



## Tourism and Road Accidents in Greece

Dimitrios Nikolaou<sup>1</sup>, Katerina Folla<sup>2</sup>, Evangelos Bellos<sup>3</sup>, George Yannis<sup>4</sup>

National Technical University of Athens

E-mail<sup>1</sup>: dnikolaou@mail.ntua.gr

E-mail<sup>2</sup>: katfolla@central.ntua.gr

E-mail<sup>3</sup>: vbel@central.ntua.gr

E-mail<sup>4</sup>: geyannis@central.ntua.gr

### Abstract

The objective of this paper is to investigate the effect of tourism on road accidents in Greece. For this reason, a data analysis for injury road accidents in Greece was conducted for the period 2011-2015. It was observed that road accidents and related casualties are increasing during touristic periods and the highest percentages of road accident casualties in touristic regions concern young people and Power Two Wheelers. Moreover, the accident fault risk per driver nationality and region was calculated by the use of the induced exposure method. It was found that foreign tourists have higher accident fault risk than Greeks and immigrants, and foreign tourists' driver fault risk is much higher in non-touristic regions. The results of the analysis allow for an overall assessment of the road safety level in touristic and non-touristic regions in Greece, while some recommendations for enhancing safe tourism are also proposed.

**Keywords:** road accidents, road safety, tourism, induced exposure, accident risk.

### Περίληψη

Στόχος της παρούσας εργασίας είναι η διερεύνηση των επιπτώσεων του τουρισμού στα οδικά ατυχήματα στην Ελλάδα. Για τον λόγο αυτό, έγινε ανάλυση δεδομένων για οδικά ατυχήματα στην Ελλάδα την περίοδο 2011-2015. Παρατηρήθηκε ότι τα οδικά ατυχήματα και οι σχετικοί τραυματισμοί αυξάνονται κατά την τουριστική περίοδο και τα υψηλότερα ποσοστά θανάτων από οδικά ατυχήματα στις τουριστικές περιοχές αντιστοιχούν στους νέους και στα δίκυκλα. Επιπλέον, η πιθανότητα πρόκλησης ατυχήματος ανά εθνικότητα και περιοχή υπολογίστηκε με τη χρήση της μεθόδου της εξαγόμενης έκθεσης σε κίνδυνο. Διαπιστώθηκε ότι οι ξένοι τουρίστες έχουν υψηλότερη πιθανότητα πρόκλησης ατυχήματος σε σχέση με τους Έλληνες και τους μετανάστες, καθώς και ότι η πιθανότητα πρόκλησης ατυχήματος για τους ξένους οδηγούς είναι πολύ υψηλότερη στις μη τουριστικές περιοχές. Τα αποτελέσματα της ανάλυσης επιτρέπουν μία συνολική αξιολόγηση του επιπέδου οδικής ασφάλειας στις τουριστικές και μη τουριστικές περιοχές της Ελλάδας. Τέλος, προτείνονται ορισμένες συστάσεις για την ενίσχυση του ασφαλούς τουρισμού.

**Λέξεις κλειδιά:** οδικά ατυχήματα, οδική ασφάλεια, τουρισμός, εξαγόμενη έκθεση σε κίνδυνο, κίνδυνος ατυχήματος.

### 1. Introduction

Despite considerable efforts and relevant progress, road safety remains a major issue worldwide. Road traffic injuries are the eighth leading cause of death for people of all ages. In 2016, it is estimated that about 1.35 million people lost their lives as a result of road traffic



accidents (WHO, 2018). According to European Commission, around 25,100 road fatalities were reported by the 28 EU Member States in 2018. Road fatalities have decreased by 28% in comparison with 2010. The highest decrease in the number of road fatalities was recorded in Greece (45%). However, despite the impressive reduction in the number of road fatalities, the fatality rate in Greece still remains very high and Greece is among the worst performing countries in Europe in terms of road safety. There were 64 road fatalities per million population during 2018, while the average rate across the EU is 49. (European Commission, 2019).

Greece has a long tradition of hospitality and it is a popular tourist destination due to its natural beauty, extensive coastline, numerous islands, history and culture. Tourism is a common cause of trip generation, which leads to the coexistence of drivers of different nationalities on the same road network. Many studies have been conducted in order to investigate the interactions between local and non-local drivers in terms of road safety.

One relevant study examined the combined effect of driver nationality and several road characteristics on accident fault risk in Greece (Yannis et al., 2007). Results showed that foreign drivers in Greece were at increased risk of involvement in road accidents. Moreover, it was found that foreign permanent residents from Albania appear to be at lower fault risk compared to foreign tourists and visitors. An older study in the Greek island of Crete (Petridou et al., 1997) showed that the odds ratio of road accidents for tourists was close to 1:3, underlying the importance of road accidents as the major health hazard during pleasure travelling. It was also estimated that that drivers from countries where driving is performed on the left side of the road were at an increased risk for road accident when they drove a rented rather than an owned vehicle. Additionally, alcohol abuse was reported as a primary cause of accident in 22% of accidents involving foreign drivers. A similar study was also conducted in the Greek island of Corfu (Petridou et al., 1999). This study examined whether traffic injuries among foreign tourists are more common and severe. It was estimated that only 15% of all accidents consisted of road accidents of residents and Greek tourists, whereas they accounted for 40% of foreign tourists. One of the most recent studies in Greece (Bellos et al., 2019) concluded that tourists are more often involved in road accidents and more specifically, it was observed that the touristic season and tourism as the purpose of traveling led to an increase in road accidents.

Another study revealed that Russian drivers in south-eastern Finland have a higher accident risk compared to Finnish drivers (Leviäkangas 1998). A study on driving behaviour in Kuwait (Koushki et al., 1998) related seat belt use with factors such as nationality, age range, gender, roadway type, vehicle type, trip time and trip distance and concluded that foreign drivers have higher seat belt use rates and lower traffic violations rates. Another study in the United States indicated that more international drivers lack understanding of traffic signs, markings, and traffic signal indications than domestic persons (Dissanayake 2001). In another study in Singapore it was found that foreign drivers have a higher probability of severe injury in motorcyclist accidents (Quddus et al., 2002). A study in the Balearic Islands of Spain has been conducted (Rossello & Saenz-de-Miera, 2011) and it was found that population growth due to the presence of tourists leads to an increase in road accidents. More recently, a study in the United States (Wang et al., 2016) showed that several accident risk factors such as geometry and traffic intensity affected local and tourist drivers in different ways. Finally, a study using data from Norway (Intini et al., 2017) showed that familiar drivers were found to be in most cases drivers involved in vehicle collisions at the rear while unfamiliar drivers were found to



be in many cases those who lost control or who invaded the opposite lane. Familiarity of drivers with the place of the accident was defined by considering a distance measure from their permanent residence.

## 2. Objectives and methodology

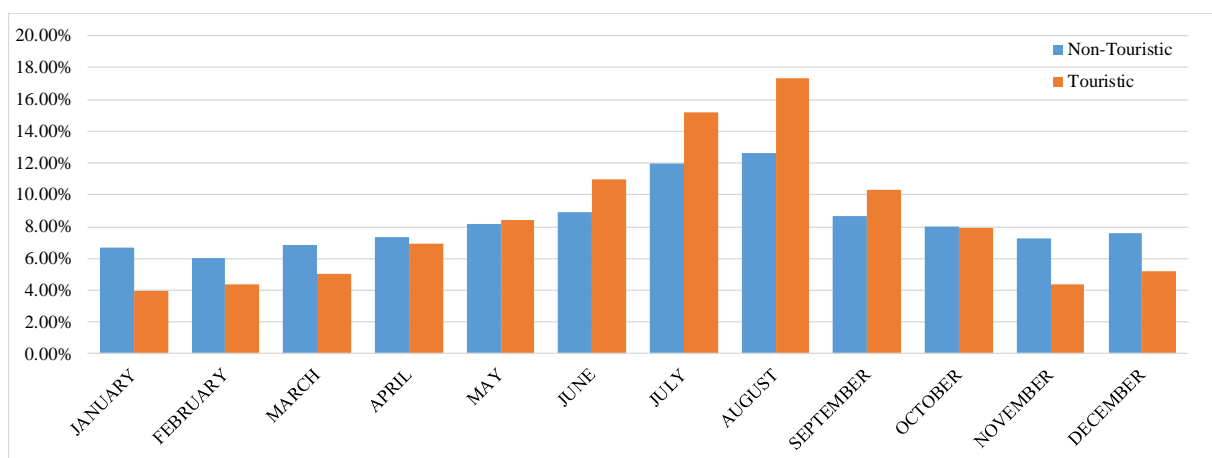
The objective of this study is to investigate the effect of tourism on road accidents in Greece. For this reason, a data analysis for injury road accidents in Greece was conducted for the period 2011-2015. The analysis is based on road accident data collected from the Police and codified into the National Road Accident Database by the Hellenic Statistical Authority (ELSTAT). This national database consists of disaggregated data for all road injury accidents in Greece. It is underlined that the examined accidents do not include damage-only accidents, as accidents without at least one injured person are not recorded.

The analysis was conducted in two stages. The first one is based on the type of region, while the second one is based on the nationality of injured or killed persons in road accidents. On that purpose, Greek regions were classified to touristic and non-touristic, while three groups of injured persons in road accidents were considered according to their nationality; i.e. Greeks, foreign tourists and immigrants. Moreover, the accident fault risk per driver nationality and region was calculated by the use of the induced exposure method. The analysis revealed several interesting findings concerning the relationship between tourism and road accidents in Greece.

## 3. Results

### 3.1 Accident frequency

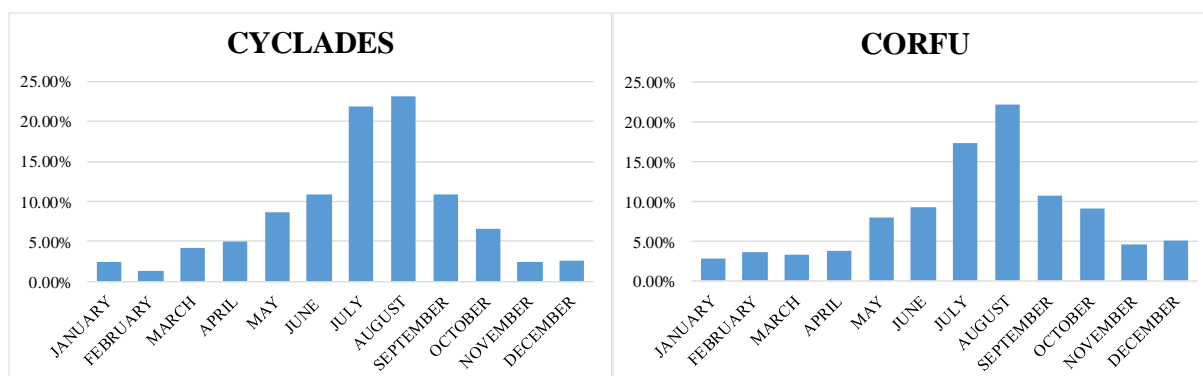
The distribution of road accident casualties (killed or injured persons) by month in touristic and non-touristic regions is shown in Figure 1.



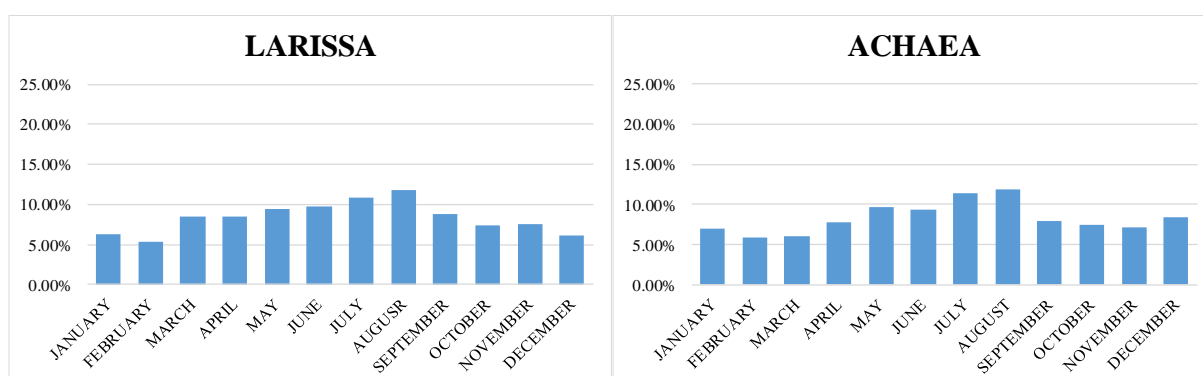
**Figure 1:** *Distribution of road accident casualties by month in touristic and non-touristic regions in Greece, 2011-2015 (Source: ELSTAT)*



It is noted that in all regions, the proportion of the killed or injured persons is higher during the summer months, with the highest rates corresponding to the touristic regions. More specifically, road accident casualties in touristic regions in August are two times higher than the average in these regions. Indicatively, the distribution of casualties in two touristic and two non-touristic regions is presented in Figure 2 and Figure 3.



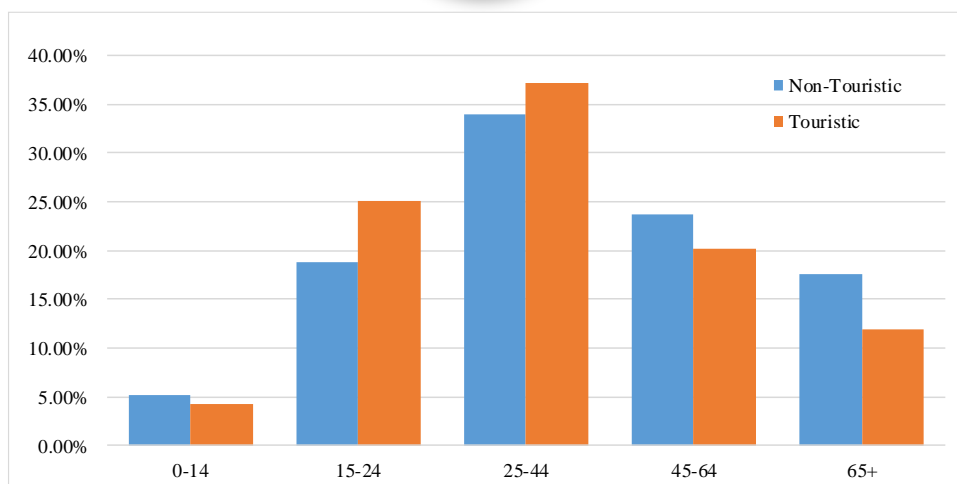
**Figure 2:** *Distribution of road accident casualties by month in two touristic regions in Greece, 2011-2015 (Source: ELSTAT)*



**Figure 3:** *Distribution of road accident casualties by month in two non-touristic regions in Greece, 2011-2015 (Source: ELSTAT)*

In most touristic regions, the number of casualties in road accidents increases during the spring, peaks in August and then decreases in September. On the contrary, a similar pattern is not observed in non-touristic regions, where the seasonal distribution of road accident casualties presents a quite smoother fluctuation.

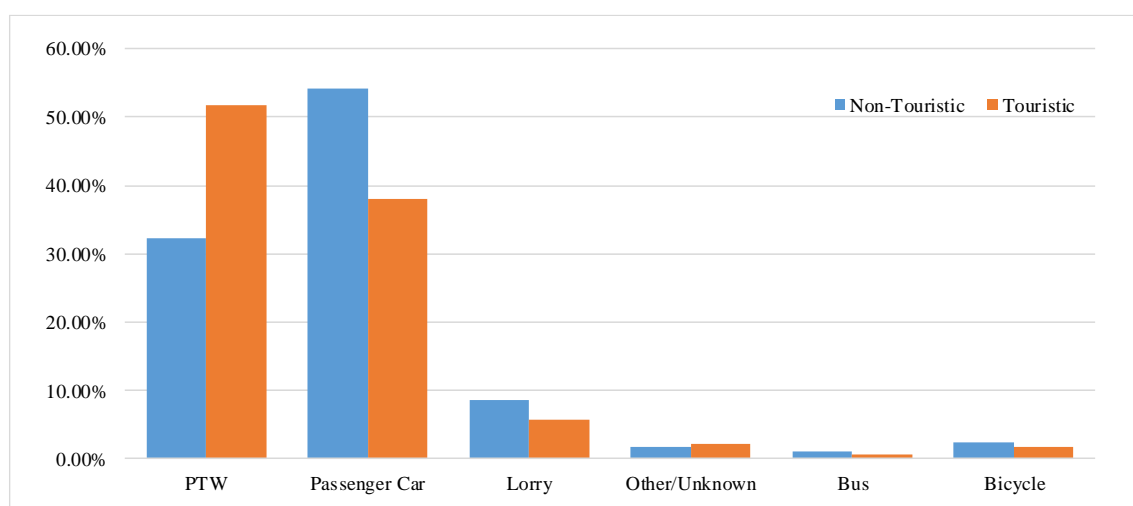
The distribution of road accident casualties by age group in touristic and non-touristic regions is shown in Figure 4.



**Figure 4:** *Distribution of road accident casualties by age group in touristic and non-touristic regions in Greece, 2011-2015 (Source: ELSTAT)*

Regarding the age of killed or injured persons according to the previous figure, in the touristic regions more killed or injured road users at the age of 15-24 and 25-44 are observed, compared to the non-touristic regions. On the contrary, in the non-touristic regions killed or injured road users at the age of 45-64 and 65+ are more than the respective figures in touristic regions. This may be due to the increased traffic of younger people in touristic periods and regions.

The following figure shows the distribution of road accident casualties by transport mode in touristic and non-touristic regions.



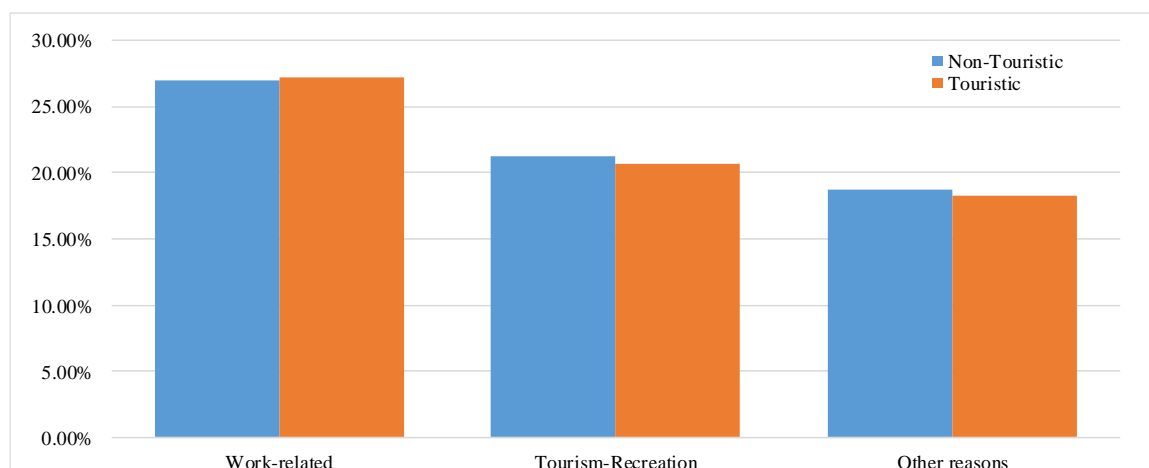
**Figure 5:** *Distribution of road accident casualties by transport mode in touristic and non-touristic regions in Greece, 2011-2015 (Source: ELSTAT)*

It is observed that in touristic regions, the highest rates of injuries concern Power Two Wheelers (PTW) (52%), while in non-touristic regions, the highest percentages of road accident injuries



are recorded for passenger cars (54%). This may be due to the quite higher use of PTWs in touristic regions.

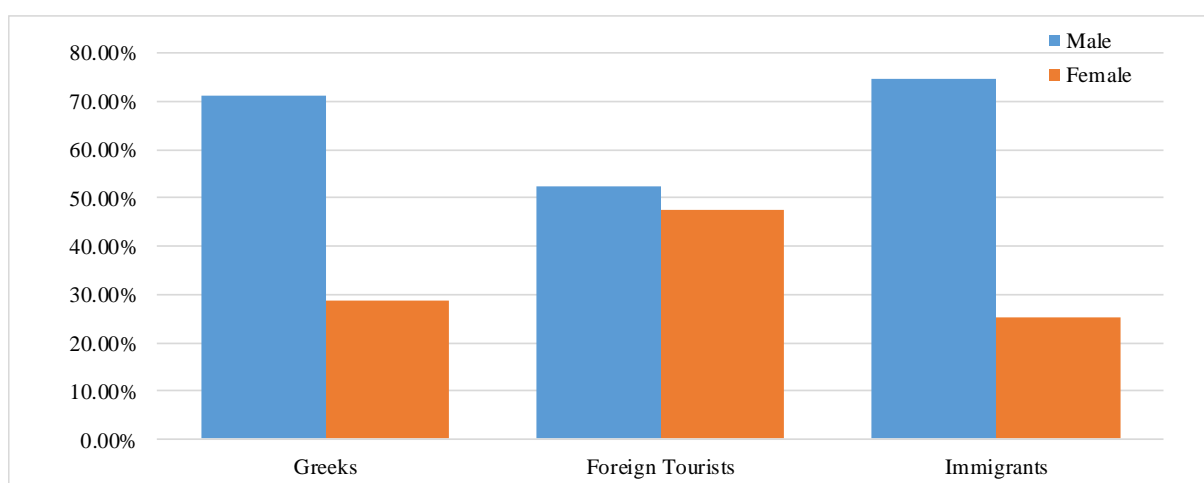
The following figure shows the distribution of killed or injured persons by purpose of journey in touristic and non-touristic regions.



**Figure 6:** *Distribution of road accident casualties by purpose of journey in touristic and non-touristic regions in Greece, 2011-2015 (Source: ELSTAT)*

No substantial difference is observed between the two types of regions. For both touristic and non-touristic regions, work related reasons are the purpose of journey with the highest percentage, as these trips are well present all year long.

In Figure 7, the distribution of casualties by nationality and gender for the period 2011-2015 is presented.

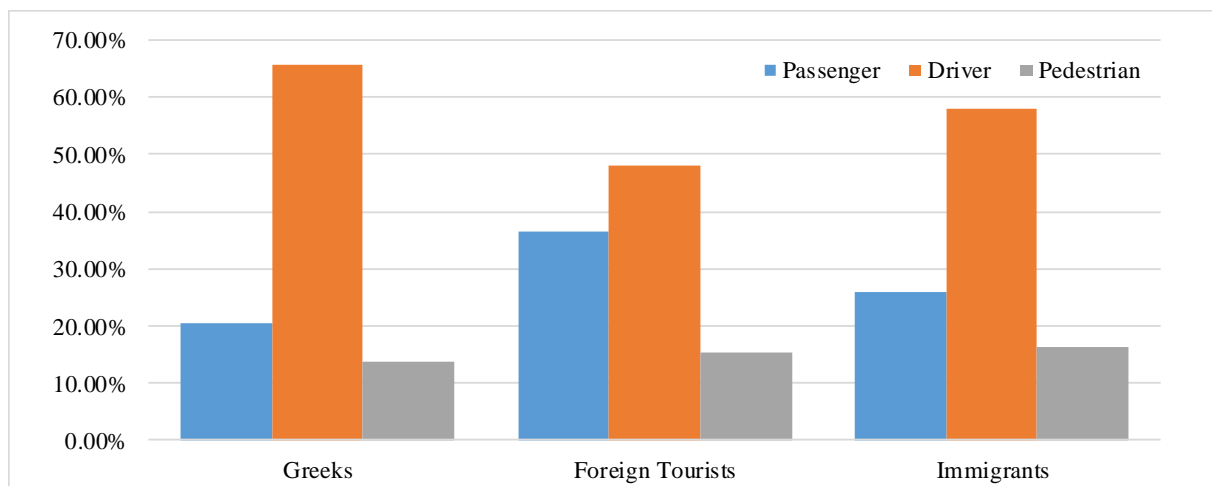


**Figure 7:** *Distribution of road accident casualties by nationality and gender in Greece, 2011-2015 (Source: ELSTAT)*



Among the Greek killed or injured road users, males are over-represented, while among foreign tourists the percentages of male and female casualties are almost equal. The residents higher percentages for male casualties observed might be explained by the higher percentage of traffic kilometers driven by male drivers.

Figure 8 shows the distribution of road accident casualties by nationality and road user type in Greece.



***Figure 8: Distribution of road accident casualties by nationality and road user type in Greece, 2011-2015 (Source: ELSTAT)***

Regarding the type of road user, it is noted that for all nationalities the highest percentage of killed or injured persons concerns drivers. However, for the foreign tourists, the difference between killed or injured drivers and passengers is not that important compared to Greeks and immigrants residents, as shown in the following diagram. Perhaps it could be explained by the fact that in touristic regions the occupancy of vehicles is higher than that of vehicles in non-touristic regions.

The following tables show the distribution of road fatalities and road accident injuries by nationality and period in touristic and in non-touristic regions.



**Table 1:** *Percentage of road fatalities in touristic and in non-touristic regions by nationality and period in Greece, 2011-2015 (Source: ELSTAT)*

	Touristic Regions			Non-Touristic Regions		
	Touristic Period	Non-Touristic Period	Total	Touristic Period	Non-Touristic Period	Total
Greeks	79%	83%	81%	88%	88%	88%
Foreign Tourists	11%	6%	8%	2%	1%	2%
Immigrants	10%	11%	10%	10%	11%	10%
Total	100%	100%	100%	100%	100%	100%

**Table 2:** *Percentage of road accidents in touristic and in non-touristic regions by injured persons' nationality and period in Greece, 2011-2015 (Source: ELSTAT)*

	Touristic Regions			Non-Touristic Regions		
	Touristic Period	Non-Touristic Period	Total	Touristic Period	Non-Touristic Period	Total
Greeks	74%	85%	79%	90%	91%	91%
Foreign Tourists	18%	6%	12%	3%	1%	2%
Immigrants	9%	9%	9%	7%	7%	7%
Total	100%	100%	100%	100%	100%	100%

Two main conclusions extracted from Tables 1 and 2:

- Foreign tourists' road fatalities in touristic period are two times higher than foreign tourists' road fatalities in non-touristic period.
- Foreign tourists' road injuries in touristic period are three times higher than foreign tourists' road injuries in non-touristic period.

### 3.2 Accident Risk

Tables 3 and 4 present the accident fault risk distribution as calculated by the use of the induced exposure method. The induced exposure method is based on the assumption that in every road accident in which two vehicles are involved there is one driver responsible for the accident and one innocent driver involved randomly from the total population of drivers. Consequently, the innocent driver can be considered as a sample of the total population of the drivers and reflects





the exposure of any specific driver population defined on the basis of certain characteristics (Yannis et al., 2007).

The basic requirement for the use of this method is the identification of the driver who provoked the accident. Accidents in which more than one drivers are responsible are not taken into consideration. Accident risk indices are the ratio of the “guilty” drivers percentage with a certain characteristic (i.e. driver's nationality) divided by the percentage of “innocent” drivers of the same characteristic group. The relative risk, which is the ratio of the two relative accident indices, is representative of the tendency of the driver groups to provoke an accident. Ratios higher than 1 show that the relative driver group with the accident index as the nominator provokes more accidents than the other group. This method has been tested in several occasions and its statistical validity has been verified.

Consequently, the induced exposure method can be valuable in road safety analyses when relative traffic data are not available. However, it should be noted that this method concerns only drivers and not all road users, has as a prerequisite the knowledge of the “guilty” and “innocent” drivers and does not take into account all types of accidents (i.e. single-vehicle accidents).

The following tables show the results of the induced exposure method applied by taken into account driver's nationality and type of region.

***Table 3: Accident fault risk distribution per driver nationality in Greece, 2011-2015 (Source: ELSTAT)***

	Greeks	Foreign Tourists	Immigrants	Total
<b>At-fault</b>	8,157	439	734	9,330
	87%	5%	8%	
<b>Not at-fault</b>	8,167	352	702	9,221
	89%	4%	8%	
<b>Accident risk</b>	0.99	1.23	1.03	
<b>Relative risk</b>	1.00	1.25	1.05	

As shown in Table 3, Greek drivers have lower fault risk than foreign tourists and immigrants; a 0.99 ratio is calculated, suggesting that in the examined category they cause fewer accidents than the ones they get caught up in. Among the three categories of drivers, foreign tourists drivers appear to have higher accident risk than the others.



**Table 4:** Accident fault risk distribution per driver nationality and region in Greece, 2011-2015  
(Source: ELSTAT)

	Greeks	Foreign Tourists	Immigrants	Total
<b>At-fault</b>				
Touristic Regions	2,258	305	241	2,804
	81%	11%	9%	
Non-Touristic Regions	5,899	134	493	6,526
	90%	2%	8%	
<b>Not at-fault</b>				
Touristic Regions	2,259	260	239	2,758
	82%	9%	9%	
Non-Touristic Regions	5,908	92	463	6,463
	91%	1%	7%	
<b>Accident risk</b>				
Touristic Regions	0.98	1.15	0.99	
Non-Touristic Regions	0.99	1.44	1.05	
<b>Relative risk</b>				
Touristic Regions	1.00	1.17	1.01	
Non-Touristic Regions	1.00	1.46	1.07	

Table 4 shows that accident fault risk for Greek drivers remains lower both in touristic and non-touristic regions compared to the other nationality categories. It is interesting to note that there is no significant difference between Greeks and immigrants mainly in touristic regions. On the contrary, a significance difference in driver fault risk between touristic and non-touristic regions can be identified for foreign tourists.

#### 4. Conclusions

The results of the previous analyses led to several useful observations regarding the effect of tourism on road accidents. During touristic periods, an increase in road accidents and related casualties is observed, with the highest increase being observed in touristic regions. This fact



demonstrates clearly the important impact of tourism on road safety in Greece. Moreover, in touristic regions, the highest percentages of road accident casualties concern PTWs, which might be explained by the higher PTW traffic observed in touristic regions. Another observation that emerges is that in the touristic regions there are more killed or injured persons at the age of 15-24 and 25-44 compared to the non-touristic regions, demonstrating also the increased traffic of younger people in touristic periods and regions. Among foreign tourists, the percentages of male and female casualties are almost equal, whereas for the residents, higher percentages are observed for male casualties, possibly due to more traffic kilometers driven by male drivers. Regarding the accident fault risk foreign tourists have the highest accident fault risk (25%) than Greeks and immigrants. In addition, foreign tourists' driver fault risk is much higher in non-touristic regions.

Consequently, it is recommended that targeted measures should be taken in order to both enhance safe tourism and achieve reduction of road casualties. For instance, stricter random breath tests and overall more systematic signage and awareness raising for the Greek road network should be conducted. Furthermore, the Greek government could develop a national road safety tourism strategy and support scientific studies for the analysis of road safety in relation to tourism. The local governments (prefectures and municipalities) could develop local tourist road safety strategies, particularly targeting high risk areas which could be identified with the corporation of Police. Additionally, vehicle rental companies should ensure that all motor vehicles meet applicable minimum regulations for occupant and other user protection, with seat belts, air bags and standard active safety systems. They should also check the validity of customers' driving licenses for the desired vehicle according to the road traffic rules of the destination country and they could also supply customers with information on local road traffic rules and information on how to ensure their own safety. Moreover, NGOs could work with the Police and local authorities to assist in the development of road safety campaigns. Last but not least, travelers themselves should take responsibility of their own safety and obey the local road traffic rules.

Concluding, the results of the present research allow for an overall assessment of the road safety level in touristic and non-touristic regions in Greece, providing, thus, useful support to decision makers working for the improvement of road safety, who should take into account the particularities of these regions and the different behavior patterns of road users.

## 5. References

- Bellos, V., Ziakopoulos, A., & Yannis, G. (2019). Investigation of the effect of tourism on road crashes. *Journal of Transportation Safety & Security*, 1-18.
- Dissanayake, S., & Lu, J. J. (2001). Traffic Control Device Comprehension: Differences between Domestic and International Drivers in USA. *IATSS research*, 25(2), 80-87.
- European Commission. (2019). *2018 road safety statistics: what is behind the figures?*. European Commission.
- Intini, P., Colonna, P., Berloco, N., Ranieri, V., & Ryeng, E. (2017, March). The relationships between familiarity and road accidents: Some case studies. In *Transport Infrastructure and Systems: Proceedings of the AIIT International Congress on Transport Infrastructure and Systems (Rome, Italy, 10–12 April 2017)*.



- Koushki, P. A., Ali, S. Y., & Al-Saleh, O. (1998). Road traffic violations and seat belt use in Kuwait: Study of driver behavior in motion. *Transportation research record*, 1640(1), 17-22.
- Leviäkangas, P. (1998). Accident risk of foreign drivers—the case of Russian drivers in South-Eastern Finland. *Accident Analysis & Prevention*, 30(2), 245-254.
- Petridou, E., Askitopoulou, H., Vourvahakis, D., Skalkidis, Y., & Trichopoulos, D. (1997). Epidemiology of road traffic accidents during pleasure travelling: the evidence from the island of Crete. *Accident Analysis & Prevention*, 29(5), 687-693.
- Petridou, E., Dessypris, N., Skalkidou, A., & Trichopoulos, D. (1999). Are traffic injuries disproportionately more common among tourists in Greece? Struggling with incomplete data. *Accident Analysis & Prevention*, 31(6), 611-615.
- Quddus, M. A., Noland, R. B., & Chin, H. C. (2002). An analysis of motorcycle injury and vehicle damage severity using ordered probit models. *Journal of Safety research*, 33(4), 445-462.
- Rosselló, J., & Saenz-de-Miera, O. (2011). Road accidents and tourism: The case of the Balearic Islands (Spain). *Accident Analysis & Prevention*, 43(3), 675-683.
- Wang, Y., Veneziano, D., Russell, S., & Al-Kaisy, A. (2016). Traffic safety along tourist routes in rural areas. *Transportation Research Record*, 2568(1), 55-63.
- World Health Organization. (2018). *Global status report on road safety 2018*. World Health Organization.
- Yannis, G., Golias, J., & Papadimitriou, E. (2007). Accident risk of foreign drivers in various road environments. *Journal of safety research*, 38(4), 471-480.