INJURIES

Epidemiology of accidents among users of two-wheeled motor vehicles

A surveillance study in two Italian cities

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Background: This paper describes a study on the epidemiology of accidents among users of two-wheeled motor vehicles in two Italian cities, Rome and Naples. Methods: A surveillance study was conducted, recruiting the victims of accidents among users of two-wheeled motor vehicles, visiting the emergency departments of two Italian hospitals. The registration form includes personal data of the involved person, circumstances of the accident, means of arrival at the hospital, type of vehicles involved, helmet use, and eventually third parties involved, and data on the specific injury diagnosis. Results: 736 injured drivers of two-wheeled motor vehicles were investigated for the study (65.1% males, 34.9% females). The mean age of the victims was 22.92 years; 42.9% of the injuries were the result of a single accident. In 35.5% of the injuries cars were involved and in 8.6% of the cases there was a passenger included. Only 12% of the injured people were wearing a helmet. Most of the lesions concerns the knee or lower leg (27.5%), followed by the head (17.5%), elbow and forearm (8.8%), wrist and hand (8.6%), shoulder and upper arm (8.4%) and ankle and foot (6.9%). Helmet use has a protective effect (OR=0.23), whereas accidents in Naples and during dark hours are associated with an increased risk of head injury (respectively OR=1.93, and OR=1.46). Conclusion: In this study the lower injury risk due to the use of the helmet on the frequency and severity of head trauma was confirmed. Moreover, the results confirm that Emergency Departments can provide essential epidemiological information, and they have already provided clear arguments in favour of extending the compulsory use of helmets to people above 18 years in Italy.

Keywords: accidents, epidemiology, Italy, two-wheeled motor vehicle

Road traffic accidents represent an important public health problem in both industrialized1,2 and developing countries.3 In Italy, around 270,000 road traffic accidents occur annually. In 1997 this resulted in 6226 deaths, more than 20% of which were the result of an accident among users of two-wheeled motor vehicles.4 The number of fatal injuries related to the use of two-wheeled motor vehicles in Italy is high in comparison to other industrialized countries and it is likely that many of these fatalities could have been prevented. In particular, head injuries and their negative consequences are largely preventable by wearing a helmet, as has been demonstrated in several studies.5-10 Moreover, it has been established that the introduction of helmet laws leads to an increasing use of helmets and to a reduction of the number of hospital admissions, serious accidents, and costs related to head trauma.11-14

In Italy, however, the compulsory use of helmets has until recently (March 2000) been restricted to persons below 18 years of age. Italy is therefore characterized by a considerable delay in the implementation of a helmet law covering the whole population in comparison to other industrialized countries. The absence of adequate surveillance systems could have contributed to this delay, because the magnitude of the problem of accidents among users of two-wheeled motor vehicles has not yet become clear. In Italy there is still no homogeneous system of notification of road accidents at Accident and Emergency (A&E) departments. In order to study a possible solution to this inadequacy, an original data collection exercise for injury surveillance was initiated.

After validation of a registration form a descriptive study was conducted on the epidemiology of accidents among users of two-wheeled motor vehicles in two Italian cities, Rome and Naples. The following specific questions were addressed:

- What is the distribution of injuries treated at an A&E Department among users of two-wheeled motor vehicles by age, sex, and type and severity of injury?
- Does this distribution differ between Rome and Naples?
- Does this distribution differ between helmeted and non-helmeted victims?

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What is the impact of helmet use on the frequency and severity of head trauma in scooter drivers attending two hospitals in two big Italian cities?

METHODS
Study design and setting
A surveillance study was conducted, recruiting the victims of accidents among users of two-wheeled motor vehicles, visiting the emergency departments of two hospitals (Policlinico Umberto I in Rome and Nuovo Pellegrini in Naples). These hospitals were chosen because of their size (the biggest hospital in Rome and the second largest in Naples) and their central location in these cities.

A pilot study of 1 month was conducted in December 1998, in order to validate the registration procedures and forms. The definite surveillance study covered a period of 6 months in both hospitals, from January to June 1999. A case was defined as an injured driver of a two-wheeled motor vehicle, 14–35 years of age visiting the emergency department of one of the two participating hospitals.

Data collection
The data collection involved medical doctors specializing in Hygiene and Preventive Medicine, neurosurgeons and general surgeons of the A&E Department in Naples, and medical doctors, general surgeons and psychologists at the A&E Department in Rome. The data were collected every day. Moreover, nurses of the A&E Departments were recruited for data collection in night hours (after 8 p.m.). In addition, for accidents that happened during the night, there was a linkage with Hospital Police Departments in order to check the completeness of the data.

The registration form filled in at the emergency department includes personal data of the person involved, circumstances of the accident, means of arrival at the hospital, type of vehicles involved, helmet use, and, eventually, third parties involved in the accident. The form also includes data on the specific injury diagnosis, according to an ICD-10 matrix system of codes with several axes representing the location and the nature of injury. For patients with head trauma the Glasgow Coma Scale (GCS) was registered, adding information concerning level of consciousness and injury severity, through scores about conditions related to eye opening, verbal and motor response, with best conditions represented by 14–15 scores.

Additional data for persons admitted to hospital were collected in collaboration with the Health Management Office with a second registration form that includes information about length of hospital stay, hospital discharge diagnoses, need of rehabilitation, diagnostic procedures and surgical interventions.

Data analysis
We composed frequency tables in order to describe the distribution of injuries among users of two-wheeled motor vehicles by several characteristics. The $\chi^2$ test was used in order to find statistically significant differences between the epidemiology of accidents in Rome and Naples, at a level of $p<0.05$.

Analysis of differences between helmeted and unhelmeted riders, and between Rome and Naples with respect to age, were done using the Student’s t test. Relative risks (95% CI) were calculated to estimate an excess risk of being injured at a specific body region in unhelmeted versus helmeted riders. A logistic regression analysis was used to estimate the influence of the following variables on head injury: helmet use (yes vs no), location of accident (city centre vs outskirts or rural), day (weekend vs working days), season (winter vs spring), hospital (Naples vs Rome), crash type (collision vs noncollision), visibility (dark vs daylight), passenger transport (yes/not), sex (female vs male), age-group (≥18 years vs <18 years). The entry method was used for the analysis, with a cut-off of 0.10 for the significance level. Data processing, parametric and non-parametric tests of significance, and logistic regression analysis were performed with SPSS statistical software.

RESULTS
Table 1 shows the distribution of injured scooter drivers and their helmet use, by city, age group and sex. A total of 736 injured drivers of two-wheeled motor vehicles was
covered in the study (65.1% males, 34.9% females) (table 1). Of these, 234 males and 193 females were from Rome, and 245 males and 64 females from Naples ($\chi^2 = 47.3; p=0.000$). The mean age of the victims was 22.92 ($\pm 5.73$) years and differed between Rome and Naples (Naples= 20.29 $\pm 5.17$ and Rome 24.82 $\pm 5.36$; $t=-11.47; p=0.000$): 21.3% were 14–17 years and 78.7% were 18–35 years of age (34.8% aged 18–23; 27.7% aged 24–29; and 16.2% aged 30–35). There was also a statistically significant difference between the two cities concerning the month of the accident, this being more frequent during winter time in Rome, and during spring time in Naples ($\chi^2 =137.75; p=0.000$).

Table 2 shows that 42.9% of the injuries were the result of a single road accident, without the involvement of other road users. On the other hand, in 44.6% of the injuries, cars were involved and in 3.7% of the cases there was a passenger included (which is not allowed by Italian law). Again, it becomes clear that there are large differences between Rome and Naples. It is evident that in Rome almost two-thirds of the injuries were the result of a single accident, while in Naples cars were involved in the majority of cases (table 2). Within our study population only 12% of injured people were wearing a helmet. Again we found a statistically significant difference between Rome and Naples, with helmet use being more frequent in Rome (19%) ($\chi^2 = 47.6; p=0.000$). Moreover, we found a statistically significant difference between the mean age of helmeted and unhelmeted riders (respectively $24.77 \pm 5.86$ and $22.67 \pm 5.67$; $t=3.24; p=0.001$).

Table 3 shows that the distribution by location and nature of injury is shown according to an ICD-10 matrix. More than a quarter of the lesions concerns the knee or lower leg (27.5%), followed by the head (17.5%), elbow and forearm (8.8%), wrist and hand (8.6%), shoulder and upper arm (8.4%) and ankle and foot (6.9%). A high frequency of contusions (59.9%) was observed in both hospitals, followed by abrasions (23.9%), dislocations, sprains and strains (6.6%), and open wounds (5.1%) (table 3). Table 4 shows the frequency distribution of head trauma by nature of injury and city. It is clear that in Naples the share of severe injuries (fractures and blood vessel injuries) is higher than in Rome (table 4). For what concerns GCS, all injured scooter drivers wearing the helmet had a score of 14–15, while for people not wearing the helmet, 0.6% and 3% had a score $\leq 13$ in Rome and Naples, respectively. Again, there is a difference between the two cities, with the worst GCS scores being more frequent in Naples ($\chi^2 =22.32; p=0.00017$). Both in Rome and Naples no scooter driver wearing a helmet had a GCS score under 14.

Table 5 compares the risk of being injured at a specific body region of helmet users and non-users respectively. Only head trauma seems to be influenced by helmet use, with a nearly sixfold increase among non-users (RR=5.73), while injuries to thorax, abdomen and ex-

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**Table 2** Third parties involved in scooter accidents, by hospital

<table>
<thead>
<tr>
<th>Third party involved</th>
<th>Rome</th>
<th>Naples</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No body</td>
<td>276</td>
<td>40</td>
<td>316</td>
</tr>
<tr>
<td>Car</td>
<td>117</td>
<td>211</td>
<td>328</td>
</tr>
<tr>
<td>Scooter passenger</td>
<td>15</td>
<td>12</td>
<td>27</td>
</tr>
<tr>
<td>Others</td>
<td>19</td>
<td>46</td>
<td>65</td>
</tr>
<tr>
<td>Total</td>
<td>427</td>
<td>309</td>
<td>736</td>
</tr>
</tbody>
</table>

$\chi^2 = 201.96; p=0.000$

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**Table 3** ICD-10 matrix indicating the distribution and severity of lesions of injured scooter drivers

<table>
<thead>
<tr>
<th>Location and nature of injury</th>
<th>Head</th>
<th>Neck</th>
<th>Thorax</th>
<th>Abdomen and lower back</th>
<th>Pelvis and spine</th>
<th>Shoulder and upper arm</th>
<th>Elbow and forearm</th>
<th>Wrist and hand</th>
<th>Hip and thigh</th>
<th>Knee and lower leg</th>
<th>Ankle and foot</th>
<th>Multiple body regions</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abrasion</td>
<td>49</td>
<td>3</td>
<td>22</td>
<td>70</td>
<td>42</td>
<td>27</td>
<td>170</td>
<td>21</td>
<td>46</td>
<td>450</td>
<td>4</td>
<td>23.9</td>
<td></td>
</tr>
<tr>
<td>Contusion</td>
<td>201</td>
<td>33</td>
<td>66</td>
<td>111</td>
<td>90</td>
<td>92</td>
<td>81</td>
<td>300</td>
<td>72</td>
<td>1124</td>
<td>72</td>
<td>59.9</td>
<td></td>
</tr>
<tr>
<td>Open wound</td>
<td>58</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>8</td>
<td>3</td>
<td>14</td>
<td>6</td>
<td>2</td>
<td>97</td>
<td>6</td>
<td>5.1</td>
<td></td>
</tr>
<tr>
<td>Fracture</td>
<td>14</td>
<td>1</td>
<td>8</td>
<td>3</td>
<td>15</td>
<td>2</td>
<td>18</td>
<td>8</td>
<td>6</td>
<td>69</td>
<td>6</td>
<td>3.7</td>
<td></td>
</tr>
<tr>
<td>Dislocation, sprain and strain injury to nerves and spinal cord</td>
<td>63</td>
<td>4</td>
<td>13</td>
<td>4</td>
<td>4</td>
<td>15</td>
<td>21</td>
<td>124</td>
<td>6.6</td>
<td>0.4</td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Injury to blood vessels</td>
<td>7</td>
<td>1</td>
<td></td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.4</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Injury to muscle and tendon</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.2</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Crushing injury</td>
<td></td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.1</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Traumatic amputation</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injury to internal organs</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total (%) 329 (17.5) 63 (3.4) 34 (1.8) 75 (4) 157 (8.4) 165 (8.8) 162 (8.6) 120 (6.4) 517 (27.5) 129 (6.9) 126 (6.7) 1877 (100)
DISCUSSION
This study has produced information on the distribution of injuries among users of two-wheeled motor vehicles in Italy, for a period of six months. It has shown that the majority of victims is male (65%), older than 18 years (80%) and not wearing a helmet (88%). It has also shown that the epidemiology of injuries may differ by city. In this study we found striking differences between Rome and Naples, and this is very interesting considering that the chosen hospitals have a central location in both cities, and that people attending the two hospitals are comparable. In Naples, for example, there are more cars involved, the mean age of the victims is lower, injury severity is higher and helmet use is even less frequent than in Rome. These results suggest that the different road behaviours in the two cities may be due to different civic cultures. Finally, in our study the lower injury risk due to the use of the helmet on the frequency and severity of head trauma was confirmed. Our study demonstrates that the observed differences in the rate of head injury among helmeted and unhelmeted scooter riders are not explained by differing crash factors, such as type of crash, localization, type of day and season, age and sex, and passenger transport. The results make it clear that injury surveillance systems may produce valuable information. Surveillance can be defined as ‘the ongoing systematic collection, analysis and interpretation of health data essential to the planning, implementation and evaluation of public health practice, closely integrated with the timely dissemination of these data to those who need to know’. Surveillance depends on the willingness of clinicians to cooperate in registration activities. In our study we found satisfactory completeness of data collection, based on registration procedures and forms that were adjusted at the suggestion of clinicians during a pilot study.
as harmless ‘bicycles with a helper motor’. So the need for formal registration and helmet laws for mopeds is apparent. Compulsory helmet laws should therefore not be limited to motorcyclists but also focus on all moped riders, and probably also bicyclists. But in spite of the great potential of wearing a helmet to protect road users from head injury, our study has shown a very low rate of helmet use among drivers of two-wheeled motor vehicles in Italy. There is a sort of hostility towards the helmet, that is often considered ‘useless, ridiculous, anti-aesthetic, uncomfortable’ especially by young people. The scarce application of this correct road behaviour reflects the fact that in our country only the ‘threat for a severe accident’ and the ‘fear for a fine’ seem to be efficient stimuli to persuade one to use helmets.

Our surveillance system suggests that Italian legislation on the compulsory use of safety helmets has so far been applied insufficiently, which could in part be due to lack of law enforcement by the police. But on the other hand, during our study period, a large number of scooter drivers was still not obliged to wear a helmet; persons above 18 years of age. Our surveillance system suggests that this may have led to unnecessary health damage.

As with all surveillance-based research, our study has suffered from several limitations. First of all, not all factors that may influence the likelihood and severity of accidents, such as speed at impact and alcohol concentration in blood, could be recorded. Secondly, the sample selection at two hospitals ensures that all riders in this surveillance study are injured. But, if helmet use is able to reduce injury severity, helmeted scooter riders are probably underrepresented, which could have led to an underestimation of the usefulness of wearing a helmet.

Considering the results of this study conducted in only two Italian cities, the next step, in order to monitor the epidemiology of scooter accidents, could be repeating the study after the implementation of the new law on mandatory helmet use for the whole population, and implementing the surveillance system at the national level. The results from this surveillance study have confirmed that emergency departments can provide essential epidemiological information, and, considering that almost 80% of injured scooter drivers were 18–35 years of age, they have already provided clear arguments in favour of extending the compulsory use of helmets to people above 18 years in Italy.

REFERENCES


Two-wheeled motor accidents in Italy