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Research note

Powered two-wheeler drivers' risk of hitting a pedestrian in towns

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ABSTRACT

Introduction: The risk of collision between pedestrians and powered two-wheelers is poorly understood today. The objective of this research is to determine the risk for powered two-wheeler drivers of hitting and injuring a pedestrian per kilometer driven in towns and to compare this risk with that run by four-wheeled vehicle drivers. *Method:* Using the bodily injury accidents recorded by the police on nine roads in the city of Marseille in 2011 and a campaign of observations of powered two-wheeler traffic, we estimated the risk per kilometer driven by powered two-wheeler drivers of hitting a pedestrian and compared it with the risk run by four-wheeled vehicle drivers. *Results:* The results show that the risk for powered two-wheeler drivers of hitting and injuring a pedestrian is significantly higher than the risk run by four-wheeled vehicle drivers. On the nine roads studied, it is on average 3.33 times higher (95% CI: 1.63; 6.78). Taking four more years into account made it possible to consolidate these results and to tighten the confidence interval. *Conclusion:* There does indeed seem to be problems in the interactions between pedestrians and powered two-wheeler users in urban traffic. These interaction problems lead to a higher risk of hitting and injuring a pedestrian for powered two-wheeler drivers than for four-wheeled vehicle drivers. The analysis of the police reports suggests that part of this increased risk comes from filtering maneuvers by powered two-wheelers. *Practical applications:* Possible countermeasures deal with the urban street layout. Measures consisting in reducing the width and the number of traffic lanes to a strict minimum and installing medians or pedestrian islands could be an effective way for the prevention of urban accidents between pedestrians and powered two-wheelers.

1. Introduction

For the last fifteen years or so, the use of motorcycles, scooters, and mopeds, collectively termed powered two-wheelers, has increased sharply in Europe, notably in large, congested metropolitan areas (European Commission, 2013). In France, the increase in the number of powered two-wheelers[1] in traffic in major urban areas has been accompanied by stagnation in automobile use (collective work, 2010). Is this increase in the number of powered two-wheelers in traffic good news for pedestrian safety? To find out, one prerequisite would be to understand the risk of accidents between pedestrians and powered two-wheelers. But our understanding is inadequate in this area. Indeed, other than Paulozzi (2005) which found that, in the United States, the risk per kilometer driven in towns by powered two-wheeler drivers of fatally injuring a pedestrian is 2.02 times (95% confidence interval: 1.23; 3.30) higher than the risk for automobile drivers; no other scientific studies have dealt with this question as far as we know. In France, we know the number of bodily injury accidents between pedestrians and powered two-wheelers recorded by the police each year and the number of pedestrians injured and killed. For the year 2011, 1,636 bodily injury accidents involving a pedestrian and a powered two-wheeler were recorded, or 13.6% of the pedestrian accidents recorded. Thirty-four pedestrians were killed in these accidents, or 6.6% of pedestrians killed (Observatoire National Interministériel de Sécurité Routière (ONISR), 2012). If we compare these proportions with the share that powered two-wheelers represent in traffic, which is approximately 2% according to the French national transport accounts (Commissariat Général au Développement Durable (CGDD), 2012), this suggests that, in France as well, powered two-wheeler users have a greater chance of hitting and injuring a pedestrian than do automobile drivers per kilometer driven. But is this trend verified in large urban areas where

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[1] In France, powered two-wheelers are separated into three main administrative categories: (*i*) mopeds, with engines under 50 cm^3 and whose construction limits their speed to 45 km/h. They can be driven from the age of 14. In this category; scooters are the majority although traditional pedal mopeds and a few trail and sport mopeds with gearboxes can be found in traffic as well; (*ii*) light motorcycles, with engines greater than 50 cm^3 and less than 125 cm^3. They can be driven with an automobile driver's license under certain conditions. Here again, scooters account for a very large share of these. There are, however, different basic, trail and sport models on the market (*iii*) heavy motorcycles, with engines greater than 125 cm^3, which require a motorcycle license. This category includes the following seven types: basic, roadster, touring, sport, trail, custom and scooter.

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powered two-wheelers are significantly more numerous[2] and where pedestrians no doubt expect to interact with them more? And if this is confirmed overall for all powered two-wheelers, does it also hold true for each category of powered two-wheelers (mopeds, light motorcycles and heavy motorcycles)? The study reported on in this paper aimed at answering these questions. More precisely, the main hypothesis that we are seeking to validate or invalidate is that of an increased risk among powered two-wheeler drivers of hitting and injuring a pedestrian in the center of large urban areas compared with automobile drivers.

2. Data and method

The study carried out concern nine roads located in the center of Marseille. With more than 1.5 million inhabitants, Marseille is the second largest urban area in France after Paris in terms of the number of inhabitants. Located in the south of the country on the Mediterranean coast, it has a long history of high powered two-wheeler use. For the most part, the roads studied are main roads in the city of Marseille's road network. They have a certain number of features in common such as the presence of several lanes in the same direction, crossroads that generally have traffic lights and the existence of bus lanes in at least one traffic direction.

For each of the nine roads, we have estimated the risk for powered two-wheelers of hitting and injuring a pedestrian in 2011. To do this, we compared the number of powered two-wheelers that hit and injured a pedestrian to the number of powered two-wheelers × kilometers exposed to this risk (number of powered two-wheelers that drove on the road in 2011 multiplied by the length of the road). The same approach was adopted for drivers of four-wheeled vehicles in order to estimate their risk of hitting and injuring a pedestrian per kilometer driven. Four-wheeled vehicles include passenger cars, light-duty trucks and heavy trucks.[3] We then expressed the relationship between these rates in the form of a relative risk to obtain an estimation of the increased risk or reduced risk for powered two-wheelers of hitting and injuring a pedestrian compared with four-wheeled vehicles. Lastly, an overall relative risk and its 95% confidence interval were calculated for all the roads by undertaking a meta-analysis. For this, we based our work on the method described in Elvik and Vaa (2004). We should point out that the investigations covered weekdays (Mondays to Saturdays, excluding public holidays) during daytime hours (from 6.00 am to 10.00 pm).

The accident data we used came from the reports drawn up by the police in 2011 concerning bodily injury accidents.[4] The data on road traffic were transmitted to us by the direction Marseille Provence Métropole's Direction Gestion des Equipements de Trafic (Traffic Equipment Management Division). This service centralizes the traffic data gathered by the inductive loop traffic counters set up on the road network in the city of Marseille. As powered two-wheelers are not distinguished from four-wheeled vehicles in these counts, we undertook a campaign of powered two-wheeler traffic observation in order to estimate the share that they represent in overall traffic. Fifty-two hours of observations was carried out on the nine roads with random distribution throughout the entire year of 2011. Each sequence of observations lasted 1 h and was carried out by a team of two investigators positioned on the sidewalk. These observations showed that, on the nine roads, powered two-wheelers on average account for 16.3% of the road traffic. Mopeds (with engines under 50 cm^3), light motorcycles (with engines under 125 cm^3) and heavy motorcycles (engines greater than 125 cm^3) represent 20%, 48%, and 32% of this traffic, respectively (for further details on the observation method and the results, see the bibliographical reference for Michel et al. (2013)).

We have access to the hourly road traffic on each of these roads for the years 2007, 2008, 2009, and 2010, as well as the precise locations of the pedestrian accidents; the same approach was adopted, this time cumulating the years 2007, 2008, 2009, 2010, and 2011. We should point out that these additional investigations were based on the hypothesis that the share of powered two-wheelers in traffic did not change between the 2007–2010 period and 2011, since we did not carry out observations of powered two-wheeler traffic in 2007, 2008, 2009, and 2010. This hypothesis appears acceptable to us.[5] Taking these additional four years into account should enable us to consolidate the results obtained for the year 2011. It should also enable us to detect a trend for the various categories of powered two-wheelers.

3. Results

In 2011, on the nine roads studied, 11 powered two-wheelers and 19 four-wheeled vehicles (including 17 automobiles) hit and injured a pedestrian. Table 1 presents the number of vehicles that hit and injured a pedestrian for each road, the annual exposure of two-wheelers and four-wheeled vehicles on each road (expressed in vehicles × kilometers), the estimated relative risk, and the 95% confidence interval.

The meta-analysis of the results obtained individually on each road gives an overall relative rate of 3.33 with a 95% confidence interval of [1.63; 6.78]. The test of heterogeneity performed[6] does not make it possible to conclude that the results are heterogeneous for the different roads, since $Q = 3.61$ and $p = 0.89$.

According to these results, on the nine roads studied in 2011, powered two-wheeler drivers had a risk of hitting and injuring a pedestrian that, on average, was 3.33 times greater than for four-wheeled vehicle drivers.

This result nonetheless remains fragile given the small number of accidents recorded on each road (see Table 1). Taking four additional years into account should enable us to specify this increased risk and to tighten the confidence interval. Table 2 presents the number of vehicles that hit and injured a pedestrian on each road during the 2007–2011 period, the exposure of two-wheelers and four-wheeled vehicles during those five years, the estimated relative risk, and the 95% confidence interval.

It appears that powered two-wheelers' risk of hitting a pedestrian is greater than that of four-wheeled vehicles on the nine roads studied (see Table 2). The lower bound of the confidence interval is greater than 1 on five of the nine roads. The results of the meta-analysis give an average relative risk of 3.06 with a tighter 95% confidence interval between 2.26 and 4.14. Here again, the test of heterogeneity does not make it possible to conclude that the results are heterogeneous between the roads ($Q = 2.63$; $p = 0.96$).

According to these results, powered two-wheeler users have, on average, three times the risk (3.06 times more) of hitting and injuring a pedestrian per kilometer driven than four-wheeled vehicle drivers. This result is statistically significant at a 0.05 threshold. The initial hypothesis is validated. When four-wheeled vehicles are limited to passenger cars, the relative risk is similar: powered two-wheeler users have 3.12 times (95% CI [2.29; 4.24]) more of a risk of hitting and injuring a pedestrian than passenger car drivers. It was not possible to make any

[2] For example, in the center of Paris and Marseille, powered two-wheelers account for approximately 17% of traffic according to Maestracci, Prochasson, Geffroy, and Peccoud (2012), Kopp (2011), and Michel, Fournier, and Clabaux (2013).

[3] We should point out, however, that in the city center of Marseille, light-duty trucks (motor vehicle having a gross vehicle weight of up to 3,500 kg) and heavy trucks (motor vehicle having a gross vehicle weight exceeding 3,500 kg) are very much in the minority compared with passenger cars.

[4] In France, a bodily injury traffic accident is defined as an accident involving at least one vehicle that takes place on a road open to traffic and leads to at least one victim (Observatoire National Interministériel de Sécurité Routière (ONISR), 2012).

[5] We feel that this hypothesis is acceptable insofar as, according to the Commissariat Général au Développement Durable (Commissariat Général au Développement Durable (CGDD), 2012), the average annual growth rate for powered two-wheelers in road traffic for the 2007–2011 period was 2.1% (see Commissariat Général au Développement Durable (CGDD), 2012, p. 61). Indeed, this share grew the most up to the year 2007 (ibid.).

[6] The test of heterogeneity carried out was that described in DerSimonian and Laird (1986).