



## Investigating the Impact of Driver and Vehicle Characteristics on the Risk of Red-Light Running Crashes

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**ABSTRACT:** Red-light running is one of the prevalent sights at signalized intersections that vehicles pass without caring for the light. A red-light runner ventures not only his life but also the safety of other road users. This study aims to identify the driver and vehicle characteristics affecting red-light running crash occurrence risk at signalized intersections of Iran. The study's methodology was based on the quasi-induced exposure concept and logistic regression model for ten independent variables and one binary target variable of "driver status." The statistical population included 12445 red-light running crashes from 2012 to 2016. The results demonstrated that vehicle type, residence, license type, and education level affect drivers' fault status in these crashes. Based on the logistic regression model, truck and emergency vehicles, foreign drivers, and type 2 driving licenses increase the risk of drivers being at fault. However, the academic education level of drivers decreases at-fault risk. Finally, some countermeasures were suggested for reducing the risk of red-light running crashes.

### Review History:

Received: 11/13/2020

Revised: 1/4/2021

Accepted: 2/9/2021

Available Online: 2/15/2021

### Keywords:

Quasi-induced exposure

Logistic regression

risk

Signalized intersections

## 1. INTRODUCTION

Traffic crash fatalities are among the challenges of the current human society that venture human health and impose many economic costs. According to World Health Organization (WHO), traffic incidents have been increasing and reach 1.35 million in 2016 [1]. Traffic injuries are the 8th leading cause of fatalities among different age groups. Moreover, socio-economic costs of crashes in European countries are estimated at ca. 500 billion euros, which constitute 3% of Europe's gross domestic production (GDP) [2]. According to UNICEF, traffic crashes in Iran kill 28000 people and disable more than 300000 annually [3]. Red-light running is one of the most critical traffic safety issues at signalized intersections [4]. Studies show that factors affecting traffic crashes are mainly divided into four groups: human, vehicle, road, and environment [5]. Studying these factors can lead to improving traffic safety and controlling accidents. Driver and vehicle factors have been studied in many countries due to their vital and essential role in red-light running crash occurrence. The current study has been organized in Iran to investigate these two factors (driver and vehicle). Identifying the factors affecting the risk of crashes could help determine appropriate countermeasures for reducing the number of crashes. This study used crash data to examine the effect of driver and vehicle features on the risk of being at-fault or not-at-fault in red-light running crashes.

The literature review's contribution shows that many

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studies have been conducted in countries to analyze the factors affecting red-light running violations, and they have different results. The present study aims to fill the gap in studying driver and vehicle factors on the risk of red-light violations in Iran. Previous studies conducted in this field in Iran were on land use, intersection geometry, and traffic light scheduling. To this aim, the logistic regression model and quasi-induced exposure concept are used.

## 2. METHODOLOGY

This study used quasi induced exposure concept and a logistic regression model.

### 2.1. Quasi-induced exposure

To achieve the study's purpose, the number of accidents and the exposure index in different conditions and separately for drivers' characteristics should be available. Exposure is the number of places and times that are prone to a particular crash occurrence. The quasi-induced exposure concept is based on two assumptions: (1) in two-vehicle crashes, one driver is at fault, and the other is not-at-fault. (2) not-at-fault driver in two-vehicle crashes is a sample of total vehicles in crash time. The main advantage of the quasi-induced exposure is its ability to estimate the exposure for a specific group of drivers and vehicles, which is impossible in other methods such as vehicle kilometers. Involvement Ratio risk is therefore obtained by dividing the percentage of at-fault drivers in a group of drivers to not-at-fault drivers in the same group:



$$IR_j = \frac{F_j}{NF_j} \quad (1)$$

In which  $F_j$  and  $NF_j$  are at-fault and not-at-fault driver frequency in group  $j$ .

## 2.2. Logistic regression model

Logistic regression models are used for examining influential variables in quasi-induced exposure. This model is used when the dependent variable discrete.

## 3. RESULTS AND DISCUSSION

Based on quasi-induced exposure concept results, drivers with 76-85 years have the highest risk and decreases in middle-age drivers. Male drivers have more risk of running the red this could be since they are driving more than women. Drivers with "special" license types have more risk than other types. The relative risk of emergency vehicles (ambulance, fire truck, and police car) is a lot more than others that could be due to their emergency usage, which cannot stop at signalized intersections. The relative risk of drivers with self-employed is more than others while drivers who are student have the lowest risk. The reason could be related to their lower kilometer traveled compared with self-employed drivers. Resident drivers have a higher risk than foreign drivers, which could be because of their route familiarity. Moreover, the relative risk of drivers decreases with increasing their driving experience. Expectedly, drivers who use seat belts have a lower risk than others. Drivers' risk rises with decreasing their educational level. Finally, vehicles' risk increases with increasing their age that could be due to their brake system failure while deciding to stop at the red signal.

According to the logistic regression results, the residence variable is statistically significant, and the odds ratio of foreign drivers is 47% more than resident drivers. In other words, foreign drivers' being at fault is 47% more than resident drivers.

In the education variable, the "academic" level of education is statistically significant. With determining "Diploma" education level as a reference category, drivers with "academic" levels are 20% less likely to be at fault. In the license type variable, the "type 2" license is significant,

and with determining "temporary license" as the reference category, the odds ratio of type 2 is 0.78, which means the probability of being at-fault in "type2" license is 30% less than "temporary" type. In-vehicle type variable, the likelihood of being at-fault in "truck" is two times, and for "ambulance," "fire truck," and "police car" is 15 times more than "trailer" as the reference category. The p-value for other variables was more than 0.05, and they were not statistically significant.

## 4. CONCLUSIONS

The current study identified driver and vehicle characteristics in the risk of the red-light running crash using quasi-induced exposure and logistic regression model. The variables related to drivers and vehicles in this study are selected based on available crash data. According to the results, drivers' residence, education level, license type, and vehicle type have a significant role in the risk of running red-light. The relative risk of men is higher than women. Also, 76-85 age group, "special" license type, ambulance, fire truck, and police car, "under diploma" education level, driving experience less than five years, vehicle age more than ten years, and "self-employed" drivers have the highest relative risk. Considering the results, some practical countermeasures like increasing the traffic knowledge of male drivers, separating educational classes according to the education level of drivers with more emphasis on driving violations in lower education levels, special arrangements for ambulances that cannot stop at red traffic signals could help prevent the occurrence of red-light violations.

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### HOW TO CITE THIS ARTICLE

A. Tavakoli Kashani, S. Amirifar, A. Mirhashemi, Investigating the Impact of Driver and Vehicle Characteristics on the Risk of Red-Light Running Crashes, Amirkabir J. Civil Eng., 53(1) (2021) 23-24.

DOI: 10.22060/ceej.2021.19246.7113

