



The Financial Burden of Road Traffic Injuries in Mozambique: A Hospital-Related Cost-of-Illness Study of Maputo Central Hospital

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Abstract

Background Road traffic injuries (RTIs) are increasingly being recognized for their significant economic impact. Mozambique, like other low-income countries, suffers staggering rates of road traffic collisions. To our knowledge, this is the first study to estimate direct hospital costs of RTIs using a bottom-up, micro-costing approach in the Mozambican context. This study aims to calculate the direct, inpatient costs of RTIs in Mozambique and compare it to the financial capacity of the Mozambican public health care system.

Methods This was a retrospective, single-centre study. Charts of all patients with RTIs admitted to Maputo Central Hospital over a period of 2 months were reviewed. The costs were recorded and analysed based on direct costs, human resource costs, and overhead costs. Costs were calculated using a micro-costing approach.

Results In total, 114 patients were admitted and treated for RTIs at Maputo Central Hospital during June–July 2015. On average, the hospital cost per patient was US\$ 604.28 (IQR 1033.58). Of this, 44% was related to procedural costs, 23% to diagnostic imaging costs, 17% to length-of-stay costs, 9% to medication costs, and 7% to laboratory test costs. The average annual inpatient cost of RTIs in Mozambique was almost US\$ 116 million (0.8% of GDP).

Conclusion The financial burden of RTIs in Mozambique represents approximately 40% of the annual public health care budget. These results help highlight the economic impact of trauma in Mozambique and the importance of an organized trauma system to reduce such costs.

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Introduction

The 1990 iteration of the Global Burden of Disease Study was the first to highlight the dearth of data on disease burden across the world and to recognize injuries as important contributors to the Global Burden of Disease [1]. Injuries are the ninth leading cause of death in all age groups and are the leading cause of death among young people aged 15–29 years [2], with road traffic injuries making up the lion's share [3]. This burden is only exacerbated by the global economic impact of treating these injuries, which exceeds half a trillion US dollars per year [2].

A significant majority of road traffic fatalities occur in low- and middle-income countries even though these

nations account for just over half of the world's vehicles [3]. The WHO-defined African region bears the highest burden of road traffic mortality, with 24.1 road traffic fatalities per 100,000 population [4]. Mozambique, like other low-income countries, sees the major effects of this crisis. Road injuries are the tenth leading cause of mortality in Mozambique according to the 2013 update of the Global Burden of Disease Study [3]. Furthermore, reflecting the global statistics, vulnerable road users are disproportionately affected, with “car versus pedestrian”-type collisions being the most frequent, and pedestrians making up more than half of road traffic mortality [5].

A 2014 micro-costing study of the cost of road traffic injuries in a South African trauma centre showed that they place a significant financial burden on hospital systems, with an average hospital cost per patient of US\$ 6988. Such costing studies provide an important basis for cost-effectiveness analyses of preventative policy interventions, as well as for the allocation of hospital budgets [6]. Despite the need for these quantitative data, few economic evaluations have been conducted in the sub-Saharan context. To our knowledge, there are no cost-of-illness studies for road traffic injuries in Mozambique. This study is the first of its kind to provide an estimate of the direct, hospital-related cost of road traffic injuries at Maputo Central Hospital, the largest trauma centre in Mozambique. We hypothesize that road traffic injuries (RTIs) carry a significant financial burden to Mozambique and set to determine direct injury-related costs.

Methodology

A retrospective, single-centre cost-of-illness study was conducted to identify the costs associated with road traffic injuries at Maputo Central Hospital. Maputo Central Hospital was chosen for this study, as it is the only national referral centre in the country and serves over 40% of the patient population in the Maputo capital region [7]. For these reasons, it was possible to capture an important proportion of road traffic injuries admitted to any hospital in Mozambique. The study estimates direct, hospital-related costs for road traffic injuries during the time period of 1 June to 1 August, 2015. All the data were recorded onto Excel spreadsheets, and all calculations were done using the same programme. Ethics approval was granted by the McGill University Institutional Review Board and Maputo Central Hospital.

Patient-level data

All patients admitted to the hospital through the emergency department following a traumatic injury due to a road

traffic collision within the time period of reference were included into the study. Exclusion criteria included those who were discharged home from the emergency department after evaluation and all patients with mechanisms of injury other than RTI's.

Basic demographic data collected, including age, gender, mechanism of injury, length of stay (LOS), and course of treatment, were recorded in a de-identified database. A micro-costing approach was used to estimate the cost. This included exact amounts and types of diagnostic imaging undergone, doses and quantities of medications taken, and a thorough record of any operations or procedures that patients underwent. Total amounts for the length of stay, diagnostic imaging, and various treatments were then calculated. These totals acted as the “prevalence” of the different components of road traffic trauma patients' course of illness in hospital.

An analysis of the seasonal variation of trauma cases in Maputo Central Hospital was also performed. The trauma database currently being implemented in Maputo was queried from September 2014 to September 2015, and the median number of traumas was calculated. This was then compared with the numbers of trauma in the study period to determine the presence of any statistically significant variation.

Costing and cost allocation

A combination of a bottom-up, micro-costing approach, and direct cost allocation was used to estimate the financial burden of road traffic injuries.

To properly delineate a comprehensive list of the cost categories, patient flow was determined for trauma patients and costs were evaluated for all inpatient treatment areas (Table 1).

Data regarding resource inputs were separated into the following categories: length of stay (included the accommodation and infrastructure component and human resources), emergency procedures, surgical procedures, diagnostic imaging, and medical treatment. Each of these

Table 1 Patient cost centres

Emergency department (ED)
Orthopaedics ward
Neurosurgery ward
General surgery ward
Intensive care unit (ICU)
Paediatric intensive care unit (PICU)
Step-down unit (SDU)
Operating room (OR)

larger categories was further subdivided to ascertain individual units of allocation. These components were measured in their natural units and formed the direct, human resource, and overhead cost categories. Unit costs were found for each of these individual components or inputs and then multiplied by the units of allocation recorded during the chart review process. The breakdown of the cost categories and allocation units is presented in Table 2. The costs of ward supplies, such as gauze, syringes, and tape, were not included, as they were deemed negligible and difficult to track.

All unit costs were calculated in Mozambican metical (MZN) and then converted to United States dollars (USD) using an exchange rate of US\$ 1 = 39.08 MZN (August 2015).

Direct costs

The unit costs for overhead departments and staff salaries were obtained from various administrative departments at Maputo Central Hospital. Unit costs for the direct cost categories—medications, diagnostic imaging, surgical procedures, and emergency room procedures—were obtained from the “Special Clinic”, the private tier extension of the hospital. This was done due to the lack of documentation within the public system for the cost of care, and, because of delays in ethics approval, access to the ministry of health documentation was not feasible.

The unit costs for surgical procedures performed at the special clinic included the cost of all the equipment and supplies used, including the cost of anaesthesia, but not the cost of the OR staff, which was calculated separately using figures from the public hospital. The OR staff cost was presented in monthly salaries and converted into hourly salaries. The length of each surgical procedure was recorded in hours, and staff salaries were then multiplied by the total number of operative hours. OR staff costs were added to the procedural costs.

Human resource costs

Although most of the human resource costs make up the direct costs of care, auxiliary and administrative staff costs contribute to the overhead costs of care. They were assigned their own category. In the public health system in Mozambique, the Ministry of Finance determines staff salaries, which only depend on the level of seniority of each staff member and are the same across all hospitals and all specialties.

Monthly salaries in Mozambican metical (MZN) for the different levels of staff were obtained from the hospital’s financial department. These monthly salaries were converted into daily salaries for ward staff and hourly salaries for operating room staff. The daily salaries of the ward staff were then added to overhead costs, which had been allocated to the different patient cost centres, and formed the per diem costs for ward admissions. Physicians

Table 2 Cost categories and units of output

Cost categories	Units of output
Direct costs	
Medication	Per amount of medication dose utilized
Diagnostic imaging (radiology)	Per diagnostic imaging study undergone
Procedures (OR and ED)	Per different types of procedures undergone
Laboratory tests	Per blood test conducted
Human resource costs	
Ward physicians	Per physician per bed per patient-day
Ward residents	Per resident per bed per patient-day
Ward nurses	Per nurse per bed per patient-day
Auxiliary staff	Per staff per bed per patient-day
Administrative staff	Per staff per bed per patient-day
OR staff (physicians, residents, nurses, and auxiliary staff)	Per number of operating room staff hours
Overhead costs	
Laundry	Per bed per patient cost centre
Electricity	Per proportion of beds per patient cost centre
Water	Per proportion of beds per patient cost centre
Food	Per number of patient-days
Housekeeping	Per proportion of beds per patient cost centre

covering the wards also covered the emergency department at Maputo Central Hospital, and therefore, in order to avoid double counting their salaries, physicians were excluded from calculations of emergency department costs.

Overhead costs collection and allocation

Costs for overhead service centres were taken from the corresponding departments at the public hospital. These included housekeeping, water, electricity, food, and laundry costs. The housekeeping, food, and laundry costs included production costs and labour costs. For housekeeping, these staff costs were included in the human resources category as each ward had staff dedicated for housekeeping purposes. For the laundry department and the kitchen, staff distribution (number of staff present per 24 h) and monthly salaries were obtained from their respective departments and added to the production costs. Each estimate of monthly costs was divided by the appropriate units of output to obtain daily overhead costs (refer to Table 2 for allocation units). Ideally, unit outputs for housekeeping, electricity, and water costs would have been calculated per unit of surface area in the different patient cost centres. However, due to the lack of availability of these data, the proportion of beds in each ward was compared with the total amount of beds in the hospital and used as the unit output for those three overhead departments. The bed distribution for the appropriate hospital treatment areas is presented in Table 3.

Once daily costs for each overhead category were calculated, they were added to the daily human resource costs and formed the cost for spending a day in each treatment area. These per diem costs were then multiplied by the total number of patient-days spent in each ward. For emergency department (ED) costs, a compromise had to be made, since data on the exact length of stay of each patient within the emergency department were not recorded. After discussing it with the trauma surgeons and ED staff, it was determined that patients spend an average of 1 day in ED

before being admitted to the wards. Hence, this value was used for all patients.

Results

During the study period, charts of all patients admitted to the hospital between June and July 2015 were reviewed, and 114 patients required admission for road traffic injuries. Since this was an “all-comers” study, no patient was excluded from this group. All patients were treated at only the Maputo Central Hospital for the entire course of treatment, and there were no transfers. The total number of patient-days spent during the defined time period was 1445. Patient characteristics are summarized in Table 4 and Fig. 1. The majority of patients were men younger than 45 years of age. Furthermore, as expected from global statistics, vulnerable road users, especially pedestrians, were disproportionately affected. The median number of all traumas over the course of September 2014 to September 2015 was 488 and was not significantly different than the number of traumas recorded for June and July (525 and 488, respectively). This is represented in Fig. 2.

No consistent injury severity score was recorded. There was 1 mortality, and 9 patients required admission to the intensive care unit (ICU) at some point during the course of their treatment. Of these 114 patients, 36 (or 34%) required operative intervention in the operating room during the course of their illness, and 6 of these surgeries were performed on an emergency basis (5%). Of the 1445 patient-days, 1275 were spent in the regular inpatient wards. A large majority of patient-days were spent in the orthopaedics ward (1054), followed by neurosurgery (187), and a minority (34) were spent in general surgery. Figure 3 represents this difference.

Table 5 summarizes the costs for each of the cost categories studied. Over a period of 2 months (June and July 2015), Maputo Central Hospital spent a total of US\$ 114,700.16 on the treatment of 114 road trauma victims. The highest costs were attributed to procedural costs and diagnostic imaging (Fig. 4). The median cost per patient was US\$ 604.28 (IQR 1033.58), and the median length of stay was 6 days (IQR 13.75).

Overhead costs represented 39% of the total length of stay costs, with human resource costs (i.e. staff salaries) accounting for the remaining 61%. The intensive care unit was the most expensive patient treatment area, followed by PICU and then SDU. Compared to the cost per patient-day in intensive care, the maximum cost for spending a day in a ward was almost 70% less. For non-critical care areas, it costs more to spend a day in neurosurgery, than it did in orthopaedic surgery or general surgery, even though the neurosurgery ward had the least amount of beds. Figure 5

Table 3 Distribution of beds

Total no. of beds in the hospital	1495
Beds per department (%)	
Orthopaedics	200 (13.4)
Neurosurgery	40 (2.7)
General surgery	80 (5.4)
ICU	16 (1.1)
PICU	20 (1.3)
SDU	12 (0.8)
ED	22 (1.5)

Table 4 Baseline patient characteristics

Age range (yrs)	5–75
Mean ± SD	32.45 ± 14.57
% of patients < 45 years old	79
Gender (%)	
Males	74
Females	26
Road user distribution (%)	
Vulnerable road users	59
Pedestrians	53
Two-wheelers	6
Car or larger vehicle	41

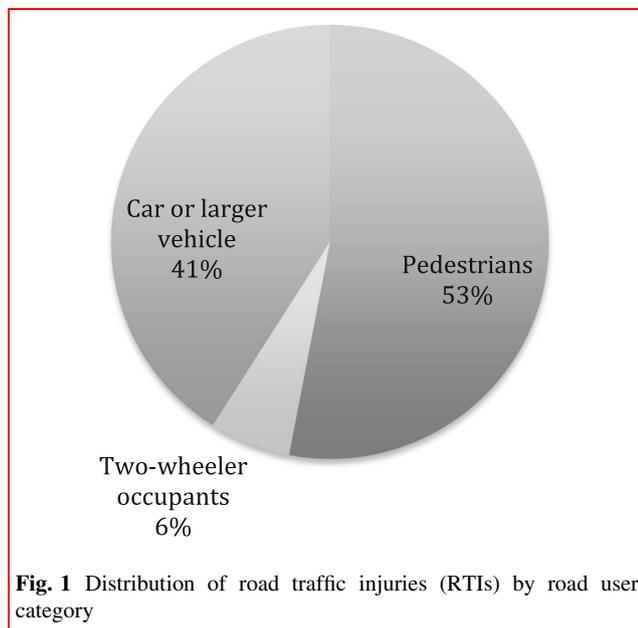


Fig. 1 Distribution of road traffic injuries (RTIs) by road user category

describes the per diem cost distribution, and Fig. 4 provides a distribution of the total costs.

Discussion

This is the first study of its kind to estimate the direct costs of road traffic injuries in Mozambique using a detailed micro-costing approach. The median cost of in-hospital care for a road traffic injury patient at Maputo Central Hospital during the study period was US\$ 604.28 (Table 6). This is a staggering figure relative to the US \$79 per person that the country spends on health, especially since external funding has been decreasing in the last decade. In 2016, the most recent year for which this information is available, external resources comprised 27% of the total health resources, down from 52% in 2008 [8]. Further details about the health care and trauma care delivery systems, including overall annual injury patterns in Maputo, are available in a separate study conducted by the McGill University Centre for Global Surgery outlining the implementation of a trauma registry in Mozambique [9].

The results of our study also highlighted the asymmetric nature of the problem. Road traffic injuries most affected the presumed economically productive segment of society—young men less than 45 years of age. They also most commonly affected vulnerable road users.

Estimating the annual inpatient costs in Mozambique

From a global health and health policy perspective, the results of this study allow us to extrapolate an annual financial burden of road injuries. In order to obtain this

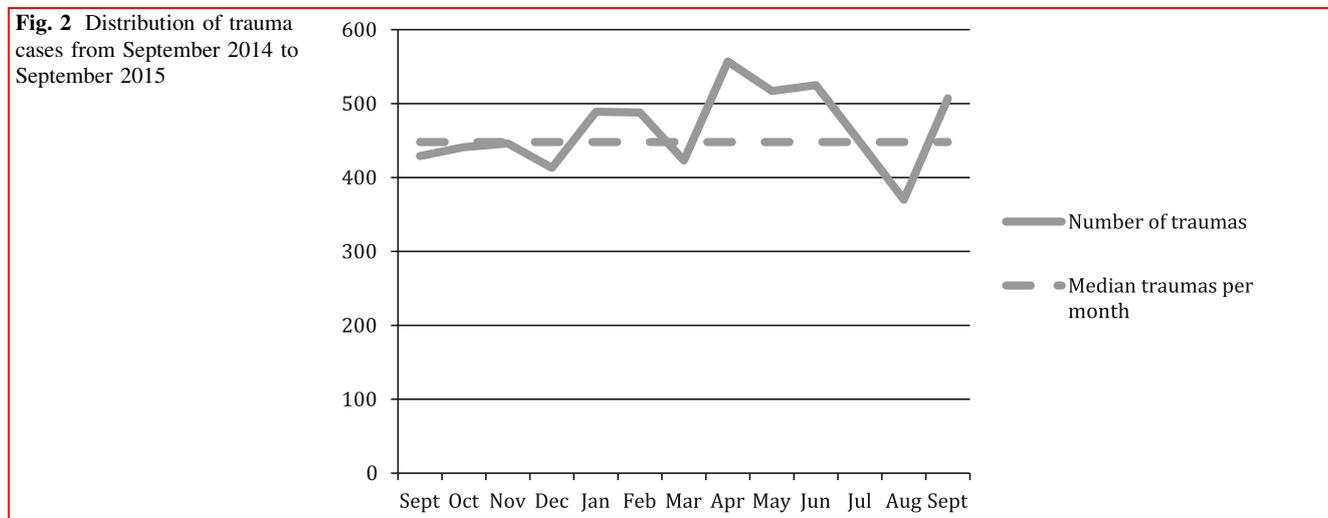
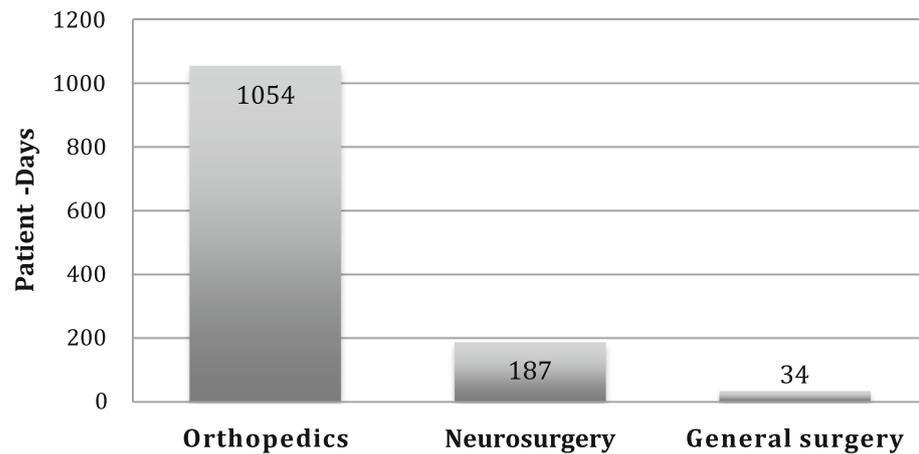
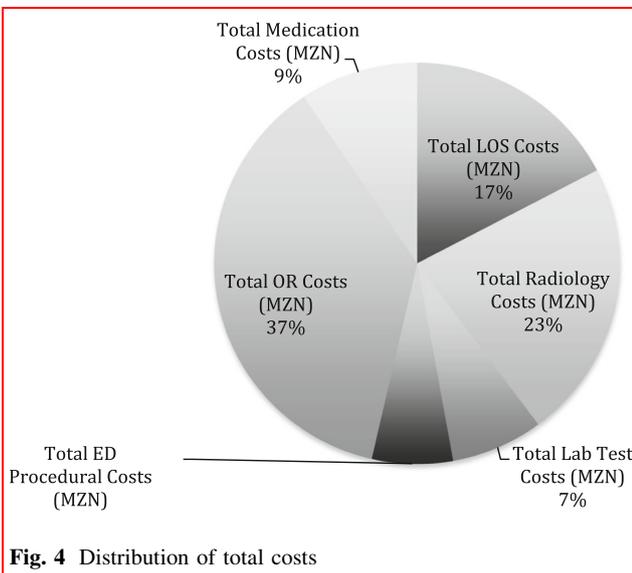


Fig. 2 Distribution of trauma cases from September 2014 to September 2015

Fig. 3 Comparison of length of stay (LOS) by inpatient ward**Table 5** Breakdown of costs per category (in 2015 USD)

	LOS costs	Radiology costs	ED costs	OR costs	Medication costs	Laboratory test costs	Total costs
Total	18,126.92	26,285.65	7524.66	43,182.30	11,009.60	8571.02	114,700.16
% of total	16	23	6	38	10	7	100
						Median cost per inpatient (IQR)	604.28 (1033.58)

**Fig. 4** Distribution of total costs

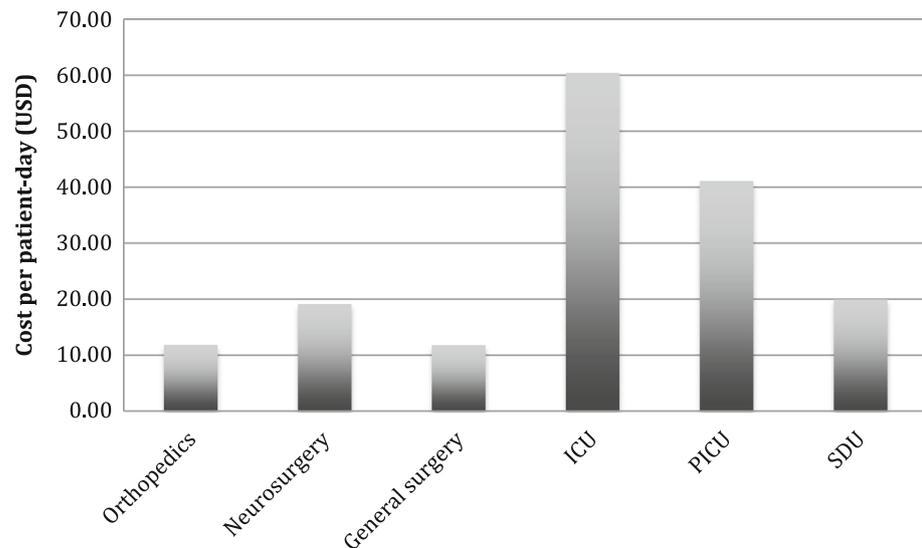
value, a reliable annual estimate of the total number of non-fatal road traffic injuries in Mozambique would be required. Yet, due to the lack of an efficient surveillance system, consistent figures for this estimate are lacking [4].

The most comprehensive and transparent study evaluating the incidence of non-fatal road traffic injuries in Mozambique was carried out by a team at the Harvard School of Public Health as a part of the Global Burden of Disease Project. The report estimated the annual number of

“non-fatal injuries due to road crashes” to be 193,000 in 2003. This figure was a result of the analysis of the 2003 Demographic and Health Survey, a national household survey based on a questionnaire. As per the authors, the estimate calculated using the results of this survey is twofold higher than governmental estimates, which are based on traffic police reports [10]. Were this result to be used to compute an annual financial burden, road traffic injuries in Mozambique would have a direct, hospital-related cost of over US\$ 116 million, representing almost 25% of the annual public health care budget of 2013 [11] and just under 0.8% of the current GDP [12] (Table 6).

Limitations

This study does have several important methodological limitations; however, it is important to examine the results in the context of the data. Data availability was a significant limitation in this study. It was problematic to track down the paper charts of patients who had only been treated in the emergency department. These patients were not included in the study. In addition, even though approval for access to documents within Maputo Central Hospital was acquired, similar approval for Ministry of Health data was not. For this reason, information such as the true prices of medications, imaging examinations, and procedures to the public health system was not available to us, and we used the equivalent prices from the private clinic. The

Fig. 5 Per diem cost comparison per patient cost centre**Table 6** Annual hospital-related costs of road traffic injuries in Mozambique

Estimate of RTIs incidence (based on 2003 data)	193,000
Median hospital cost per patient (2015 USD)	604.28
Total annual inpatient costs (2015 USD)	116,626,040
% of total public health budget	25
% of GDP	0.8

profit margins of the private clinic were not within the public domain, and therefore, an accurate value for this overestimation could not be calculated.

Furthermore, as the short-term goal of this study was to determine how much the hospital would save if road traffic injuries were eradicated, it was conducted solely from the point of view of the hospital. By taking such a narrow perspective, the results of this study may help highlight the role of policy interventions in maximizing the capacity of a limited public budget. However, it is important to remember that they do not provide information about maximizing the welfare of the entire society [13].

Finally, this was a single-centre study. In order to obtain a more accurate estimate of the fiscal costs, data from as many centres as possible should have been included. One must take into account the above-mentioned methodological limitations while analysing the estimates provided by this study. While it is likely that this study overestimates the in-hospital costs, the true costs of RTIs on the health care system in Mozambique are likely to be much higher than those projected by our study. Including data from rural health centres, which perhaps do not have the same health care technologies as their urban counterparts, may well

have caused a downward shift in average cost. However, this study was conducted solely from the point of view of the hospital, which means that the costs of health-related care that was not provided by the hospital (e.g. rehabilitation costs) were not included. In addition, neither non-medical costs nor indirect costs, which represent the loss of wages incurred by the patient or family secondary to the morbidity and mortality associated with RTIs, were included in our analysis. These three categories are likely to represent a very large proportion of the true economic burden of RTIs and should be taken into account when thinking about maximizing the welfare of the entire society.

Conclusion

This study clearly underscores the substantial financial burden that road traffic injuries place on the Mozambican health care system. In agreement with previously reported statistics for low-income countries [14], the annual hospital-related costs alone of road traffic injuries represent approximately 0.8% of the GDP of Mozambique. A financial need such as this cannot be met by the current capacity of the government or of external aid without policy interventions aimed at reducing the rate of this public health crisis. Robust surveillance systems are needed to support the feasibility of costing studies, and cost-effectiveness analyses should be performed to inform resource allocation decisions in order to build cost-effective trauma systems. It is only by using such a paradigm that the plight of injury in sub-Saharan Africa and other low- and middle-income countries can be better addressed.

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Compliance with ethical standards

Conflict of interest Authors O. Neves and D. Deckelbaum received financial support from Grand Challenges Canada for the implementation of a trauma registry in Mozambique, which was unrelated to this work.

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