvers	1823 [5.6]	1784 [5.7]	*39 [3.1]*	*2.1*	0.68	[0.39–1.21]
Lane change	1392 [4.3]	1366 [4.4]	*26 [2.1]*	*1.9*	0.90	[0.45–1.80]
Speeding	1325 [4.1]	1144 [3.6]	**181 [14.5]**	**13.7**	**2.42**	[1.72–3.43]
Red light/stop sign violation	7942 [24.4]	7810 [25.0]	*132 [10.6]*	*1.7*	0.70	[0.45–1.08]
Other	3805 [11.7]	3680 [11.7]	125 [10.0]	3.3	1.03	[0.71–1.49]

[a]Reference (base) value

[b]Age: Mean ± 2.54z (99 CI%)

[c]aOR: Adjusted Odds Ratios derived from multivariate logistic regression analysis. Bold values indicate a significance at $p < 0.05$

[d]Fatally injured drivers: 30-day mortality of drivers

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