Economic impact of fatal and nonfatal road traffic injuries in Belize in 2007

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ABSTRACT

Objective. *To estimate the economic cost of road traffic injuries in Belize in 2007.*

Methods. *A cross-sectional study was conducted using secondary cost data, assuming the health system and social perspectives. Epidemiologic information was obtained from the mortality database, the national hospital discharge database, and administrative records from police and the Ministry of Health. A health provider survey was carried out in order to estimate the postdischarge ambulatory utilization figures. Direct cost was estimated with the World Health Organization WHO-CHOICE (CHOosing Interventions that are Cost Effective) database. Prehospital costs were obtained from the Belize emergency response team. After estimating years of potential life lost using the Belize life expectancy for 2008 and methodology proposed by the Pan American Health Organization, the indirect cost associated with premature death was estimated with the human capital approach. Total estimation of road traffic injuries' economic costs used a decision tree model approach. Multiway sensitivity analysis was used to incorporate uncertainty in the estimations.*

Results. *Sixty-one people died due to road traffic injuries during 2007, 338 were hospitalized, and 565 people were estimated to be slightly injured. A total of 2 501 years of potential life were lost in Belize due to premature death, with a total economic cost of US$11 062 544. This figure represents 0.9% of the Belize gross domestic product. Direct cost was estimated at US$163 503, of which 2.4% was spent on fatalities, 46.7% on the severely injured, and 50.9% on the slightly injured.*

Conclusions. *The economic cost estimations make clear the need to prevent road traffic injuries with a strategic and multisectoral approach that focuses on addressing the main problems identified.*

Key words Accidents, traffic; health care costs; costs and cost analysis; Belize.

In recent years, there has been a significant increase in the number of collisions on major highways and roads in Belize. Between 2004 and 2006, the Government Information System of the Police Department reported approximately 6 295 collisions, of which 128 were identified as fatal, resulting in 143 deaths. Most of the deaths occurred in 2004, with a slight decrease in 2005 and 2006. Statistics from the Ministry of Health indicate that in 2005, death as a result of road traffic injuries (RTI) was identified as the fourth leading cause of death in general, regardless of age and sex (1). The adjusted mortality rate due to RTI in 2006 was 15.4 per 100 000 population. The country has laws

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that cover speed limits, blood alcohol content (0.08%), helmet use, and seat belt use (although not all seating positions are covered). However, application of these laws was considered very weak. There is not a law for use of child restraints (2).

RTI can have a significant negative impact on a country at all levels, as they cause a large number of sick days and an elevated amount of healthy life years lost. These factors have serious consequences on society as a whole. In Mexico, for example, it has been documented that RTI are the second leading cause of orphaned children, which has implications in terms of poverty perpetuation in low- and middle-income countries such as Mexico (3). Moreover, since RTI affect the young population in its most productive years, the economic cost in terms of medical treatment, rehabilitation, and loss of productivity tends to be high, with economic repercussions in societies (3, 4).

In the United States of America, the costs of motor-vehicle-related fatal and nonfatal injuries in 2005 exceeded US$99 billion. Costs associated with motor vehicle occupants' fatal and nonfatal injuries accounted for 71.0% ($70 billion) of all motor-vehicle-related costs (5). In Brazil, the cost of road traffic accidents on highways amounted to US$10.0 billion per year, which is equivalent to 1.2% of the Brazilian gross domestic product (GDP). Among the examined cost elements, loss of production had the greatest economic impact, followed by vehicle damage and medical costs. Fatal accidents had the highest mean value—US$200 000 per accident—showing that the more severe the accident, the higher the cost. The total cost can be even higher should the costs of environmental damage and posttraumatic stress disorder be included (6).

Not enough data are available to determine accurately the cost of RTI in Belize. In order to understand the need for action, it is imperative that a comprehensive understanding of the cost of RTI be developed. For that reason, there is an urgent need to calculate the economic cost of RTI in Belize and to evaluate the consequences that current RTI rates represent for Belize, which will provide valuable information in terms of injury prevention and safety promotion. This information will serve not only to identify the economic cost from a public health perspective but also to show the potential economic benefits from reducing RTI by undertaking road safety measures such as developing and implementing appropriate interventions (with a multisector approach). The main objective of this study was to estimate the economic costs (direct and indirect) of fatal and nonfatal RTI in Belize in 2007 from health system and social perspectives.

METHODS

Study population

All road traffic injuries in Belize in 2007 were included in this study according to ICD-10 (7) criteria, which include the following ICD-10 codes for fatal and nonfatal RTI: V02–V04 (.1, .9), V09 (.2, .3, .9), V12–V14 (.3–.9), V19.4–V19.6, V20–V28 (.3–.9), V29–V79 (.4–.9), V80.3–V80.5, V81.1, V82.1, V83–V86 (.0–.3), V87.0–V87.8, V89.2, and V89.9. All injuries were categorized in three mutually exclusive severity categories following previous proposals (8):

- Fatal injury: an injury that causes the death of the injured person in the first 30 days after the accident occurred. The 30-day definition of a road traffic fatality proposed by the World Health Organization (WHO) was used, although the official Belize definition includes all people who die within a year after the collision (9). In order to facilitate international comparisons it was important to make this adjustment.
- Nonfatal severely injured: either a person remains in the hospital as an inpatient or any one of the following injuries is sustained regardless of whether the individual is detained in the hospital: fractures, concussions, internal injuries, crushing, severe cuts and lacerations, and severe general shock requiring medical treatment. This category includes deaths that occur after 30 days.
- Nonfatal slightly injured: a minor injury such as a cut, sprain, or bruise.

Data collection and confirmation of variables

A secondary database analysis was undertaken in order to estimate epidemiologic information. Fatal injuries were obtained from a mortality database that contained all deaths that occurred during 2007. Serious injuries were obtained from the national hospital discharge database, which contained all discharges during 2007. This information was used to estimate the total number of people hospitalized (assuming they all had serious injuries). Administrative records from the Belize Police Department were used to estimate the number of slightly injured people as information from the health sector was not available for the number of slightly injured people who visited the emergency room. The reliability of this information is not known with certainty, but it was the best information available. Finally, information about population figures was obtained from the World Bank online database (http://ddp-ext.worldbank.org/ext/DDPQQ/member.do?method=getMembers&userid=1&queryId=135).

Estimation of direct costs included expenditures for medical care and treatment such as ambulance and prehospital care services, emergency room use, hospital care, physician services, nursing home care, drugs and other medical needs, postdischarge ambulatory medical consultations, and rehabilitation. Categories included for each severity level group depended on the availability of information.

Unitary cost data were obtained as follows:

- Ambulance and prehospital care services: estimates for ambulance and prehospital care services used secondary data provided by the Belize Emergency Response Team (BERT). With a top-down approach, the total expenditure figures of this institution were prorated by all services provided in order to estimate an approximate cost per run. Total figures correspond to the sum of the following cost categories: salaries, fuel, maintenance, utilities, medical supplies, insurance, and equipment. Medical supplies are subsidized by the Belize Ministry of Health. In the same way, maintenance is subsidized by Cisco Construction (free labor). This cost was assumed for each of the six districts that divide the country, although BERT services are provided only in Belize district.
- Hospitalization, emergency room hospital-based services, and ambulatory medical care costs: secondary data from the WHO-CHOICE (CHOosing Inter-

ventions that are Cost Effective) database were used to estimate direct costs (available from http://www.who.int/choice/country/blz/cost/en/print.html). Information on specific econometric techniques used to estimate country-specific costs is available elsewhere (10). Cost per bed-day represents only the "hotel" component of hospital costs, including personnel, capital, and food costs but excluding drugs and diagnostic tests. Cost per outpatient visit by hospital level and cost per visit at a health center include depreciated capital items but exclude drugs and diagnostics (10). All costs in this study are presented in US dollars after converting them to 2007 Belize dollars by means of the national consumer price index (available from http://www.statisticsbelize.org.bz/dms20uc/dynamicdata/docs/20100901211434_2.pdf). Costs accrued after a year or more were discounted at annual rates of 3% and 5%.

Utilization figures were obtained as follows:

- Emergency ambulance services: estimated by using a database containing all emergency ambulance services provided by BERT on RTI patients during 2007. Although this information was only for Belize district, it made it possible to estimate the proportion of severely injured people who received ambulance and prehospital care services for the entire country.
- Ambulatory health care services: to estimate postdischarge utilization figures, a health provider survey was carried out. Experienced medical doctors with different specialties (general surgery, maxillofacial surgery, neurosurgery, ophthalmology, urology, orthopedics, and traumatology and rehabilitation) were consulted and asked to note the proportion of RTI patients who would be hospitalized based on ICD-10 diagnosis, which was taken from the hospital discharge database. In addition, they were asked to estimate the proportion of patients who would potentially use ambulatory health services (including rehabilitation) and the number of medical consultations for hospitalized and nonhospitalized patients. When specialists did not fill out the questionnaire to provide missing information, those figures (both the proportion that use services and the number of consultations) were assumed to be the same as those for a similar injury (from an anatomic and severity perspective). When that option was not possible, the median of the number of ambulatory medical consultations (or rehabilitation) of all the other injuries was imputed. The total number of rehabilitation consultations estimated for each patient was included in the total number of ambulatory medical consultations. This survey also made it possible to estimate utilization figures for severely injured nonhospitalized patients and slightly injured non-emergency-room users (information presented in Table 1). Table 1 shows mean, median, and mode of hospital stay (obtained from the hospital discharge database).

TABLE 1. Use of health care services by patients with road traffic injuries, Belize, 2007

	Hospitalized			Nonhospitalized	
Variable	Hospital stay (days)	Ambulatory medical consultations	Rehabilitation consultations	Ambulatory medical consultations	Rehabilitation consultations
Mean	5	4.87	19.71	4.63	2.11
Median	2	3	2	3	2
Mode	1	2	0	2	2

By multiplying the median figures for utilization per unitary cost, direct costs were estimated for Belize. In this sense, all emergency room medical consultations, specialized medical consultations, and rehabilitation were assumed to be tertiary outpatient visits to hospital services. In the same way, given that 63.6% of hospital discharges received attention at the Karl Heusner Memorial Hospital (KHMH) and as hospital costs do not consider drugs and diagnostic tests, it was decided to use the cost per bed-day of a tertiary hospital level. Finally, hospital stay information was obtained from the hospital discharge database for those who died. Both survivors and casualties have median lengths of stay of two days.

Indirect cost estimation was calculated by using the human capital approach, in which the productivity cost was estimated as the future reduction in gross income due to mortality and morbidity. In this study, the Belize average income for 2007, documented by the Belize Social Security Board, was used for indirect cost estimates. Indirect costs associated with premature death take as reference the Belize life expectancy for 2008 documented by the Pan American Health Organization (PAHO) (76.1 years) (11). Life expectancy was used instead of age at retirement (55 years) to take into account country preferences on how society values life at different ages, something important to consider (12). This decision was taken as recommended by the Belize National Road Safety Committee. In this sense, elderly people in low- and middle-income countries tend to have a very small income or none at all. This situation does not mean that their time has no value or should not be valued. This circumstance is similar to the value of time for housewives. Although in real terms they might not receive a salary, their work and activities are highly valued (and needed) by societies (11). Calculations were made as follows:

Indirect cost of fatal RTI =

$$Loss\ of\ output\ (death) = \sum_{0}^{n} \frac{S}{(1+r)^n} \qquad (1)$$

where

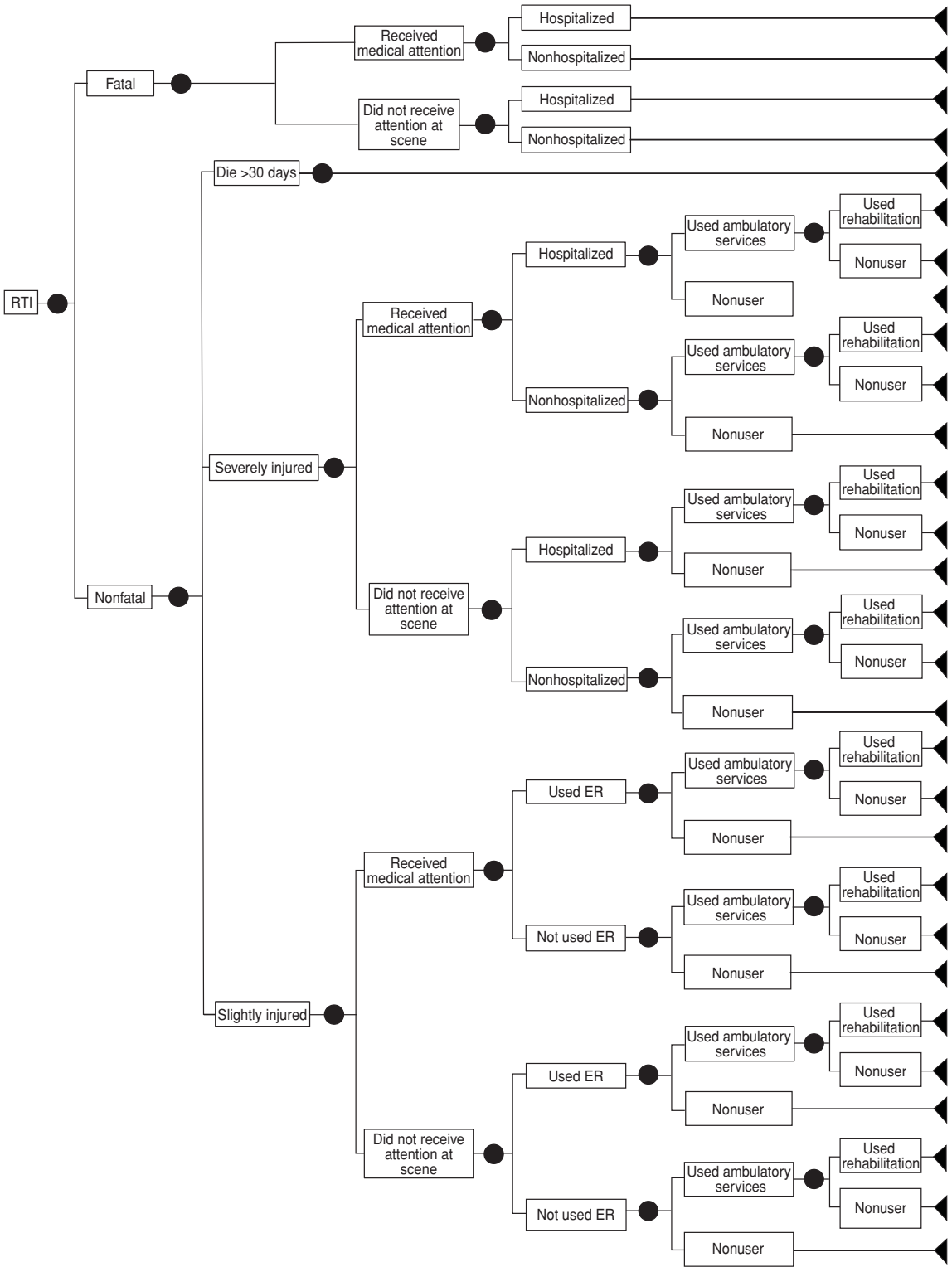
S = salary,
r = discount rate, and
n = number of years of potential life lost due to premature death.

For morbidity figures, indirect costs included the valuation of postdischarge average time injured spent at home recovering from injuries (72 days). In addition, the value of productivity losses due to transitory or permanent disability was estimated by using the value of disablement pensions awarded to the road traffic injured. This information was provided by the Belize Social Security Board.

Estimating total RTI economic costs

Total estimation of RTI economic costs used a decision tree model approach as presented in Figure 1. The decision tree allows one to disaggregate patients by fatal and nonfatal type of injury. The lat-

FIGURE 1. Decision tree to model economic cost of road traffic injuries (RTI) in Belize, 2007



Note: ER: emergency room.

ter category is disaggregated into severely injured and slightly injured. In addition, the decision tree follows the natural history of disease, starting with prehospital medical attention at the scene, continuing with hospital-based care (hospitalization versus emergency room only), utilization of ambulatory health services, and disaggregating ambulatory services into rehabilitation services. Each tree branch has a probability of occurrence and a specific associated

cost. In this way, total cost per tree branch corresponds to the multiplication of unitary cost per total number of injured estimated for that specific branch.

The individual total cost of RTI for this study was thus obtained after adding direct costs to indirect costs of those hospitalized and those who received emergency care only. The economic cost of RTI in Belize was estimated in the following manner:

$$TC(Belize)=\left(AEC_d\times\sum_{i=1}^{n}D\right)+\left(AEC_s\times\sum_{i=1}^{n}S\right)+\left(AEC_{sl}\times\sum_{i=1}^{n}SL\right) \quad (2)$$

where

TC = total economic cost of RTI,
AEC_d = average economic cost per RTI death f,
AEC_s = average economic cost of severely injured s,
AEC_{sl} = average economic cost of slightly injured sl,
D = total number of RTI deaths registered in 2007,
S = estimation of total number of severely injured, and
SL = estimation of total number of slightly injured.

Analysis

A descriptive analysis was performed for all databases. Central tendency and dispersion measures were calculated for the continuous variable (mean, median, standard deviation, maximum, and minimum values) as well as frequencies and percentages for the categorical variables using Stata 9.2 (13).

Uncertainty surrounding some of the model's assumptions was explored with a multiway and probabilistic sensitivity analysis. The analysis was performed for variables such as prevalence and incidence figures (death, hospitalized, attended at emergency room) and for three discounted rates (0%, 3%, and 5%), although in the text only results using the 3% discount rate are presented. Sensitivity analysis of the number of RTI hospitalized considered a literature review to simulate potential scenarios considering the possibility of hospital underregistration (14–21). This was also the case for slightly injured people. This part of the analysis was carried out with software @RISK 5.5 (22). Figures are presented in US dollars, using an exchange rate of US$1.00 = BZ$2.00, which has been pegged to the US dollar since 1976 (11).

RESULTS

Epidemiology of RTI in Belize

During 2007, 63 people died as a consequence of RTI, of whom 79.4% were men (Table 2). This figure is equivalent to a total of 61 people if adjusted by WHO's 30-day definition (total number of deaths multiplied by the adjustment factor of 0.97). Mean age was 37 years (median = 33) and 68.3% of all injured were between 15 and 49 years of age. It was not possible to determine the type of road user most affected, because most

TABLE 2. Descriptive analysis of road traffic injury casualties, Belize, 2007

Variable	Frequency	%
Individual characteristics		
Sex		
Women	13	20.6
Men	50	79.4
Age group (years)		
0–14	4	6.3
15–24	13	20.6
25–49	30	47.6
50–74	14	22.2
≥ 75	2	3.2
Civil status		
Common law	7	11.1
Divorced	0	0.0
Married	12	19.0
Single	43	68.3
Unknown	0	0.0
Widowed	1	1.6
Schooling		
None	3	4.8
Primary	43	68.3
Secondary	5	7.9
Tertiary	3	4.8
Unknown	9	14.3
Activity/occupation		
Wage earner	41	65.1
Nonremunerative activity	5	7.9
Unknown	17	27.0
Death and medical attention information		
Place of death		
Hospital	32	50.8
Road/street	27	42.9
Home/farm/workplace	2	3.2
Route to hospital	0	0.0
Unknown	2	3.2
District of residence		
Belize	32	50.8
Cayo	8	12.7
Corozal	5	7.9
Orange Walk	8	12.7
Stann Creek	3	4.8
Toledo	7	11.1
District of death occurrence		
Belize	48	76.2
Cayo	0	0.0
Corozal	3	4.8
Orange Walk	6	9.5
Stann Creek	2	3.2
Toledo	4	6.3
Hospital that registered death		
Belmopan Hospital	0	0.0
Central Region Belize District	48	76.2
Corozal Town Hospital	3	4.8
Orange Walk Hospital	6	9.5
Punta Gorda Hospital	4	6.3
San Ignacio Town Hospital	0	0.0
Southern Regional Hospital	2	3.2

TABLE 3. Descriptive analysis of hospital discharges due to road traffic injuries, Belize, 2007

Variable	Frequency	%
Individual characteristics		
Sex		
Women	85	25.1
Men	253	74.9
Age group (years)		
0–14	69	20.4
15–24	86	25.4
25–49	142	42.0
50–74	33	9.8
≥ 75	8	2.4
Civil status		
Common law	49	14.5
Divorced	0	0.0
Married	60	17.8
Single	199	58.9
Unknown	28	8.3
Widowed	2	0.6
Schooling		
None	74	21.9
Primary	145	42.9
Secondary	53	15.7
Tertiary	12	3.6
Unknown	54	16.0
Activity/occupation		
Wage earner	128	37.9
Nonremunerative activity	119	35.2
Unknown	91	26.9
Medical attention and occurrence		
Admittance		
Emergency	281	83.1
Outpatient	57	16.9
District of residence		
Belize	112	33.1
Cayo	93	27.5
Corozal	35	10.4
Orange Walk	20	5.9
Stann Creek	44	13.0
Toledo	34	10.1
District of discharge		
Belize	215	63.6
Cayo	53	15.7
Corozal	12	3.6
Orange Walk	23	6.8
Stann Creek	14	4.1
Toledo	21	6.2
Hospital		
Belmopan Hospital	40	11.8 (1.6)[a]
Corozal Town Hospital	12	3.6 (1.1)[a]
KHMH Consolidation	215	63.6 (2.5)[a]
Orange Walk Hospital	23	6.8 (0.9)[a]
Punta Gorda Hospital	21	6.2 (1.5)[a]
San Ignacio Town Hospital	13	3.8 (1.0)[a]
Southern Regional Hospital	14	4.1 (0.5)[a]
Description of service		
Accident and emergency	1	0.3
General medicine	32	9.5
Gynecology	1	0.3
In-patient services	64	18.9
Pediatric	42	12.4
Surgical services	177	52.4
Discharge condition		
Alive	302	89.3
Dead	8	2.4
Self-discharge	9	2.7
Transferred	18	5.3
Missing values	1	0.3

Note: KHMH: Karl Heusner Memorial Hospital.
[a] Numbers in parentheses indicate road traffic injuries as percent of total.

deaths were coded as "other and unspecified." Most deaths took place in Belize district (76.2%) and 50.8% of all deaths occurred in a hospital. This value translates to a mortality rate of 20.1 deaths per 100 000 population. When analyzed with a Poisson regression model, on average, the relative risk of dying as a consequence of RTI in Belize decreased 7.1% each year during 2001–2007 (95% confidence interval 3.3% to 10.8%).

During 2007, 338 hospital discharges due to RTI were recorded in all public hospitals in Belize (hospital discharge rate of 117.36 discharges per 100 000 population). Of them, 74.9% were men, with a mean age of 29 years (standard deviation = 18, median = 26) and 67.5% were between 15 and 49 years of age (Table 3). Most road users were also classified as "other and unspecified." A large majority of hospital discharges were reported by KHMH, the only tertiary level hospital in Belize. Of all RTI hospitalized, 2.7% died during hospitalization (n = 8).

Table 4 presents all emergency ambulance services provided by BERT in Belize district in 2007. A total of 222 ambulance services were solicited, although 24 of them did not require any service. Of the remainder, 47 (23.7%) were severely injured (42.0% of the total number hospitalized in Belize district the same year), 73.2% were slightly injured, and 3.0% of the injured died. Most people attended were men (71.7%) and 74.5% were between 15 and 49 years of age. Of all injured, 90.4% received treatment and were transferred to a medical institution.

No detailed information was available on patients slightly injured after a collision. Similarly, no information on emergency room hospital-based medical attention was provided. Using BERT figures (an estimated 77.5% of the total number of nonhospitalized slightly injured in Belize district the same year), a total of 565 slightly injured was estimated.

Economic cost of RTI

Direct cost. A total of US$163 503 was estimated for direct costs during 2007, of which 2.4% was spent on fatalities, 46.7% on severely injured, and 50.9% on slightly injured. Figure 2 shows that most of this cost was estimated for prehospital care (36.8%), hospitalization (21.5%), and ambulatory medical consultations (20.3%), while rehabilitation represented 11.2%.

TABLE 4. Emergency ambulance services due to road traffic injuries, Belize district, 2007

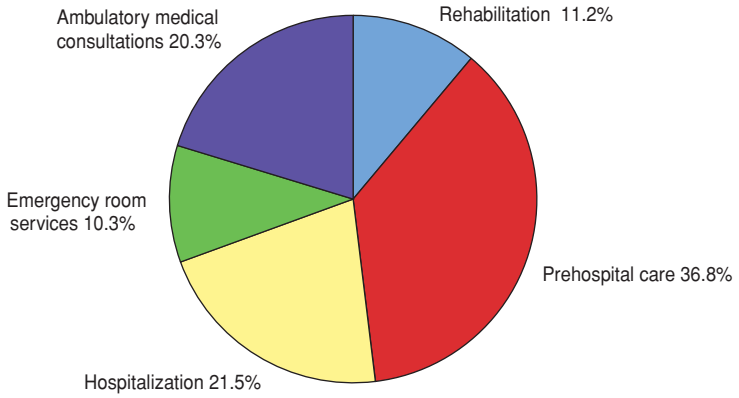
Variable	Type of injury							
	Slight		Serious		Fatal		Total	
	No.	%	No.	%	No.	%	No.	%
Sex								
Women	41	28.3	8	17.0	0	0.0	49	24.7
Men	102	70.3	37	78.7	3	50.0	142	71.7
Missing value	2	1.4	2	4.3	3	50.0	7	3.5
Age (years)								
Mean	29.6	NA	28.4	NA	(. . .)	(. . .)	NA	NA
0–14	9	6.2	6	12.8	(. . .)	(. . .)	15	7.8
15–24	45	31.0	12	25.5	(. . .)	(. . .)	57	29.7
25–49	66	45.5	20	42.6	(. . .)	(. . .)	86	44.8
50–74	12	8.3	3	6.4	(. . .)	(. . .)	15	7.8
≥ 75	1	0.7	0	0.0	(. . .)	(. . .)	1	0.5
Missing value	12	8.3	6	12.8	(. . .)	(. . .)	18	9.4
Day								
Monday	10	6.9	3	6.4	1	16.7	14	7.1
Tuesday	8	5.5	2	4.3	1	16.7	11	5.6
Wednesday	19	13.1	5	10.6	0	0.0	24	12.1
Thursday	23	15.9	6	12.8	0	0.0	29	14.6
Friday	20	13.8	7	14.9	2	33.3	29	14.6
Saturday	32	22.1	17	36.2	2	33.3	51	25.8
Sunday	33	22.8	7	14.9	0	0.0	40	20.2
Month								
January	6	4.1	4	8.5	1	16.7	11	5.6
February	13	9.0	5	10.6	2	33.3	20	10.1
March	13	9.0	1	2.1	0	0.0	14	7.1
April	7	4.8	7	14.9	0	0.0	14	7.1
May	28	19.3	8	17.0	2	33.3	38	19.2
June	7	4.8	1	2.1	0	0.0	8	4.0
July	24	16.6	5	10.6	0	0.0	29	14.6
August	10	6.9	6	12.8	0	0.0	16	8.1
September	9	6.2	2	4.3	0	0.0	11	5.6
October	9	6.2	4	8.5	0	0.0	13	6.6
November	6	4.1	1	2.1	0	0.0	7	3.5
December	13	9.0	3	6.4	1	16.7	17	8.6
Type of service provided								
Treated on site only	8	5.5	0	0.0	0	0.0	8	4.0
Treated and transport	135	93.1	44	93.6	0	0.0	179	90.4
Air transportation	1	0.7	0	0.0	0	0.0	1	0.5
No treatment	1	0.7	3	6.4	6	100.0	10	5.1
Total	145	73.2	47	23.7	6	3.0	198	89
No service provided	NA	NA	NA	NA	NA	NA	24	11
Grand total	NA	NA	NA	NA	NA	NA	222	100

Source: Belize Emergency Response Team administrative records.
Note: NA: not applicable, (. . .): information not available.

From this figure, the potential underestimation of hospitalization costs is evident, as drugs and diagnostics are not included in unitary cost estimations used for this analysis.

Indirect cost. A total of 2 501 years of potential life were lost in Belize during 2007 due to RTI (Table 5). This number translates to a social loss of US$8 116 917 attributed to indirect cost due to productivity loss (Table 6). Table 6 disaggregates indirect cost by district for both methods and considers different scenarios in terms of discount rates. Belize district is where more indirect cost was lost: 53.3% of the total or US$4 328 717. In addition, injured people who were hospi-

FIGURE 2. Health system costs estimated for Belize, by type of service, 2007



Note: Cost of hospitalization does not include drugs and diagnostic tests, which could represent a large proportion of total hospitalization costs in this type of patient.

TABLE 5. Deaths and years of potential life lost by district, Belize, 2007

Characteristic	District of residence	Number
Total deaths	Belize (district)	32
	Cayo	8
	Corozal	5
	Orange Walk	8
	Stann Creek	3
	Toledo	7
	Belize (country)	63
Years of potential life lost[a]	Belize (district)	1 380
	Cayo	371
	Corozal	214
	Orange Walk	238
	Stann Creek	105
	Toledo	194
	Belize (country)	2 501[b]

[a] PAHO life expectancy in Belize for 2008—age at death for people with less than life expectancy.
[b] May not sum to total due to rounding.

talized stayed an average of 5 days in the hospital. This value represents an average of US$76 of indirect cost per RTI hospitalization and a total of US$25 456 lost for this cause.

Total economic cost of RTI. Aggregated figures are presented in Table 7. As indicated, the base model estimated a total economic cost of US$9 453 615 due to RTI during 2007. The great majority of the cost is due to fatal injuries, specifically indirect costs attributed to premature death. When the distribution of total economic cost estimated in all 10 000 iterations of the simulated model was analyzed, 90.0% of all estimates fell between US$10 005 971 and US$12 273 030 (average of US$11 062 544 using a discount rate of 3%). This estimation represents 0.9% of the Belize GDP during 2007 and 2.8% of the total government budget for the same year (Table 8). Table 9 shows the base model results compared with the sensitivity analysis figures (simulation). According to the simulation, during 2007 the total nonfatal RTI rate was 1 468.7 per 100 000 population. Finally, information provided by the Social Security Board showed that at least two people were disabled in 2007 as a consequence of RTI (0.7 per 100 000 population).

DISCUSSION

The usefulness of cost-of-illness studies for health systems lies in justifying the design and implementation of specified intervention programs and making evident the economic loss that the illness presents, with its specific and current mortality and morbidity rates. In the same way, these studies help the resource allocation process by contributing to determination of the importance of each illness from an economic perspective and highlighting medical care and specific research needs. In addition, they provide a basis for planning and establishing political and public health initiatives for prevention and control and an economic-referenced framework for the next evaluation of programs and implemented interventions (23).

Information generated in this study will allow all districts and national authorities in Belize to have valuable information for decision making. In general, this study will aid decision making, justifying the need for implementing a meaningful road traffic safety program. It also allows for understanding the real magnitude of a problem that so far seems reflected only in causes of mortality and social security payments. Therefore, the economic assessment of a problem of this extent will allow visualization of the potential resource savings that can be applied to other social and health problems. In this sense, the results make evident the large problem that RTI cause to the health system in Belize and society as a whole. From the results of economic cost estimations, there is an urgent need to prevent RTI through a strategic and multisectoral approach that focuses on the principal problems detected.

This study faced methodologic challenges due to the lack of specific information, such as costs and number of nonhospitalized injured people. Although secondary cost information used might underestimate the real problem, it gives a general idea of the magnitude of the problem in economic terms. Future efforts should consider the use of primary data to evaluate to what extent these estimates change. In the same way, problems in current information systems were evident. That was the case in the

TABLE 6. Indirect costs of premature death (US dollars) by district, Belize, 2007

Indirect cost	District of residence	Discount rate 0%	Discount rate 3%	Discount rate 5%
Minimum wage	Belize (district)	4 844 151	2 637 812	1 828 566
	Cayo	1 301 508	704 967	487 627
	Corozal	749 385	403 516	281 063
	Orange Walk	834 678	570 191	425 693
	Stann Creek	369 603	231 689	168 315
	Toledo	679 536	398 073	281 701
	Belize (country)	8 778 861	4 946 247	3 472 963
Average wage	Belize (district)	7 949 376	4 328 717	3 178 414
	Cayo	2 135 808	1 156 869	846 064
	Corozal	1 229 760	662 179	489 891
	Orange Walk	1 369 728	935 697	744 428
	Stann Creek	606 528	380 208	293 404
	Toledo	1 115 136	653 247	496 671
	Belize (country)	14 406 336	8 116 917	6 048 871

Note: Exchange rate is US$1.00 = BZ$2.00.

TABLE 7. Economic impact of road traffic injuries by severity and cost type, Belize, 2007

Severity	Direct cost (US$)	Indirect cost[a] (US$)	Total (US$)
Fatal	3 886	8 795 959	8 799 845
Nonfatal			
Severe	76 400	488 083	564 483
Slight	83 218	6 070	89 288
Total	163 503	9 290 112	9 453 615

[a] Indirect costs with discount rate of 3% under base model assumptions.

TABLE 8. Economic cost of road traffic injuries as percentage of gross domestic product and government budget, Belize, 2007

Characteristic	Amount
Total GDP (US$)	1 267 000 000
Total government budget (US$)	396 657 177
Total MOH budget (US$)	43 213 108
MOH budget as percentage of government budget	10.9
MOH budget as percentage of GDP	3.4
Total cost of RTI (US$)	
0% discount rate	17 995 415
3% discount rate	11 062 544
5% discount rate	8 599 470
Cost of RTI as percentage of GDP	
0% discount rate	1.4
3% discount rate	0.9
5% discount rate	0.7
Cost of RTI as percentage of government budget	
0% discount rate	4.5
3% discount rate	2.8
5% discount rate	2.2
Cost of RTI as percentage of MOH budget	
0% discount rate	41.6
3% discount rate	25.6
5% discount rate	19.9

Note: US$1.00 = BZ$2.00. GDP: gross domestic product, MOH: Ministry of Health, RTI: road traffic injuries.

codification of external causes of death, as most deaths and hospitalizations were coded as "other and unspecified." This coding problem did not allow estimation of cost per type of road user or analysis of the medical attention characteristics of different road users. Improved coding efforts should be attempted in the future in order to better appreciate the type of problem Belize faces in terms of road safety. This information would be invaluable for policy making, as most prevention strategies differ depending on the type of road user who is most affected. In addition, no information was available on the number of emergency room hospital-based services provided as well as the number of ambulatory services provided (including rehabilitation). In this sense, it is important to consider that better information systems would translate to better estimates of the economic cost of this important public health problem.

The methodology used to estimate indirect costs could overestimate actual figures because it gives more weight to deaths that occurred at an early stage of life, according to some perspectives such as the investment–producer–consumer model perspective. This conceptual framework, originally proposed by Gardner and Sanborn (24), argues that during the investment period (less than 18 years of age), people only receive from society (negative value) while dur-

TABLE 9. Economic cost of road traffic injuries estimated for Belize, 2007

Injury	Total cost (US dollars)						Total injured	
	Base[a]			Average of simulation[a] with				
	DR 0%	DR 3%	DR 5%	DR 0%	DR 3%	DR 5%	Base	Simulation
Fatal								
Hospitalized	1 988 122	1 153 106	856 446	2 160 922	1 253 330	930 885	8	
Not hospitalized	13 190 201	7 646 739	5 677 287	14 336 643	8 311 364	6 170 735	53	
Total	15 178 323	8 799 845	6 533 733	16 497 565	9 564 694	7 101 620	61	66
Nonfatal								
Died > 30 days	3 970	3 970	3 970	4 320	4 320	4 320	2	
Hospitalized								
Hospitalization	517 685	517 685	812 772	812 772	812 772	338	338	531
Ambulatory users	16 003	16 003	25 125	25 125	25 125	261	261	
Rehabilitation users	8 672	8 672	13 615	13 615	13 615	212	212	
ER users	17 161	17 161	117 918	117 918	117 918	471	471	3 239
ER services								
Ambulatory users	14 506	14 506	99 674	99 674	99 674	237	237	
Rehabilitation users	8 255	8 255	56 719	56 719	56 719	202	202	
Total (hospital + ER)	642 908	642 908	1 446 170	1 446 170	1 446 170	854		
Nonusers of health services	NA	NA	NA	NA	NA	83		
Total (fatal + nonfatal)	15 832 094	9 453 615	7 187 504	17 995 415	11 062 544	8 599 470	998	4 531

Note: Both models (base and simulation) use average income reported by Social Security Board to estimate indirect costs (BZ$960, US$480 per month). DR: discount rate, ER: emergency room, NA: not applicable.

[a] Simulation figures consist on average of the 10 000 iterations for different distributions of uncertain parameters (carried out with @RISK software).

ing the production period they give back to society (positive value). However, this framework should also take into account country preferences on how society values life at different age periods. In addition, some authors believe there are costs households would have incurred without suffering RTI that could be evaluated only by using counterfactuals (control group scenario), which was not considered in this study (25).

WHO estimates that RTI cost represents 1.0% of the GDP in low-income countries, while in medium- and high-income countries the cost can reach 1.5% and 2.0% of GDP, respectively (19). This study documents that the total economic cost of RTI in Belize accounts for 0.9% of the GDP in the study year. In this regard, Mohan argued that the method used may influence the final estimation (20). When he analyzed the differences between low- and high-income countries, he found that estimates in high-income countries tended to be more detailed and comprehensive, since they included willingness to pay, quality-adjusted life years, and healthy life years (20). According to this author, if the willingness-to-pay method had been used in India, the total cost of RTI would have increased from 0.8% to 2.0% of GDP. He also highlighted some problems, such as lack of access to health services and technology, which, together with few work opportunities for people with disabilities, contributed to underestimation of the RTI cost in low- and medium-income countries. Epidemiologic information from countries with better registers shows how estimates from different countries would also increase to 2.0% of GDP (20). That might be the case in the Belize estimates.

CONCLUSIONS

According to this study, it was possible to identify the high cost that RTI represents to Belize society in general. During 2007, the economic cost of RTI in Belize was estimated to be US$11 062 544 (90% confidence interval US$10 005 971 to US$12 273 030), from which the great majority corresponds to the indirect cost of premature death. This value represents almost 1.0% of the total GDP of Belize for the same year and is equivalent to 2.8% of the total government and 25.6% of the Ministry of Health budgets. These figures make it possible to visualize the potential financial resources that can be used for RTI prevention and other social and health conditions if current epidemiologic figures decrease. The study identified that the main victims are men and youth; however, there is a gap of information about the type of road user injured or dead. Current fatal, nonfatal, and disability rate figures (20.1, 1 468.7, and 0.7 per 100 000 population, respectively) highlight the need to implement effective preventive strategies in the short term to alleviate the current burden of RTI in the country. Information generated in this study therefore allows for greater understanding of the real magnitude of RTI, including economic impact.

Recommendations

The considerable economic costs of RTI and deaths in Belize require special attention to apply cost-effective strategies and law enforcement in order to provide road safety for all road users. Improving the health information system to capture important data on RTI is essential. In this regard, unification data from different sources (health, police, and other) are essential to have a better idea of the magnitude of the problem. Belize should work on a single RTI database common for the entire country, with the type of road user coded properly. Epidemiologic information such as the number of injured people attended in emergency rooms and hospital-based facilities as well as ambulatory follow-up patients as a result of RTI should be available and quantified. This information will allow for greater in-depth analysis of RTI in the country.

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RESUMEN

Repercusiones económicas de los traumatismos mortales y no mortales por accidentes de tránsito en Belice en 2007

Objetivo. Calcular el costo económico de los traumatismos por accidentes de tránsito registrados en Belice durante el año 2007.

Métodos. Se realizó un estudio transversal a partir de datos secundarios sobre los costos, tanto desde la perspectiva social como desde la del sistema de salud. La información epidemiológica se obtuvo a partir de la base de datos de mortalidad, la base de datos nacional de egresos hospitalarios y los expedientes administrativos de la policía y el Ministerio de Salud. Se llevó a cabo una encuesta a los prestadores de servicios de salud para calcular las cifras correspondientes a la atención ambulatoria posterior al egreso. Para calcular los costos directos, se utilizó la base de datos del proyecto WHO-CHOICE (elección de intervenciones eficaces en función de los costos) de la Organización Mundial de la Salud. El equipo de respuesta a las urgencias médicas de Belice aportó los datos sobre los costos prehospitalarios. Después de calcular los años de vida potencial perdidos tomando como parámetro la esperanza de vida de Belice correspondiente al año 2008 y empleando el método propuesto por la Organización Panamericana de la Salud, se calculó el costo indirecto asociado a la muerte prematura desde el enfoque del capital humano. Se utilizó un modelo de árbol de decisiones para calcular el costo económico total derivado de los traumatismos causados por el tránsito y se hizo un análisis de sensibilidad multivariado y probabilístico para incorporar los parámetros de incertidumbre en las estimaciones.

Resultados. En Belice, durante el año 2007, los traumatismos causados por el tránsito provocaron la muerte de 61 personas, la hospitalización de 338 y, según se calcula, lesiones menores a 565. Se perdieron 2 501 años de vida potencial a causa de las muertes prematuras, lo que se tradujo en un costo económico total de US$11 062 544. Esta cifra representa 0,9% del producto interno bruto de Belice. Se calculó que el costo directo fue de US$ 163 503, del cual 2,4% fue ocasionado por las muertes, 46,7% por la atención de las personas que sufrieron traumatismos graves y 50,9% por la atención de quienes presentaron lesiones menores.

Conclusiones. El costo económico calculado en este estudio pone de manifiesto la necesidad de prevenir los traumatismos causados por el tránsito adoptando un método estratégico y multisectorial que se centre en abordar los principales problemas detectados.

Palabras clave Accidentes de tránsito; costos de la atención en salud; costos y análisis de costo; Belice.