BRIEF REPORT

# The economic cost of road traffic crashes in an urban setting

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The objective of this article is to assess the total economic costs of road traffic crashes in Barcelona, a metropolitan city located in Southern Europe. A cost-of-illness study was conducted using a prevalence approximation, a societal and healthcare system perspective, and a 1-year time horizon. Results were measured in terms of Euros in 2003. Total costs of road traffic crashes in Barcelona in 2003 were €367 million. Direct costs equalled €329 million (89.8% of total costs), including property damage costs, insurance administration costs and hospital costs. Police, emergency costs and transportation costs had a minimum effect on total direct costs. Indirect costs were €37 million, including lost productivity due to hospitalization and mortality. The results of the sensitivity analysis showed the upper limit of total economic cost of road traffic crashes in Barcelona to be €782 million. This is the first study to estimate the costs of road traffic crashes for a city in a developed country. The importance of the problem calls for further interventions to reduce road traffic crashes.

According to a report of the World Health Organization, road traffic injuries account for almost 1.2 million deaths a year around the world and for 20–50 million injuries or disabilities.[1] The economic consequences of road traffic crashes are also very important, in terms of both lost productivity and all healthcare resources needed. In economic terms, the cost of road crash injuries is estimated at roughly 1% of the gross national product in low-income countries, 1.5% in middle-income countries and 2% in high-income countries.[1] The economic costs for traffic crashes range are between €7347 per injury in Portugal and €119 174 in Sweden, and between €105 546 per death in Holland and €2 160 000 in the US.[2 3] In Spain, economic costs of road traffic crashes have been estimated as €6280 million in 1997 and €10.538 million in 1999.[2 4] There are no estimations of the cost of road traffic crashes for a city, but as in 2004, 53% of total road injury crashes occurred in urban areas, and injured 46% of the total population, but caused only 33% of road fatalities.[5] Information about costs is the first step towards the assessment of the cost effectiveness of strategies to reduce the effect of traffic crashes.[6]

As in many other cities in developed countries, in Barcelona road traffic crashes pose an important public health problem. Barcelona has a population of 1.3 million and a road length of 1275 km; in 2004 there were 9745 injurious crashes, injuring 12 911 people in the city, although most of them had low-severity injuries (87.5% injury severity score <4), and 42 met with death. The statistics per million kilometers traveled (MKmT) were 787.7 crashes/MKmT, 983 people injured/MKmT and 1502 vehicles involved/MKmT.[7]

We aimed to assess the economic costs of road traffic crashes in Barcelona, a metropolitan city located in Southern Europe.

## METHODS

We conducted a cost-of-illness study to identify the different cost elements associated with road traffic crashes, with and without injured people and fatalities, and assign them a monetary value using the available epidemiological and economic information.[8 9] The counterpoint of the analysis is that the costs are being calculated against the hypothetical alternative of the non-existence of road traffic crashes.

We used a prevalence approximation—that is, we estimated all costs having an effect on the time period of reference.[10] We used a societal and a healthcare system perspective. The temporal horizon used was 1 year, and the estimation of costs and consequences was referred to 2003.

We included estimations of direct and indirect costs. As direct costs we included healthcare costs such as acute care in hospitals, emergency care, and transportation, and non-healthcare costs such as police, insurance administration and property damage. To calculate the cost of acute care, we took into account the number of stays in general and the number of rehabilitation hospitals from the 2003 hospital discharge register. Hospital stays corresponding to a discharge either reported as road traffic crash (and paid by an insurance company) or with any of the following International Classification of Diseases—ninth edition codes: E810–E819 and E826 were included. To this figure, and as a proxy to the cost for the healthcare system, we applied a reimbursement tariff according to the complexity of the hospital and the length of stay.[11] We could not include information about admissions in long-term care centers, due to the limitations of their information system. However, we included stays in the main rehabilitation centers of the city, where many long stays take place. Those stays are reimbursed as acute care, so they were analyzed jointly with acute care.

To calculate the cost of emergency care, we took into account the number of hospital emergency visits due to road traffic crashes. This figure is based on the Road Emergencies Surveillance System, where the main hospitals of the city provide data on road injuries.[12] This surveillance system has a coverage of 85% of all emergencies attended in public hospitals, so the number of emergency visits was increased by 15% as an estimation of the total number of emergencies. We then applied to this a reimbursement tariff according to the complexity of the hospital where the cases were attended.[11] To calculate patient transportation costs, we obtained the number of transfers that the public emergency services of the city did in 2003; to this number, we applied the corresponding reimbursement tariff (Servei Català de la Salut, personal communication, 2005). For transportation costs, we also obtained the reimbursement tariff of insurance companies—much higher—that we used in the sensitivity analysis.[11]

Regarding direct non-healthcare costs, to the number of traffic crashes attended by the police, we applied an estimation of the city police department about the cost to attend them (Guardia Urbana, personal communication, 2005). Estimations about insurance administration and reimbursements for property damage were obtained from insurance companies for the whole province, and were adjusted proportionally to the number of crashes that occurred in the city (ICEA, personal communication, 2005).[13] We could not include any estimation about prevention, education and research, fire department, and

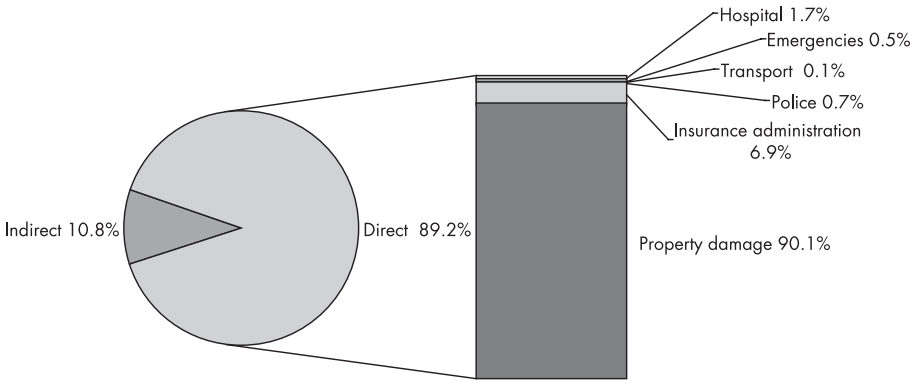


**Figure 1** Distribution of the base case scenario costs of road traffic.

the justice system costs owing to the lack of data and poor information systems.

To estimate indirect costs, we applied the human capital approach, using lost working days, mean wages and occupation rates.[4 14 15] To calculate indirect costs related to mortality, we calculated the lost productivity, measured as the number of deaths that occurred due to road traffic crashes and the mean wage in 2002 of the autonomous community of Barcelona, actualized to 2003.[16] To calculate the indirect costs attributable to morbidity, we included the length of stay of patients in general and rehabilitation hospitals both paid as road traffic crashes or with any of the relevant International Classification of Diseases—ninth edition codes (E810–E819, E826), and applied to them the mean wage in 2002, actualized to 2003.[16] Both calculations were corrected by the occupation rate in Barcelona during 2003.[17]

The values presented thus far allowed estimating a conservative cost value (base case scenario). For a sensitivity analysis, we varied the values of the variables for:

- transportation costs, using the highest reimbursement tariff of ambulances[11];
- indirect costs, including the cost of the foregone earnings of the deceased people, taking into account a maximum of 70 years of life expectancy (the standard way years of potential life lost are calculated).

## RESULTS

The conservative cost of road traffic crashes in Barcelona is €367 million (base case scenario; table 1). Direct costs are the biggest part of them, equaling €329 million (89.8% of total costs). Among direct costs, we could highlight property damage costs (90.1% of direct costs), insurance administration costs (6.9%) and hospital costs (1.7%; fig 1). Police, emergency costs and transportation costs have a minimum effect on total direct costs (each of them account for <1%). Indirect costs are €37 million.

From the perspective of the healthcare system, the conservative cost of road traffic crashes is €7.3 million. In this case, hospital costs are the biggest part, corresponding to 74.4% of the total healthcare costs.

By sensitivity analysis, and taking into account the highest value for transportation costs, healthcare costs would amount

**Table 1** Costs of road traffic crashes in Barcelona

| Costs | No units | Unit cost | Total cost |
|---|---|---|---|
| **Direct costs** | | | |
| Healthcare costs | | | |
| Hospital stays | 29890 stays | €18832/stay | 5461038.74 |
| Emergency visits | 17583 visits | €82.99/visit | 1581017.86 |
| Transportation | 12200 transfers | €24.61/transfer (€171.00/transfer) | 300242 (2086200) |
| Total healthcare costs | | | 7342298.60 (9128256.60) |
| **Non-healthcare costs** | | | |
| Police | 11137 transfers | €222.37/tranfer | 2476534.69 |
| Insurance administration | | | 22649748.00 |
| Property damage | | | 297325140.00 |
| Total non-healthcare costs | | | 322481422.69 |
| Total direct costs | | | 329823721.29 (331609679.29) |
| **Indirect costs** | | | |
| Due to hospitalization | 29890 stays | €21350.46/month | 18249467.54 |
| Due to mortality | | | |
| Deaths | 85 deaths | €21350.46/month | 19305726.45 |
| YPLL | (1903 life years) | (€21350.46/month) | (432221146.19) |
| Total indirect costs | | | 37555193.98 (450470613.73) |
| Total costs | | | 367378915.27 (782080293.02) |

YPLL, years of potential life lost.
Parameters and numbers in parentheses indicate variables varied in the sensitivity analysis. Figures correspond to upper limit values obtained in the sensitivity analysis.

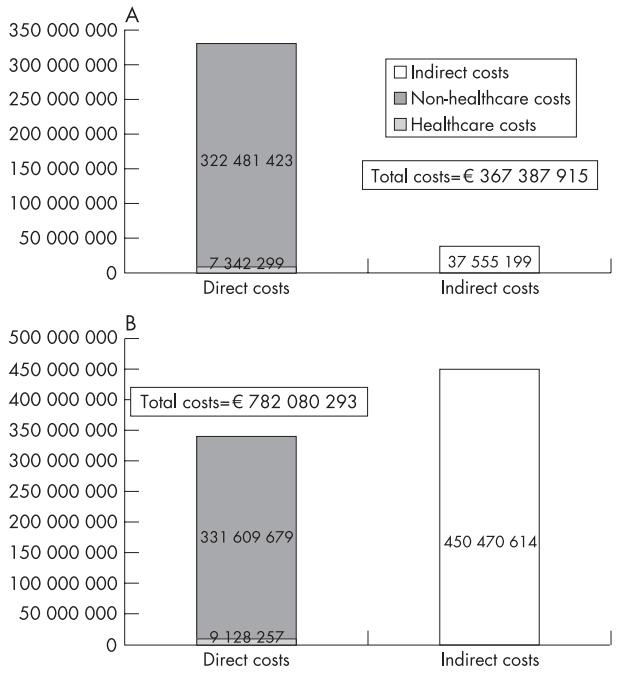


**Figure 2** (A) Base case scenario. (B) Upper limit costs.

to €9.1 million; taking into account the highest value for future foregone earnings, indirect costs could amount to €450 million; so, the upper limit of total economic cost of road traffic crashes in Barcelona would be €782 million (fig 2).

## DISCUSSION

This study estimated that the conservative cost of road traffic crashes in Barcelona in 2003 is €367 million. Putting these figures in relative terms, the minimum and maximum cost values estimated would represent between 19.7% and 41.9% of the whole budget of the city.[18] Although direct comparison of study figures is not recommended due to methodological differences between studies and different scopes (ie, studies have been conducted in countries, not in cities), we could say that the economic cost of road traffic crashes in Barcelona is in the range of values presented in other developed countries: €10 538 million in Spain in 1999; US$230 600 million in the US in 2000.[2–4]

There are several limitations to this study. In the case of acute care, we worked with the hospital discharge register, which carries with it the limitations of working with hospital administrative databases and morbidity codes,[19] and also the non-inclusion of some private hospitals (accounting for an estimated 18% of all discharges).

A second limitation is that in all cases, the estimation is a minimum value, because some other elements have not been included due to the absence of information. This could be the case for long-term care, drugs prescribed by primary care doctors, prevention, education, research, the fire department and the justice system. We have not included household work loss, as well as delay due to traffic jams caused by road traffic crashes. Regarding indirect costs, we did not include productivity losses of uninjured occupants, carers, long-term work absences and quality of life lost.

This is the first study to estimate the costs of road traffic crashes for a city, instead of a region or a country, in a developed country. Study results showed that the costs of road traffic crashes in Barcelona are very high, in epidemiological and economic terms, and point out an important public health problem. The importance of urban road traffic crashes has been the spark for the design of interventions to reduce them. A few already-evaluated traffic control initiatives have shown to be efficient, and have been recommended elsewhere.[20–23] Actually, in March 2003, eight speed cameras were installed in the Barcelona belt parkway; their effectiveness and cost effectiveness are currently being assessed, although preliminary results allow optimism about their effectiveness.[24]

Furthermore, detailed cost information related to healthcare services should be available, such as long-term care registries, and primary care drug prescription information, as well as other non-healthcare costs such as those involved in prevention, education and research, the fire department and the justice system. Moreover, some international harmonization procedures of cost data could be locally applied.[25 26]

### Key points

- This is the first study to estimate costs of road traffic crashes for a city in a developed country.
- Total costs of road traffic crashes in Barcelona in 2003 were €367 million; the upper limit of total economic cost of road traffic crashes in Barcelona would be €782 million.
- Direct costs equal €329 million (89.8% of total costs), including property damage costs, insurance administration costs and hospital costs; police, emergency costs and transportation costs have a minimum effect.
- Indirect costs are €37 million, including lost productivity due to hospitalization and mortality.
- The importance of the problem warrants further interventions to reduce road traffic crashes.

## IMPLICATIONS FOR PREVENTION

This is the first study to estimate costs of road traffic crashes for a city instead of a region or a country. Despite being less severe and lethal than non-urban crashes, costs of road traffic crashes in the city of Barcelona are very high, both in epidemiological and economic terms, and call for further interventions to reduce road traffic crashes.

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