

Analysis of Direct Medical Expenses Resulting from Road Traffic Injuries in the City of Tabriz

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Abstract

Background: Road crashes as a major global public health problem cost 3% of most countries and 5% of low- and middle-income countries' gross domestic product (GDP). The World Health Organization has predicted that without sustained action, road traffic crashes will become the seventh leading cause of death by 2030. **Objectives:** The aim of this study was to analyze the death rate, severity of injuries, and direct medical costs caused by road traffic injuries (RTI) in the city of Tabriz in 2014. **Methods:** Trauma injury admissions due to RTI in Imam Reza Hospital in Tabriz City were investigated in terms of etiology and the direct medical costs during 2014–2015. Data were collected using a researcher-made checklist after being confirmed by relevant experts in terms of face validity. All information on direct medical costs are extracted from several sources including hospitals, database of the Ministry of Health and Medical Education, disaster and emergency medical management center, and public and private physiotherapy clinics across the city. **Results:** Review of the hospital records showed that the mean age of the patients (67.9% males and 32.1% females) was 34 ± 17.3 years. In addition, 79.2% of the patients were treated on an outpatient basis, and 20.8% were treated on a hospitalization basis (hospitalization or death). The mean times of inpatient and outpatient hospitalization for injuries were 3 h and 6.7 ± 5.3 days, respectively. Total direct medical costs were 11.631 dollars, of which 8% was for hospital costs, 9.7% for prehospital costs, and 2.3% for physiotherapy costs. Chest and lower part injuries had highest medical costs. From etiological standpoints, the greatest reason of being injured and hospitalization is multiple injuries and bruises, and the prominent cause of death was blow to the head and neck (70%). **Conclusions:** The results of the present study showed that direct medical costs in Tabriz during 2014–2015 were equal to 0.1% of GDP, which is a considerable amount. High economic and social costs of road accidents and their harmful physical and psychological effects on individuals and community require the attention of professionals and experts in the transportation industry and health-care system to determine appropriate strategies for interventions in reducing accidents' burden and injuries.

Keywords: Direct medical costs, hospital, Iran, road traffic injuries, Tabriz, trauma

INTRODUCTION

According to the World Health Organization report in 2015, 1.25 million people annually lose their lives in road accidents worldwide, which is the leading cause of death among the youth of 15–29-year-old. It is estimated that traffic injury is the ninth leading cause of death in all ages the world and it is anticipated that by 2030, it will be the seventh leading cause of death. The rate of deaths from road accidents is 17.4/100,000 in the world, 9/100,000 in Europe, and 19.9/100,000 in the Eastern Mediterranean region.^[1] The increased mortality in low- and middle-income countries (LMICs) is particularly associated with the country's economic development and automation. More than 90% of deaths from road accidents occur in LMICs while

these countries account for 82% of the world population and 54% of the world's vehicles.^[1]

According to the 2015 Global Status Report on Road Safety, the costs of road accidents in the world and in LMICs are 3% and 5% of the gross domestic product (GDP), respectively.^[1] While the shares of health care and military expenditures from GDP are 9.9% and 2.2%, respectively.^[1] The Islamic Republic of Iran, having 32.1 deaths per 100,000 in 2014, is far above

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the global and regional average (17.4, 19.9).^[1] The economy spends 6% of GDP on road accidents while the total shares of health sector and defense from GDP are 6.8% and 2.3%, respectively.^[2]

Review of related literature demonstrates that researchers have tried to estimate the economic burden of injuries through three main approaches, namely, cost-of-illness method, willingness to pay method, and macroeconomic simulations. Each method has its own pros and cons and has been adopted in various studies according to the study context and audiences, data availability, and researchers expertise. The cost-of-illness method, which is most commonly used in related literature, includes direct medical costs such as hospital expenses, transport, funeral, or all out-of-pocket expenses due to the injury. Moreover, indirect costs such as productivity loss due to premature death or reduced productivity are to be considered in this method. Since the cost-of-illness method categorizes economic burden of illness into transparent categories (e.g., medical, productivity loss, and administrative) that are easy to interpret and easy to communicate with policy makers, it was adopted in this study while the researchers were aware about potential limitations.^[3]

Although the direct cost of injury treatment is only a small fraction of the economic burden imposed by road accidents, this fraction can be of great importance and can directly influence the injured person and absorb health sector budget in LMICs where people deprived from essential primary health-care needs. Connelly *et al.* showed that the total cost imposed on the country due to road accidents was 17 billion dollars, which is equal to 2.3% of GDP in 2003 for Australia, of which 4.2% of costs were related to health care.^[4]

The overall methods proposed for estimating the cost of traffic accidents are based on the gross output method, human capital method, net output method, life insurance method, court award method and willingness-to-pay method.^[3] According to Reynold's classification, the cost of road accidents is divided into direct, indirect, and intangible social costs. The direct costs or tangible costs include medical expenses, vehicle damage, and insurance costs. Indirect costs or intangible costs include loss of production and human costs.^[5] The cost of accidents was first calculated in 1955 in England and then in America.^[6] According to the estimates, the total cost of road traffic injuries (RTI) is \$ 518 billion annually, \$ 65 billion of which is related to LMICs that are slightly more than the amount of financial aid these countries receive from developed countries.^[7] In a study conducted in Thailand, traffic and road accidents were one of the main reasons of mortality in Thailand and the death rate caused by road accidents had increased from 2.5 to 19.8 per hundred thousand in 2002–2004. In addition, approximately 81% of admissions in public hospitals in Thailand during 2004 were due to road accidents. It was planned as commonness based cost-of-disease investigation from a societal viewpoint, utilizing a micro-costing costing base up approach. The mean cost of RTI per patient was USD 2,569 (include USD 102, or 4% as direct cost, and USD 2,494,

or 96% as indirect cost) at 2004 prices.^[8] A study conducted by Rezaei *et al.* showed that the total costs due to road accidents in Iran in 2009 were \$ 7.2 billion, which costs 2.9% of the country's GDP.^[9] Road accidents, after cardiovascular diseases, are the second cause of mortality in Iran.^[10] Although RTIs are a worldwide challenge and can massively affect nation's health and economy, so far, insufficient action has been taken to meet the problem in LMICs. Reducing the burden of RTIs needs a holistic "Safe System" in which the national-level actions supposed to be commissioned by governments and nongovernmental organizations. Call for such a commitment needs to be supported by economic evidence, which can attract more advocates and determine resource allocation decisions. Despite the abundance of epidemiological studies, there is a clear paucity of economic evidence on the extent and burden of RTIs. This study aimed to estimate the extent and burden of direct medical costs and productivity loss due to hospital stay caused by RTIs in capital city of Tabriz, Iran.

Objectives

The study aimed to analyze the direct medical costs and productivity loss due to hospital stay, which caused by RTIs in the capital city of Tabriz

METHODS

This cross-sectional study was conducted through the cost-of-illness method at the Trauma Center of East Azerbaijan Province (Tabriz). The survey was conducted among injured people who were transferred to the Center. All costs identified from health provider's perspective were cost of transportation, hospital admission and stay, and physiotherapy expenses. To provide economic evidence for negotiating with policymakers as well as shipping industry stakeholders, cost of productivity loss and reduced productivity due to hospital stay was estimated using human capital approach. Because the time horizon of the study was up to 1 year, no discounting was carried out for estimated costs.^[11] Because the data for indirect costs which incurred by society (insurance compensation, traffic jam, etc.) and intangible costs due to pain or suffering were not included in cost estimation, researchers declare that the study results should not be translated as a social cost of RTIs.

Data collection

From a total of 17719 RTIs in Tabriz city, data of 773 traumatic patients were collected using a data gathering form administered by the researcher containing informed consent, sociodemographic characteristics, all in/outpatient costs, date of admission/discharge, damaged organ, and type of vehicle in 2014.

We collected the information in two sections. In the first section, data and information were collected using 773 clinical records for the calculation of the average cost of direct treatment. In the second part, considering that we used a kind of microcost approach, the census method was used to generalize it to Tabriz city, and information of 17719 RTIs in Tabriz city was collected in 2014 (by subcategory and all injured). The

Table 1: Data collection sources for direct medical cost estimation of road traffic injuries

Data requirement	Data sources
Number of victims and the deaths caused by road accidents	Health information system of teaching hospitals affiliated to Tabriz University of Medical Sciences
Information on direct medical costs	Imam Reza Hospital (Trauma center) and traumatic patient's medical records
Prehospital costs	Disaster and emergency medical management center and management of training and funding center of university
Physiotherapy costs	Public and private physiotherapy clinics

type of data required to estimate the costs and sources of data extraction was determined at first using literature review. Then, a designed form containing demographic characteristics of the patients, how they visit the hospital, stay length, cost of treatment and surgery, type of vehicle, damaged organs, and other characteristics were developed. After verifying the face validity of the form with the help of experts, data were collected referring to each organization [Table 1].

Prehospital costs

To estimate prehospital costs, the coefficient of traffic injury patients' share of the total emergency missions was first specified and then multiplied by the current budget related to the medical emergency in 2014, and finally, the total prehospital cost was obtained.

Hospital costs

To estimate the direct medical costs, participants' medical records were examined, then the average cost for the study samples was calculated and multiplied by the number of admitted patients during 2014.

Physiotherapy costs

To estimate the cost of physiotherapy and rehabilitation, according to studies conducted by the World Health Organization and the World Bank, about half of road accident patients have orthopedic injuries on average, of which about 10% require physiotherapy and rehabilitation services;^[2] therefore, 5% of all road accident casualties need physiotherapy. As a result, the cost of physiotherapy estimated as follows:

$$\text{Physiotherapy cost} = M \times Q \times 0.05 \times P$$

Where, M is the number of traffic accident injuries, Q is the mean number of sessions required for a patient, and P is the cost of treatment per session.^[9,12]

To estimate the mean number of sessions and costs per session, the researcher referred to private and public clinics in the city of Tabriz, collected the data, and then, the mean cost and the number of required sessions were estimated.

Direct medical costs

To estimate the direct medical costs of road accidents in the city of Tabriz, patients were divided into three groups according to

the severity of injury: The deceased, minor injury, and severe injury.^[9,12] Minor injuries included patients with minor injuries and treated as outpatient; severe injury included those patients with more severe injuries and hospitalized for >24 h. Then, an average duration of hospitalization and treatment costs of each group of the patients (deceased, severe, and minor injury) were obtained. All costs were converted to dollar currency value at 2014 (26509IR = 1USD).

Production lost

Potential lost production due to hospitalization and for outpatient injuries: To calculate these costs, the average length of hospitalization (in terms of days) and the average outpatient time were obtained using hospital records, and this amount multiplied by the number of hospitalized traffic injuries and the daily wage rate in the country.^[9,12] According to the Ministry of Labor and Social Affairs, the daily wage rate for the country was US \$ 8 in 2014. Eventually, the total potential loss of production was estimated for injured patients.

Statistical analysis

Data of hospital costs were analyzed using statistical methods by the SPSS Version 20 (IBM Corp) software.^[13]

RESULTS

From a total of 773 injured people included in this study, 248 (32.1%) were females, and 525 (67.9%) were males. The mean age of the patients was 34 ± 17.3 years. In addition, 612 (79.2%) of the patients were outpatients, 141 (18%) were inpatients, and 20 (2.6%) cases were deceased. In terms of injured areas, 106 (13.7%) subjects had head and neck injuries, 584 (75.5%) had limb and body contusions, 13 (1.7%) had chest injuries, 15 (1.9%) had upper limb injuries, 40 (5.2%) cases had abdomen or pelvis injuries, and 15 (1.9%) had lower limb injuries [Table 2]. The major cause of injury and hospitalizations was multiple injuries, and the main cause of death was blow to the head and neck, 14 out of 20 deaths (70%) [Table 2]. Most deaths, 9 out of 20 (45%), occurred to car occupants. In terms of medical costs, injuries to chest with \$2179 were the highest rate and multiple injuries with \$194 were the lowest rate of hospital costs. In addition, the mean cost of injured pedestrians and drivers was the highest cost (\$257) [Table 2].

Prehospital costs

Of the total 773 cases studied, 751 (97.3%) patients were transferred by the emergency medical services and 22 (2.7%) patients were transferred to the hospital by private vehicle. The prehospital cost for those who were transferred to hospitals by emergency was US \$ 1127 dollars. In other words, the mean cost of \$ 208.6 was estimated for each transfer.

Hospital costs

The average amount of times of hospitalization for injuries that were treated on an outpatient basis was 3 h and for injuries that were treated on a hospitalization basis was about 5.3 ± 6.7 days. Table 3 shows that the lower limb and abdomen

Table 2: Distribution of hospital costs according to the injured areas, site, type of vehicle, and position of the injured person using cases examined in 2014

	Mean of hospital costs (in US dollar)	Total number of injuries	Percentage of total number of injuries	Percentage of total costs	n (percentage of deceased)	n (percentage of severe injuries) (hospitalization)	n (percentage of minor injuries) (outpatient basis)
Injured organ							
Head, face, neck	975	105	13.7	28.5	14 (70)	59 (41.84)	32 (5.23)
Upper limb	955	15	1.9	4	0	8 (5.67)	7 (1.14)
Chest	2179	13	1.7	7.8	1 (5)	11 (7.8)	1 (.16)
Abdomen, waist, hip	1849	41	5.2	20.4	2 (10)	27 (19.15)	12 (1.96)
Lower limb	1929	15	1.9	8	1 (5)	10 (7.1)	4 (0.66)
General bruise	194	584	75.6	31.3	2 (10)	26 (18.44)	556 (90.85)
Accident site							
Urban areas	339	336	43.5	31.5	7 (35)	42 (29.79)	287 (46.9)
Roads outside the city	553	284	36.7	43.4	8 (40)	59 (41.84)	217 (35.46)
Rural throughways	586	17	2.20	2.8	0	6 (4.26)	11 (1.8)
Rural roads	644	65	8.40	11.6	2 (10)	21 (14.89)	42 (6.86)
Highway out of town	550	36	4.70	5.3	1 (5)	8 (5.67)	27 (4.41)
Highway in the city	559	35	4.50	5.4	2 (10)	5 (3.55)	28 (4.57)
Vehicle/injured							
Pedestrian	495	180	23.3	24.5	6 (30)	36 (25.53)	138 (22.55)
Motorcycle	477	130	16.8	17	4 (20)	33 (23.4)	93 (15.20)
Cars, pickup heavy vehicle	448	448	58	55.3	9 (45)	69 (48.94)	370 (60.45)
	816	15	1.9	3.2	1 (5)	3 (2.13)	11 (1.8)
The position of the injured person							
Passenger	403	325	42.2	36.4	8 (40)	49 (34.75)	268 (43.79)
Driver	509.5	273	35.1	38.3	6 (30)	55 (39.01)	212 (34.64)
Pedestrian	527.5	175	22.7	25.3	6 (30)	37 (26.24)	132 (21.57)
Total patients (n=773)	469	773	100	100	20 (100)	141 (100)	612 (100)

Table 3: Length of hospital stays in terms of the injured organs

Injury	Patient (n)	Length of stay (day) ± SD
Head, face, neck	106	6.35±5.03
Upper limb	15	7.25±6.29
Chest	13	5.33±3.6
Abdomen, waist, hip	40	7.34±5.8
Lower limb	15	8.7±8.2
Multiple organs	584	6.8±4.6
Total	773	6.74±5.4

SD: Standard deviation

injuries had the highest length of stay. The average cost was US \$ 86.9 for an outpatient injured, US \$ 1919 for a hospitalized injured person, and \$ 469 for the total average cost per patient. The total hospital cost of outpatients was \$ 1153 and the total cost of hospitalization (hospitalization + deceased) was estimated to be \$ 9079. The total medical costs of RTI in Tabriz during 2014 were estimated to be \$10232. Statistical analysis showed that the cost of treatment in patients with chest and lower limb injuries was significantly higher than the cost of other injured areas [Table 2].

Physiotherapy costs

According to the survey, the average number of proposed sessions for physiotherapy was 20 sessions and the average

cost of each session was \$ 15.8 in 2014. Therefore, the total cost of physiotherapy was estimated to be \$ 273000 in 2014.

Direct medical costs based on severity of injuries

The results showed that the total direct medical cost of road accidents in the city of Tabriz was 11631 thousand dollars, of which \$ 1998 (17%) was for outpatients, \$ 9094 (78%) was for patients with severe injuries, and \$ 538 thousand (4.6%) for deceased [Table 4]. Due to road accidents in 2014 in the city of Tabriz, 17719 were injured and of which, 272 people (1.5%) were died; 4100 people (23.5%) were hospitalized and 13085 people (75%) were outpatients [Table 4].

Total potential production lost

Potential lost production for injured patients

Based on hospital records, the average number of hospital admission days for road accidents was 6 days. In addition, because the injured people did not return immediately after being discharged, the average was determined as 15 days. The total potential lost production for hospitalized injuries in road accidents in Tabriz was \$ 501480 in 2014.

Potential lost production for outpatient injury

Based on hospital records, the average hospital admission time for road accidents was 3 h. In addition, because the injured people did not return immediately after being discharged, the average was determined as 3 days. The total potential lost

inpatients and 3 days for outpatients.^[9] The study showed that the cost of the loss of income for inpatients and outpatients due to road accidents in the city of Tabriz was \$ 766,840.

On the other hand, the national standard length of stay in hospital was 4.1 days, which is an indicator of hospital resource consumption and one of the main reasons of the high cost of hospital bed-days.^[9,30] In other words, it can be said that policymakers, hospital administrators, and third-party payers (insurers) emphasize shortening the length of stay as a major policy harnessing hospital costs and effective and efficient use of limited hospital resources. The present study shows distance with the relevant national standards that may be due in part to disease type and severity of the injuries; therefore, it can be said that the prevention of traffic accidents significantly helps controlling costs and increasing efficiency in the health sector.

With regard to the main cause of death and the average age of victims of road accidents, it is suggested to prioritize the education and culturalization for the use of helmets and safety belts, particularly for intercity travels, to reduce traffic accidents and its complications and relevant costs. The obligation to observe traffic laws and use of safety devices in adverse weather conditions all can be efficient as strategies to minimize the adverse consequences of traffic accidents, especially in the age group of young and middle-aged people, who are active and productive forces of society. Road transport system officials and policymakers of the country are also recommended to take steps to standardize the roads with the necessary planning to prevent road accidents as much as possible, the result of which is increase in available resources to invest in other areas and contribute to the progress and prosperity of the country.

CONCLUSIONS

The results showed that direct medical costs resulting from road accidents in the city of Tabriz are very high. According to the 2015 Global Status Report on Road Safety, the cost of road accidents in Iran is 6% of GDP. In comparison, the share of health-care and military sectors' costs are 6.8% and 2.3% of GDP in Iran. The present study showed that direct medical costs in Tabriz during 2014 were equal to 0.1% of Iran's GDP, which is a considerable amount only for the city of Tabriz. It is noteworthy that in implementing the provisions of Article 92 of the Fourth Economic, Social, and Cultural Development program of Islamic Republic of Iran, all general and specialized hospitals, and governmental and nongovernmental medical centers are required to accept and treat road accident injuries immediately and without receiving any money. In fact, the government will bear the cost of hospital due to traffic accidents and reduce the financial strain on the victims, but the costs incurred by the government are undeniable. Considering other economic and social costs of road accidents and its harmful physical and psychological effects on individuals and community, professionals, and

experts in the transportation industry and health care system are required to take actions to manage the prevention of accidents and reduction of its complications and costs with appropriate strategies and planning.

Limitations of the study

The present study had a few limitations. First, considering that there was no access to the data of other costs, direct medical costs were only calculated. Second, the estimated costs in the health sector did not include informal care costs and time wasted by patients' families; therefore, the estimated cost is less than the actual amount. Moreover, in the case of physiotherapy costs, due to the lack of specific information on the number of traffic incidents required physiotherapy services we referred to related studies.

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Authors' contribution

Narges Shadkam is the principal researcher responsible for the design of the study, collection, and analysis of data and drafting the paper; Alireza Mahboub-Ahari was responsible for the initial design of the study, supervision of the collection, and analysis of data and had active cooperation and participation in the preparation of the final paper; Ali Imani was responsible for the design of the study, monitoring data collection and analysis, writing the article, and accountability for the accuracy of issues presented in the article; and M. Asghari Jafarabadi was statistical consultant of the project in all analysis procedures and conducted statistical analyses.

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Conflicts of interest

There are no conflicts of interest.

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