Accident Analysis and Prevention 94 (2016) 162–167

Contents lists available at ScienceDirect

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap

Short communication

The role of exposure on differences in driver death rates by gender and age: Results of a quasi-induced method on crash data in Spain

José Pulido [a,b], Gregorio Barrio [a,*], Juan Hoyos [b], Eladio Jiménez-Mejías [b,c,d], María del Mar Martín-Rodríguez [e], Sjoerd Houwing [f], Pablo Lardelli-Claret [b,c,d]

[a] Escuela Nacional de Sanidad, Instituto de Salud Carlos III, c/Monforte de Lemos, 3-5, Pabellón 7, 28029 Madrid, Spain
[b] CIBER Epidemiología y Salud Pública (CIBERESP), Avenida Monforte de Lemos, 3-5, Pabellón 11, 28029 Madrid, Spain
[c] Departamento de Medicina Preventiva y Salud Pública, Facultad de Medicina, Universidad de Granada, Avenida de Madrid, 11, 18012, Granada, Spain
[d] Instituto de Investigación Biosanitaria de Granada, C/Doctor Azpitarte 4 4a Planta, Edificio Licinio de la Fuente, 18012 Granada, Spain
[e] Servicio de Medicina Preventiva, Complejo Hospitalario Universitario Insular-Materno Infantil, Avenida Marítima, s/n, 35016 Las Palmas, Spain
[f] SWOV, Institute for Road Safety Research, Bezuidenhoutseweg 62, The Hague 2594 AW, The Netherlands

ARTICLE INFO

Article history:
Received 24 November 2015
Received in revised form 21 April 2016
Accepted 20 May 2016
Available online 12 June 2016

Keywords:
Traffic accidents
Mortality
Quasi-induced exposure
Sex factors
Age factors
Spain

ABSTRACT

Aim: Part of the differences by age and gender in driver death rates from traffic injuries depends on the amount of exposure (km/year travelled). Unfortunately, direct indicators of exposure are not available in many countries. Our aim was to compare the age and gender differences in death rates with and without adjustment by exposure using a quasi-induced exposure approach in Spain, during 2004–2012.
Methods: Crude and adjusted death rate ratios (CDRR and ADRR, respectively) were calculated for each age and gender group. To obtain the latter estimates, in accordance with quasi-exposure reasoning, the number of registered drivers was replaced by the number of non-infractor drivers, passively involved in collisions with another vehicle whose driver committed an infraction. 18–29 years and female drivers were chosen as the reference categories for age and gender.
Results: Striking differences were found between CDRR and ADRR estimates. When CDRR were estimated, we found the highest traffic mortality among the youngest drivers, except for females in non-urban roads. ADRR however showed the highest mortality among the oldest groups, especially in females, peaking among drivers >74 years in all types of roads. Regarding differences by gender, both estimates revealed higher traffic mortality in males, although the differences were much smaller when using ADRR. CDRR and ADRR for males tended to converge as age increased.
Conclusions: Death risk from traffic injuries among drivers is clearly influenced by the amount of exposure. These findings further emphasize the need to obtain direct traffic exposure estimates by subgroups of drivers.

1. Introduction

Driver death rates are widely used in all countries as health indicators for road crashes, with several purposes; i.e., quantifying the magnitude of the problem, monitoring the usefulness of road safety measures, or identifying subgroups of high-risk drivers. Regarding the latter purpose, the experience in Europe, one of the safest regions in the world, has shown the success of the adoption of feasible quantitative targets based on the reduction of death rates in specific sub-groups of drivers (International Road Traffic and Accident Database, 2013). The large differences found in death rates from traffic injuries across age and gender groups of drivers (European Road Safety Observatory, 2013) has been used to identify subgroups of high-risk drivers (for example, young male drivers), in order to prioritize preventive strategies for these subgroups (Santamarina-Rubio et al., 2014). However, the real causes of these differences cannot be easily ascertained through the use of mortality rates based on the number of registered drivers by gender and age, because this denominator does not capture the amount of exposure yielded by each group of drivers (European Road Safety Observatory, 2005). Therefore, direct exposure indicators that truly fit these mortality rates to real conditions of the driver population are required. Different types of direct exposure measures are used for estimating mortality risk. Vehicle-kilometers (or person-kilometers, taking into account vehicle occupancy) and time spent in traffic are the closest to the theoretical definition of exposure

* Corresponding author.
E-mail addresses: gbarrio@isciii.es, goybarrio@gmail.com (G. Barrio).

http://dx.doi.org/10.1016/j.aap.2016.05.020
0001-4575/

(European Road Safety Observatory, 2005). Together with number of trips, they are usually measured by both national surveys and specific questionnaires (Blanchard et al., 2010; Chipman et al., 1992). Vehicle-kilometers is perhaps the most often used direct exposure measure because it captures regional and temporal variations in the use of roads in a particular area (European Road Safety Observatory, 2005). Unfortunately, in Spain there are no routine surveys addressing the amount of exposure for different subgroups of drivers and driving environments. Instead, the information on exposure is based on aggregate estimates of the average kilometers travelled, referred only to non-urban roads (Ministerio de Fomento, 2014), or on indirect estimates from the registered drivers or fleet (Novoa et al., 2009). This entails a strong limitation for investigating the traffic accidents-related factors, prioritizing road safety interventions and explaining the differences in the magnitude of death rates across subgroups of drivers.

In an effort to overcome the above limitation, in the present study we apply an indirect approach based on a quasi-induced exposure method (Lardelli-Claret et al., 2006; Stamatiadis and Deacon, 1997), which may be useful for those countries that do not get direct exposure estimates, allowing to adjust for the differences in driver death rates found between age and gender subgroups of drivers by their respective amount of exposure. Therefore, the aim of the present study was to compare and explain the age and gender differences in driver death rates with and without adjustment by exposure in Spain, from 2004 to 2012.

2. Methods

The Spanish Dirección General de Tráfico (Traffic General Directorate) provided the two data sources for this study. The first one was the Spanish Register of Drivers of motorized vehicles (Dirección General de Tráfico, 2015), from which we obtained the number of licensed drivers stratified by year (from 2004 to 2012), by gender and age groups (15–17 years, 18–29 years, 30–44 years, 45–64 years, 65–74 years and >74 years). The study period started in 2004, when road safety was included on the political agenda by the Spanish Government in that year (Novoa et al., 2011), implementing a large package of road safety actions during 2004–2005 that led to a marked decline on mortality from traffic injuries. Age categories were selected taking into account the legal requirements for driving in Spain: it is allowed to ride a moped at 15, a motorcycle ≤125cc at 16, and riding almost any type of motorcycle, cars, vans and trucks ≤7500 kg at 18.

The second data source was the Spanish Register of Road Traffic Crashes with Victims, a nationwide police-based register which included information at the scene of the crash collected by the national police force (for collisions on nonurban roads) and local police forces (for urban roads). From this register, we obtained the following information:

- Number of driver deaths occurred at the time of the accident or within 30 days after it, in accordance with Illustrated Glosary for Transport Statistics of the European Union (European Union et al., 2010),
- Number of non-infractor drivers involved in collisions between two motorized vehicles in which only one of the drivers committed any driving infraction.

Both series of data were stratified by year, gender, age (using the same categories as those described for registered drivers), and type of road in which the crash occurred (urban and non-urban roads). Appendix A shows the corresponding figures of drivers killed (17,975) and non-infractor drivers (186,806) for each stratum.

In the analysis stage, we chose a specific *j* type of drivers as a reference group. Therefore, the crude (unadjusted by exposure) death rate ratio of any other group of drivers *i* ($CDRR_i$), should be obtained as follows:

$$\text{CDRRi} = (\text{number of fatally injured drivers in category i/number of registred drivers in category i})/(\text{number of fatally injured drivers incategoryj/number of registred drivers in category j}) \quad (1)$$

Expression (1) may be rewritten as follows:

$$\text{CDRRi} = (\text{number of fatally injured drivers in category i/number of fatally injured drivers in category j})/(\text{number of registred drivers in category i/number of registred drivers in category j}) \quad (2)$$

According to quasi-induced exposure reasoning, in a representative sample of collisions between two vehicles in which only one of the drivers is the responsible for the collision (i.e., clean collisions), the distribution of non-responsible drivers involved in this kind of collisions (i.e., passively involved drivers) should resemble the distribution of general driving population (Jiang and Lyles, 2010; Lardelli-Claret et al., 2006; Stamatiadis and Deacon, 1997). Hence, the quotient

$$\text{numberofnon-responsible drivers involved in clean collisions in category i/number of non-responsible drivers involved in clean collisions in category j} \quad (3)$$

informs about the relative increase of exposure rate of i-group drivers compared to the exposure of the reference category (j drivers). Therefore, replacing the original denominator of equation (2) by the expression (3):

$$\text{ADRRi} = (\text{number of fatally injured drivers in category i/numberof fatally injured drivers in category j})/(\text{number of non-responsible drivers involved in clean collisions in category i/number of non-responsible drivers involved in clean collisions in category j}) \quad (4)$$

The resulting expression (4) is the adjusted-by-exposure death rate ratio of i-group drivers ($ADRR_i$) compared to j-group drivers. The Spanish Register of Road Traffic Crashes with Victims does not contain specific information on the responsibility of each driver involved in the crash. To assess driverís responsibility, in the present study we have considered as clean collisions those in which only one of the two involved driverís had committed any driving infraction. Doing so, we assume that in two-vehicle collisions in which only one of the drivers has committed any driving infraction, the sample of non-infractor drivers has a high probability of being non-responsible for these collisions. Therefore, it can be considered as a representative sample of the general driving population (as they have been passively hit by a responsible driver).

To estimate CDRR and ADRR by age and gender categories, we have chosen two reference (*j*) categories: 18–29 years and female drivers, respectively. All estimates have been stratified according to gender (when assessing the effect of age), age (when assessing the effect of gender), and type of road (urban and non-urban roads). Assuming that both crude and adjusted death rates follow a Poisson distribution (Fleiss et al., 2003), we have constructed Poisson regression models to obtain 95% confidence intervals for