

# Economic impact of fatal and non-fatal road traffic injuries in Guadalajara Metropolitan Area and Jalisco, Mexico

Ricardo Pérez-Núñez,<sup>1</sup> Leticia Ávila-Burgos,<sup>1</sup> Martha Híjar-Medina,<sup>2</sup> Blanca Pelcastre-Villafuerte,<sup>1</sup> Alfredo Celis,<sup>3</sup> Aarón Salinas-Rodríguez<sup>4</sup>

<sup>1</sup>Centro de Investigación en Sistemas de Salud del Instituto Nacional de Salud Pública, Cuernavaca, Mexico

<sup>2</sup>Centro de Investigación en Salud Poblacional del Instituto Nacional de Salud Pública, Cuernavaca, Mexico

<sup>3</sup>Centro Universitario de Ciencias de la Salud de la Universidad de Guadalajara, Guadalajara, Mexico

<sup>4</sup>Centro de Investigación en Evaluación y Encuestas del Instituto Nacional de Salud Pública, Cuernavaca, Mexico

## Correspondence to

Ricardo Pérez-Núñez, National Institute of Public Health, Universidad #655, Colonia Santa María Ahuacatlán, Cerr los Pinos y Caminera, CP 62100, Cuernavaca, Morelos, México; [ricardo.perez@insp.mx](mailto:ricardo.perez@insp.mx)

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## ABSTRACT

**Objective** To estimate the economic cost of fatal and non-fatal road traffic injuries (RTI) in Guadalajara metropolitan area (GMA) and Jalisco, Mexico during 2007.

**Materials and methods** Using an incidence-based cost of illness analysis from a household perspective employing a bottom-up approach all direct medical and non-medical costs, and indirect costs were estimated for a sample of RTI people who sought care during 1 month in four different medical facilities. Individuals were surveyed just before discharge from emergency rooms (ER) and hospitalisation services. Hospitalised individuals were followed up at 8 weeks after discharge. Productivity loss was estimated with the human capital approach. Using estimated costs and administrative records of mortality and morbidity, the economic costs were dimensioned for GMA and for Jalisco. A multivariate and probabilistic sensitivity analysis was conducted to evaluate variations resulting from assumptions used.

**Results** 297 injured were included in the study, 20% were hospitalised and 237 only received care at ER. A total cost of US\$21 190 was estimated in all injured receiving care at ER and \$83 309 for those hospitalised. Direct cost represents more than 30% of reported income in 8% of the ER users and 80% of hospitalised. Total economic cost was US\$329 061 813 for GMA (discount rate of 3%), nearly 51% of the state total (US \$650 908 924 or 1.3% of State GNP).

**Conclusions** This estimation shows the high cost (both, direct and indirect) RTI impose in households affecting their economy and leading families to lose wealth assets, get in debt or impoverished.

## INTRODUCTION

Road traffic injuries (RTI) are the seventh leading cause of death in Mexico accounting for 3% of all deaths in the general population. Within the 15–59 age group, RTI represents the fourth leading cause of death (6% of deaths).<sup>i</sup> Almost 10% of these deaths occur in the state of Jalisco.<sup>ii</sup> RTI in the Guadalajara metropolitan area (GMA)<sup>iii</sup> accounted for more than 50% of RTI deaths in Jalisco from 2000 to 2007.

<sup>i</sup>Published and available at the webpage of the Ministry of Health: <http://www.salud.gob.mx/>.

<sup>ii</sup>Estimations based on official mortality databases of the respective years, including the following codes: ICD-10: V02-V04 (0.1, 0.9), V09 (0.2, 0.3, 0.9), V12-V14 (0.3-0.9), V19.4-V19.6, V20-V28 (0.3-0.9), V29-V79 (0.4-0.9), V80.3-V80.5, V81.1, V82.1, V83-V86 (0-0.3), V87.0-V87.8, V89.2, V89.9.

<sup>iii</sup>The Guadalajara metropolitan area includes the municipalities of: Guadalajara, Ixtlahuacán de los Membrillos, Juanacatlán, El Salto, Tlajomulco de Zúñiga, Tlaquepaque, Tonalá and Zapopan.

Prevalence of non-fatal RTI is estimated at 10 per 1000 inhabitants and Jalisco is the state with the highest rate (15.1 per 1000 inhabitants).<sup>1</sup>

Little work has been done in Mexico to address the RTI burden in economic and social terms.<sup>2-3</sup> An analysis of the 2000 National Health Survey (ENSA-2000)<sup>4</sup> estimated that 510 655 individuals used health services in Mexico as a result of a non-fatal RTI. The estimated out of pocket expenditure was 67 108 million pesos, and more than 60 million pesos of work time was lost.<sup>iv</sup> However, these figures and previous efforts<sup>2-3</sup> have underestimated the problem since no estimation has included both direct and indirect costs for morbidity and mortality, and aspects such as indirect cost associated to caregivers and economic cost after hospital discharge has not been included either. The objective of this study was to prospectively estimate and analyse direct and indirect costs of fatal and non-fatal RTI during 2007 in GMA and Jalisco.

## MATERIAL AND METHODS

This research was evaluated and approved by the Ethics, Biosecurity and Research Committees of the National Institute of Public Health in Mexico. To estimate the economic cost of RTI secondary information of incidence figures and income (for those who died) was used. Since information on costs was not available, it was estimated on a sample of non-fatal RTI.

### Sample selection for non-fatal RTI

One Ministry of Health hospital and one of the Mexican Social Security Institute hospital were selected in two stages, through a random, probabilistic, stratified cluster sampling strategy. The probability was proportional to the number of discharges due to RTI during 2005. Given that they provide a large proportion of in-and-out patient care, one unit of the GMA's Municipal Medical Services unit and one private hospital were also included using a convenience sampling approach.

In each of the four hospitals all surviving patients diagnosed as RTI according to the ICD-10 classification criteria were interviewed just before discharge of ER and hospital services and after signing an informed consent form. When patients were unconscious or less than 18 years old, parents, guardians or legal representatives were interviewed. The study

<sup>iv</sup>In January 2008 the Exchange rate was \$1 peso = US\$0.09179. Exchange rate was taken from the following internet webpage: <http://www.oanda.com/convert/fxhistory>.

was done between August and October 2007 and interviews were conducted 24 h per day during 1 month in each hospital.

### Data collection and computations

A face-to-face survey was carried out using three different questionnaires: a.) for people who had been injured and received emergency care without being hospitalised; b.) for people who were hospitalised; and c.) to follow-up hospitalised people 8 weeks after being discharged. Information regarding deceased people was obtained through secondary sources.

Direct costs were estimated through incident cases with a 'bottom-up' approach, taking the Household's perspective. Direct cost included all medical and non-medical categories of cost reported. Since there was no information about direct cost of those who died it was estimated using information of the sample under study and taking as reference the average number of intrahospital stays from the 2007 Ministry of Health hospital discharge database.

Indirect cost was estimated using a human capital approach and taking self-reported income as reference. In order to estimate the value of time for those 15 years and older that did not report income in the surveys (33% of ER patients and 36% of hospitalised) a multiple imputation method<sup>5-8</sup> of individual income was employed. Indirect cost of household's caregivers was also included for the same period of time. Given that salaries of caregivers were not available, the minimum wage of Jalisco in January 2008 was taken as reference for all (USD\$4.68 per day).

In the case of fatal RTI, the estimation of productivity losses was approximated through the net present value of their future wage earnings, following the approach proposed by Fienkelstein and cols.<sup>9</sup> This approach takes into account the probability of survival from one age group to another age group<sup>v</sup> times the expected earnings while in that age group. Average annual wage and fringe benefit costs were estimated from the 2008 National Survey of Household's Income and Expenditure for each year of age and sex carried out by the National Institute of Statistics Geographic and Informatics.<sup>10</sup>

Total economic cost of RTI for the study sample was obtained after adding the direct and indirect costs of those hospitalised and those who only received emergency care. This information was then used to estimate total cost of RTI for GMA and for Jalisco. Epidemiological information obtained from secondary analysis of mortality databases, hospital discharge databases and national health surveys such as the ENSA-2000 and ENSANUT-2006 were also used.<sup>vi</sup> Other publications<sup>11-24</sup> were employed to estimate the number of injured people treated in ERs as well as those who were hospitalised.

### Statistical and economic analysis

Univariate analysis of socio-economic and demographic variables of the sample was performed. Total cost was estimated using a multivariate linear regression analysis. The adjusted average cost was used to estimate the economic impact of RTI in GMA and Jalisco, using a decision tree approach. A multivariate and probabilistic sensitivity analysis was performed,<sup>25</sup> using @RISK 5.5@software,<sup>26</sup> on estimations considering different discount rates (0%, 3% and 5%) and the range (or distribution) of uncertain or estimated variables and parameters. In this sense, three scenarios of under-reporting of RTI mortality were considered:

<sup>v</sup>Probability of survival was taken from the Consejo Nacional de Población (National Population Council), Mexico ([http://www.conapo.gob.mx/index.php?option=com\\_content&view=article&id=36&Itemid=234](http://www.conapo.gob.mx/index.php?option=com_content&view=article&id=36&Itemid=234)), Accessed on August 24, 2010).

<sup>vi</sup>National Health and Nutrition Survey 2006 held by the National Institute of Public Health.

0% (best scenario), 1.25% documented for Jalisco in recent reports<sup>27</sup> and 5% (worst scenario). Additionally, indirect cost associated with permanent disability was also included in the sensitivity analysis, in the same way as in fatal injuries. For each discount rate a total of 10 000 iterations were performed; the average value and the range including 90% of the iterations were reported. All figures were converted into US dollars using an exchange rate of 1 Mexican Peso to US\$ 0.09179 for January 2008.

### RESULTS

A total of 297 injured persons were included in this study, 79.8% received attention in ER of participant hospitals, and the rest were hospitalised. From those attended only in the ER, about 62% were men and the average age was 26.4 years, 22% were pedestrians, 39% were automobile occupants and 32% were cyclists or motorcyclists. Of those hospitalised 80% were men, 48% were automobile occupants, 28% cyclists or motorcyclists and 23% pedestrians. More detailed information is presented in table 1.

**Table 1** Descriptive statistics of categorical variables in study population, by questionnaire, Guadalajara metropolitan area 2007

Variables	Descriptive statistics		
	E.R. % (N = 237)	Hospitalised % (N = 60)	8 Weeks % (N = 41)
<b>Individual characteristics</b>			
Sex			
Women	38	20	15
Men	62	80	85
<b>Marital status</b>			
Single	NA	60	66
Separated-Widowed	NA	12	10
Married-Civil partner	NA	28	24
<b>Occupation</b>			
Non remunerative activity	40	47	49
Working class-Employed-Labourer-Piecework	53	40	41
Boss-Employer-Owner	6	7	7
Missing values	1	7	2
<b>Medical Insurance</b>			
Insured	75	43	44
Non-insured	23	55	54
Missing values	2	2	2
<b>Schooling</b>			
Less than elementary school	14	35	37
Elementary school	24	30	24
Secondary	31	20	20
High school or equivalent and more	26	15	20
Missing values	5	0	0
<b>Road User</b>			
Pedestrian	22	23	22
Car occupant	39	48	46
Public transport passenger	6	0	0
Cyclist / Motorcyclist	32	28	32
Missing values	1	0	0
<b>Medical attention</b>			
Institution			
Municipal Medical Services	32	7	7
IMSS	51	17	20
Ministry of Health	11	67	66
Private Hospital	7	10	7
<b>Discharge condition</b>			
Discharge due to improvement	84	NA	NA
Reference to other institution	8	NA	NA
Self-Discharge	2	NA	NA
Other / not known	6	NA	NA

NA: Information unavailable; IMSS: Mexican Social Security Institute.

**Table 2** Descriptive statistics of continuous variables in study population, by questionnaire, Guadalajara metropolitan area 2007

Database	Variables	N	Summ	Mean	S.D.	p50	min	max
E.R. (N=237)	Age	236	—	26.4	14.6	24	1	80.0
	Total income per month self-reported by injured	130	—	553.9	458.6	394.7	121.2	2753.7
	Income per month of injured (multiple imputation)	189	—	509.4	404	371.8	99.8	2753.7
	Injury Severity Score (ISS)	231	—	2.2	1.8	1	1	14
	Direct Medical Cost	237	4313.6	18.2	56.3	0	0	384
	Direct Non-medical Cost	237	1281.8	5.4	27	0	0	275.4
	Total Direct Cost	237	5595.4	23.6	75.5	0	0	605.8
	Indirect cost: injured	187	14528	77.7	140.9	42.2	1.8	1545.1
	Indirect cost: companions	237	1066.6	4.5	8.4	1.8	0	70.2
	Total Indirect Cost	237	15594.6	65.8	131.7	33.2	0	1587.2
	TOTAL COST	237	21190	89.4	154	43.2	0	1587.2
Hospitalised (N=60)	Age	60	—	24.4	15.6	21	0	84
	Total income per month self-reported by injured	28	—	509.0	400.8	459.0	37	2294.8
	Income per month of injured (multiple imputation)	45	—	480.8	333.1	440.6	36.7	2294.7
	Injury Severity Score (ISS)	60	—	12	8.5	9.0	1	33
	Days of intrahospital stay	59	601	10.2	9.9	7.0	1	55
	Direct Medical Cost	60	26622	443.7	561.2	219.8	0	2918.9
	Direct Non-medical Cost	60	8410.7	140.2	159.1	91.8	0	688.4
	Total Direct Cost	60	35032.8	583.9	598.9	360.5	0	3001.5
	Indirect cost: injured	60	7731.1	128.9	195.8	65.4	0	1214
	Indirect cost: companions	60	5244.2	87.4	83.4	52.6	0.6	322.8
	Total Indirect Cost	60	12975.3	216.3	242.5	141.2	0.6	1424.5
TOTAL COST	60	48008.1	800.1	674.6	589.8	48.9	3186.9	
Surveyed at 8 weeks (N=41, non-response rate: 32%)	Total number of days lost	60	1641	27.4	34.5	20	0	150
	Time invested in ambulatory medical care (hours)	41	109.1	2.7	3.8	0.8	0	16
	Days of intrahospital stay (readmission)	2	0.3	0.2	0	0.2	0.1	0.2
	Direct Medical Cost	41	3169	77.3	105.5	38.6	0	436
	Direct Non-medical Cost	41	9527.6	232.4	1150.6	4.6	0	7347.8
	Total Direct Cost	60	13690.7	228.2	955.8	52.3	0	7347.8
	Indirect cost: injured	41	16110.6	392.9	585.9	208.6	0	2576.3
	Indirect cost: companions	29	1537	53	131.4	3.5	0	550.7
	Total Indirect Cost	60	21610	360.2	518.8	208.5	0	2627.4
	TOTAL COST	60	35301	588.3	1323.1	260.9	0	9649.7
	Total cost (hospitalisation and 8 weeks)	60	83308.7	1388.5	1545.2	935.9	168.6	10410

Figures in January 1st US dollars.

—, Does not apply; ISS, Injury Severity Score; p50, median.

The 237 patients attended only in the ER paid a total US \$5595 out-of-pocket (mean of US\$23.6); 77% was direct medical cost and the rest was non-medical. Indirect costs associated with medical attention summed to US\$15 595; 93% for the injured and 7% for their companions/caregivers' time. As shown in table 2 the total economic cost of patients attended only in the ER was US\$21 190 (mean of US\$89). Direct cost for the 60 hospital-admitted patients totalled US\$35 033 (mean of US \$584) with 76% direct medical cost. Indirect costs for hospitalisation were US\$12 975 (60% of injured person's time and 40% of caregivers'/companions' time). In total, economic cost for the hospitalised was US\$48 008 with an average of US\$800 per hospitalised person.

The questionnaire conducted 8 weeks after hospital discharge had a response rate of 68%. Given that there were no statistical differences in age, gender, asset index, marital status, medical insurance, schooling, type of road user, number and severity of injuries, place of care, the median cost (US\$261) was imputed to those who did not answer this questionnaire. As a result, total cost was US\$35 301, 61% of which was indirect cost. After considering hospitalisation and costs at 8 weeks after discharge, economic cost for those hospitalised totalled US\$83 309 (average of US\$1389). However, interviewers indicated that 46.3% of those interviewed at 8 weeks would incur future expenses or suffer incapacity due to RTI; 36.6% were reported as having temporary disability and 12.2% with any type of permanent

disability. These cases will incur direct and indirect costs not—quantified in this study.

Had all those affected by RTI not been injured, households would have saved a total of US\$104 499. This has great implications if we consider that according to this estimates, 7.5% of those who received care in ER spent 30% or more of their monthly income paid out-of-pocket, or 12.2% if we take the minimum monthly wage of Jalisco as reference, see table 3. This scenario is even worse for the injured who were hospitalised. About 80% of hospitalised victims spent 30% or more of their monthly household income to paid out-of-pocket (85% if we estimate household income through household expenses reported). Between 1.6% and 3.4% of injury victims who received only emergency care and 50% of those who were hospitalised went into debt or dipped into savings as a result of RTI, since they spent more than 100% of their monthly income.

Table 4 presents the multivariate analysis that allowed the estimation of the average cost adjusted by variables of interest. As can be observed, in injured patients who were attended in ER services, having medical insurance and receiving care at the Municipal hospital was negatively associated with total cost. While, on the other hand, having higher education and severe injuries was positively associated with the total cost. Among persons hospitalised, the asset index and longer hospitalisation stay were associated with higher total costs. Although having medical insurance showed no relationship with less cost, those

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**Table 3** Relation between cost (direct and total) and income of patients attended in emergency rooms and Hospitalised, Guadalajara metropolitan area 2007

E.R.	% of injured income*				% of the minimum monthly wage in Jalisco †			
	>20%	>30%	>40%	>= 100%	>20%	>30%	>40%	>= 100%
Direct cost	8.6%	7.5%	6.4%	1.6%	16.0%	12.2%	9.3%	3.4%
Total cost ‡	34.8%	17.6%	12.3%	3.7%	21.1%	16.0%	11.0%	5.1%

  

Hospitalised§	% of household income				% of total household expenditure			
	>20%	>30%	>40%	>= 100%	>20%	>30%	>40%	>= 100%
Direct cost	85.0%	80.0%	73.3%	50.0%	86.7%	85.0%	76.7%	50.0%
Total cost	100.0%	100.0%	95.0%	71.7%	96.7%	96.7%	86.7%	76.7%

\*Income of injured people is that self-reported by people aged 15 or more, and the multiple imputation of income for those of the same age who did not report (N = 187, mean: 398 USD, median: 330 USD, SD=462 USD).

†Minimum wage of the state of Jalisco is 4.68 USD per day (140.33 USD per month). This indicator uses all individuals irrespective of their age (N = 237).

‡Indirect cost was estimated for those adults (15 years or older) that did not self-reported any income using multiple imputation techniques.

§N=60. 10 households report income=0 and thus were included in the numerator of both indicators. 2 households report expenditure=0 and were also included in both indicators.

who received care at social security hospital had statistically lower expenses. One major finding among those who were hospitalised was the interaction between intrahospital stay and Injury Severity Score (ISS): positive association between hospital stay and total cost was no longer statistically significant when ISS was 19 or higher. In this sense, ISS was not associated with total cost nor correlated with intrahospital stay.

**Economic impact of RTI in Jalisco and GMA**

Secondary analysis of mortality databases showed a total of 1510 fatalities due to RTI in Jalisco during 2007. Of this number, 46% of fatalities occurred in GMA. As shown in table 5, the majority were men with an average of 36.8 years. A total of 58 434 YPL were lost due to RTI in Jalisco, from which, 43% corresponded to people that died in GMA.

**Table 4** Variables associated to the in of total cost in patients attended in emergency rooms and Hospitalised in the Guadalajara metropolitan area Jalisco, during 2007

Variables	Model for E.R. patients*		Model for Hospitalised †			
	Coefficient	95% CI	p Value	Coefficient	95% CI	p Value
Age	0.0325	0.0203 to 0.0447	0.000	0.0174	0.0028 to 0.0320	0.019
Age2	—	—	—	-0.0006	-0.0014 to 0.0003	0.194
Men	-0.2791	-0.6859 to 0.1277	0.178	0.1685	-0.4624 to 0.7994	0.601
Insured	-0.6588	-1.2344 to -0.0831	0.025	0.2653	-0.3237 to 0.8543	0.377
Asset Index	—	—	—	0.2164	0.0319 to 0.4009	0.021
No or <Elementary school ‡	—	—	—	—	—	—
Elementary school	0.7905	0.1703 to 1.4106	0.013	—	—	—
Secondary school	0.8333	0.2337 to 1.4329	0.007	—	—	—
Highschool or equivalent and more	1.1331	0.4816 to 1.7845	0.001	—	—	—
Number of injuries	0.0718	-0.0193 to 0.1629	0.122	—	—	—
ISS	0.0922	0.0097 to 0.1747	0.029	0.0201	-0.0168 to 0.0571	0.286
Intrahospital Stay	—	—	—	0.0568	0.0194 to 0.0941	0.003
ISS§Intrahospital Stay	—	—	—	-0.0012	-0.0039 to 0.0015	0.392
Pedestrian ‡	—	—	—	—	—	—
Motor vehicle occupant ≥4 tyres	0.5325	0.0600 to 1.0050	0.027	0.2277	-0.3125 to 0.7678	0.409
Motorcyclist and cyclist	0.1448	-0.3458 to 0.6354	0.561	0.0354	-0.5130 to 0.5838	0.899
Municipal medical Services	-1.5509	-2.2458 to -0.8559	0.000	-0.2841	-1.1809 to 0.6127	0.535
IMSS	-0.4725	-1.2461 to 0.3010	0.230	-0.9571	-1.6012 to -0.3130	0.004
Ministry of Health	—	—	—	—	—	—
Private Hospital	-0.3055	-1.3694 to 0.7583	0.572	-0.0224	-1.0953 to 1.0506	0.967
Global goodness of fit of the model						
Observations	—	212	—	—	58	—
Prob > F or $\chi^2$	—	0.0000	—	—	0.0053	—
R <sup>2</sup>	—	0.3865	—	—	0.4535	—
R <sup>2</sup> adjusted	—	—	—	—	0.292	—
AIC	—	697.981	—	—	128.4099	—
BIC	—	744.9732	—	—	157.2561	—
loglikelihood	—	-334.9905	—	—	-50.20496	—

\*Indirect cost estimated through multiple imputation of income, in logarithmic scale. Robust Standard Errors.

†Indirect cost estimated through multiple imputation of income and imputation of the median of total cost at 8 weeks, in logarithmic scale. Bootstrap Standard Errors (10 000 iterations).

‡Reference category.

IMSS: Mexican Social Security Institute; ISS: Injury Severity Score.

**Table 5** Characteristics of road traffic deaths in Jalisco and the Guadalajara Metropolitan Area, during 2007

Categorical variables	Deaths 2007						
	ZMG (N = 687)	Jalisco (N = 1510)					
Sex							
Men	77.6%	77.2%					
Women	22.4%	22.8%					
Medical attention							
Yes	55.3%	32.3%					
No	39.3%	57.8%					
Non-specified	5.4%	9.9%					
Medical insurance							
Insured	52.0%	38.9%					
Non-insured	39.7%	39.2%					
Non-specified	8.3%	21.9%					
Continuous variables	N	Summ	Mean	S.D.	Median	Min.	Max.
ZMG							
Age	685	—	38.9	22.7	34.0	0	100
Years of Potential Life Lost (All)	629	25 274	40.2	19.3	44.2	0.2	75.2
Jalisco							
Age	1503	—	36.8	21.4	32	0	100
Years of Potential Life Lost (All)	1421	58 434.3	41.1	18.7	45.2	0.2	75.2

GMA, Guadalajara metropolitan area; N, number of observations.

Table 6 shows the economic impact of RTI estimated for Jalisco and GMA. A basal model, as well as results of the sensitivity analysis with different scenarios or discount rates is presented. It was estimated that 128 725 people were affected by RTI during 2007 in Jalisco. In this population, 18% did not use medical services.<sup>vii</sup> Thus, for each death, 13.6 injured persons were hospitalised, 53.9 were attended in ER services and 15 people did not use any medical services and almost 1.7 were permanently disabled. Using a 3% discount rate, the estimated total cost of RTI for Jalisco was US\$650 908 924 (90% CI 307 998 757 to 993 615 395). The majority of this cost was associated with disability (56%) and fatal injuries (25%). This figure equals 1.3% of the GDP of the State.<sup>viii</sup> The total cost of RTI estimated for GMA was US\$329 061 813 (90% CI 166 908 527 to 491 060 532). This amount represents about 51% of the total estimated cost for the state. The majority of the cost was due to disability (53%) and fatal injuries (30%).

## DISCUSSION

Based on this work it was possible to identify the high cost of RTI not only within households but also within society in general. This problem affects the economic status of households of all social strata leading families into debt or impoverishing them, which initiates or perpetuates the cycle of poverty. Since families had to pay out-of-pocket for high, unexpected, expenses, this is in opposition to one intrinsic goal of every health system which is to find justice and equity in health system financing.<sup>28</sup>

<sup>vii</sup>The low number of injured people that did not use the health services might be related to the fact that the memory bias is more important among those who have suffered a collision with slight injuries. Besides, the number, would increment substantially if it is added to those who had a collision without any injury. This question was not asked in the ENSA-2000 nor in the ENSANUT-2006.

<sup>viii</sup>Gross Domestic Product (GDP) on 2006 was US\$50 346 940 672, according to official numbers reported by INEGI (<http://www.inegi.org.mx>). These figures were first converted to 2008 Mexican pesos using the consumer Price index reported by Banco de México (<http://www.banxico.org.mx>) for the period: January 2006 to January 2008 (7.83) and then converted to US dollars.

This study presents some strengths. Since it is one of the few studies whose estimation focuses on the economic perspective of households, it allows for more direct documentation and visualisation of the impact of RTI. In addition, this study considers indirect cost estimations related to caregivers and companions, time which is also valuable. Since indirect cost associated with caregivers and companions represented 20% of the whole indirect cost of the sample we could appreciate its importance and the strength of having included it in these estimations. Additionally, having followed-up with persons who were hospitalised 8 weeks after hospital discharge allowed us to have better estimations of the real cost of RTI. This cost represented 30% of the total cost reported by the informants.

The estimates here are low because 46.3% of hospitalised cases were expected to have further costs after the 8-week survey. Besides, these estimations did not quantify the direct and indirect cost associated with injured people who did not use health services; some authors<sup>29</sup> suggest this is not a common problem since perception of gravity is higher than in other diseases increasing the use (sometimes unnecessary) of health services. Non-users of 'formal' health services could have also had direct and indirect costs as result of their injuries, as has been documented previously. Cost as a result of self-medication, consultation of non-formal providers and remedies recommended represent an important part of total cost figures reported in a recent study.<sup>30</sup>

Some injuries in their acute stage are considerate 'slight' but they can have a higher impact on future health for individuals, impacting the cost that this represents for both households and society. 'Whiplash'<sup>ix</sup> is a classic example, despite the fact that it has a value of AIS-2005 of '1' (slight) and does not always require hospitalisation, it is one of the most expensive injuries for some European Union insurance companies.<sup>31</sup> This might affect our estimations since neck injuries were one of the most common injuries in hospitalised persons and the most common in patients attended only in ER services (who were not followed up in this study). The same thing happens with psychosocial conditions such as post-traumatic stress disorder, which has been considered very frequent, with prevalence ranging from 25% 3 months to 18% 61 months after the collision.<sup>31</sup>

However, present study could have overestimated total cost as well. Some authors think that there are costs households would have made without suffering RTI, that could only be evaluated using counterfactuals.<sup>32</sup> There are also strategies used by households to face costs (coping strategies) for example when a family member becomes ill in a family business his/her place is taken by other family member without representing a loss of income, but this situation was not considered in the present study.<sup>32</sup> The number of persons estimated to be permanently disabled is higher than observed in a recent study performed in Belize<sup>33</sup> (rate of 0.7 per 100 000 inhabitants versus 22.2–37.1) but smaller than previously reported in Nigeria<sup>34</sup> (29.1% of RTIs versus 12.2% in persons hospitalised or 2.7% in all RTIs documented in this study). This estimation could significantly impact on our figures. In addition, assuming they will lose income permanently could overestimate the total cost.

This study faces huge challenges in terms of external validity. Nevertheless, different studies have shown how random cost identification of RTI cases is more complicated and consumes more time.<sup>35</sup> Identifying hospital cases is a more cost-effective

<sup>ix</sup>Whiplash is a very frequent injury on RTI or when breaking abruptly, since due to the kinetic energy the body goes forward and then backwards (like a whip) which may cause in some cases a fracture on the cervical spine or even medullar damages.

**Table 6** Economic impact of road traffic injuries in the Guadalajara Metropolitan Area and Jalisco, during 2007

Type of injured	Concept	Total cost (USD\$)			Total number of injured		
		Basal*	Simulation Scenarios†			Basal	Simulation†
			Rate 0%	Rate 3%	Rate 5%		
<b>GMA</b>							
Fatal	Hospitalised	38 699 799	87 356 899	52 066 921	39 465 196	362	—
	Without hospitalisation	34 532 780	78 350 455	46 585 079	35 253 373	325	—
	Total	73 232 579	165 707 354	98 651 999	74 718 569	687	701
Non-fatal	Hospitalised						
	Die >30 days‡	19 308 712	71 291 482	42 543 904	32 288 742	180	—
	Hospitalisation	6 870 831	11 231 319	11 231 319	11 231 319	5718	9562
	Ambulatory medical consultations	93 307	154 072	154 072	154 072	4146	—
	Rehabilitation	10 524	98 116	98 116	98 116	2209	—
	E.R. Users	1 709 102	3 233 996	3 233 996	3 233 996	22 586	37 772
	TOTAL (hospital + E.R.)	27 702 356	85 452 134	56 704 556	46 449 394	28 304	47 334
	Non-users of health services	—	—	—	—	9374	10 531
	Indirect cost of disability	75 053 181	341 507 759	173 705 257	121 987 262	698	1167
	Total	Fatal + Non-Fatals + Disability	175 988 116	592 667 247	329 061 813	24 315 5225	38 366
<b>Jalisco</b>							
Fatal	Hospitalised	60 643 886	168 395 882	86 236 250	61 916 905	796	—
	Without hospitalisation	53 980 576	15 070 2900	769 40 800	55 107 134	714	—
	Total	114 624 462	319 098 782	163 177 051	117 024 039	1510	1541
Non-fatal	Hospitalised						
	Die >30 days‡	40 582 919	151 136 409	89 546 013	67 864 111	395	—
	Hospitalisation	15 101 826	24 686 015	24 686 015	24 686 015	12 568	21 018
	Ambulatory medical consultations	20 5085	33 8645	33 8645	33 8645	9113	—
	Rehabilitation	23 132	215 656	215 656	215 656	4855	—
	E.R. Users	3 756 541	7 108 200	7 108 200	7 108 200	49 644	83 020
	Total (hospital + E.R.)	59 031 832	182 260 986	120 670 591	98 988 689	62 212	104 038
	Non-users of health services	—	—	—	—	20 605	23 146
	Indirect cost of disability	158 523 370	724 967 741	367 061 282	257 835 977	1533	2564
	Total	Fatal + Non-Fatals + Disability	332 179 665	1 226 327 509	650 908 924	473 848 705	84 327

\*Basal estimation uses a 3% discount rate and means of cost information.

†Values presented are the mean of the 10 000 iterations for each scenario-discount rate.

‡Direct cost for injured people that died after 30 days was estimated for 48.42 days of intrahospital stay and assuming a mean age of 42 years; both assumptions were taken from the 2007 hospital discharge database of the Ministry of Health unities.

GMA, Guadalajara Metropolitan Area.

strategy, even though they might not represent the whole of persons injured.<sup>35</sup> Therefore results should be taken cautiously in terms of population inference.<sup>35</sup> The selection of a private hospital does not reflect what happens in other private institutions attending RTI patients in the GMA, considering the diversity in terms of costs and quality of the private sector: private sector services' costs might have being influenced by "what patients could afford to buy" or could get.<sup>35</sup>

WHO estimates that RTI cost represents 1% of the GDP in low income countries, meanwhile in medium and high income countries the cost can get to 1.5% and 2% respectively.<sup>12</sup> This

study documents for the state of Jalisco a loss equivalent to 1.3% of the GDP although it does not report institutional cost, which could substantially increase the estimated cost. The method used may influence the final estimation. In this regard, Mohan analyzes the differences between low and high income countries, admitting that estimations in high income countries tend to be more detailed and comprehensive since they include willingness to pay, quality adjusted life years or healthy life years.<sup>23</sup> According to the author, if the willingness to pay method would have been used in India, the total cost would have increased

### What is already known on this subject

- ▶ RTI are the seventh leading cause of death in Mexico, but the fourth leading cause of death within the 15–59 age group, accounting for 3% and 6% of total annual deaths, respectively.
- ▶ Almost 10% of all RTI deaths in Mexico occur in the state of Jalisco where almost four people die each day as a result.
- ▶ WHO estimates that the economic cost of RTI worldwide represents a loss of US\$518 billion, from which US\$65 billion are lost in low and middle-income countries, an amount that exceeds total annual development assistance for these countries.

### What this study adds

- ▶ More than 8% of injured attended only in ER and 80% of those hospitalised reported out of pocket expenditures of 30% or more of their total monthly income.
- ▶ Indirect cost associated to time lost of caregivers and companions represented 20% of the total indirect cost. Important cost category seldom estimated in similar studies.
- ▶ Economic cost that hospitalised injured people face within 8 weeks of hospital discharge are important, representing 30% of the total cost documented in this work.
- ▶ During 2007, society lost more than US\$329 061 813 for GMA and US\$650 908 924 at the state level (1.3% of State GNP).

from 0.8% to 2% of GDP. If a willingness to pay value were used for fatalities, the value per statistical life would be between US \$268 152 and US\$370 849,<sup>x</sup> about 2.5 to 3.6 times the estimated earnings loss per death in our study.<sup>36</sup> Additionally, problems such as lack of access to health services and technology; besides low work opportunities for people with some kind of disability, contribute to underestimating the cost of RTI in low and medium income countries.<sup>23</sup>

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**Patient consent** Obtained.

**Ethics approval** This study was conducted with the approval of the National Institute of Public Health, Mexico.

**Contributors** RPN and LAB conceived and designed this study and were responsible of data collection and analysis. RPN drafted the article. ASR collaborated in data analysis. All authors revised critically the article and approved final version.

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<sup>x</sup>Figures from the original study were converted to US dollars of January 2008 to facilitate comparability.



## Economic impact of fatal and non-fatal road traffic injuries in Guadalajara Metropolitan Area and Jalisco, Mexico

Ricardo Pérez-Núñez, Leticia Ávila-Burgos, Martha Híjar-Medina, et al.

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