ORIGINAL ARTICLE

Estimating the Social and Economic Burden of Road Traffic Injuries in the Philippines

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ABSTRACT

Background. Road traffic injuries (RTI) are a leading cause of morbidity and mortality globally. Despite underreporting, the scarce Philippine data suggest that RTI pose a significant health problem in the country. It is imperative, therefore, to accurately quantify the burden of RTI in the Philippines.

Objective. This study aimed to provide the first comprehensive baseline estimation of the socioeconomic burden of RTI in the Philippines for year 2014.

Methods. The study was a mixed method study design that utilized both primary and secondary data. These data were used to construct parameters needed for the modeling estimates. Measure of socioeconomic burden estimated were (1) economic costs, (2) disability-adjusted life years (DALYs), and (3) healthy life years (HeaLY).

Result. Estimated deaths due to RTI in 2014 were 12,336 translating to 454,650 years life lost due to premature death. Injury episodes from RTI were estimated to be 2,798,088 in 2014 with 186,174 leading to admissions, translating to 56,224 years life lost to disability. The total DALY loss due to RTI in 2014 was estimated at 510, 874, while healthy life years lost were estimated to be 76,215,477.4. The estimated deaths and injuries for that year equaled to direct medical cost of PhP 1.213 B, productivity loss due to premature death of PhP 24.620 B, and productivity loss due to illness of PhP 685 M resulting to a total economic cost of PhP 26.519 B to the society.

Conclusion. The findings indicate that RTI is an important public health concern in the Philippines with substantial economic and health burden. Investing in preventive measures will likely yield significant economic and health gains for the Philippines.

Key Words: Road traffic injuries (RTI), socioeconomic burden, healthy life years (HeaLY), years lost to disability (YLD), years of life lost (YLL), disability adjusted life years (DALYs)

INTRODUCTION

According to the World Health Organization, road traffic injury (RTI) is the 8th leading cause of death globally and the leading cause of death among of the age group 15-29 years old. With 1.24 million lives lost, it is equivalent to 25% of all deaths in the world.[1] It is expected to become the third leading cause of death by 2020.[2] Middle income countries bear the majority (80%) of road traffic deaths despite accounting for only 52% of the registered vehicles in the world.[3]

The Department of Health[4] reported that in 2003,RTI was the second leading cause of death due to injury and in national roads, there were 5,870 non-fatal injuries and 1,185

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deaths. RTIs were the most common injuries reported in the Online National Electronic Injury Surveillance System for all the quarters of 2013[5-8] since they account for 30% of all reported injuries. An estimate of the socio-economic cost for RTI in Metro Manila, using the Human Capital Approach, found that on average, each fatal RTI costs PhP 4 million, a serious injury costs PhP 743,867, and a minor injury costs PhP 71,483.[9]

Information on RTI in the Philippines is limited to a handful of studies which reviewed hospital records and surveillance data covering only major cities, major highways, or selected hospitals. But even the underreported numbers suggest that RTI poses a significant health problem in the country. This study therefore aimed to bridge the gap in the literature by providing the first comprehensive baseline estimation of the socioeconomic burden of RTI in the Philippines for year 2014.

METHODS

Overview of Modeling Approach

Modeling was done to estimate burden in terms of (1) economic costs, (2) disability-adjusted life years (DALY), and (3) healthy life years (HeaLY). Parameters were sourced from both primary and secondary data collection methods. Calculations were done in Microsoft Excel 2013. The computation involved multiplying the estimated number of RTIs and deaths in the Philippines in 2014 with the appropriate unit costs to arrive at the economic costs. Unit costs included direct medical costs as well as opportunity or indirect costs and other direct costs (e.g. legal fees, funeral fees).

On the other hand, the DALY computation was a two-step computation since DALYs is the sum of years life lost to premature death (YLL) and years life lost to disability (YLD). YLL is equal to life expectancy for the sex-age bracket multiplied by the number of deaths in sex-age bracket. Life expectancy at sex-age bracket was converted to net present value with a discount rate of 3%. YLD is a sum of short and long-term disability. Short-term YLD is the number of injured multiplied by disability weight and duration of injury while long-term YLD is the number of injured multiplied by the proportion with long term disability, disability weight, and life expectancy at mean age of injury. No age weighting was applied in the disability weights for YLD.

Meanwhile, for HeaLYs, the following formula from Hyder et al was used:

$$\text{HeaLY} = \text{I} \times \{[\text{CFR} \times \{\text{E(Ao)} - [\text{Af} - \text{Ao}]\}] + [\text{CFR} \times \text{De} \times \text{Dt}]\}$$

where "I" is the incidence rate per 1,000 population, "CFR" is the case fatality rate, "E(Ao)" is expectation of life at age of onset of injury, "Af" average age of death, "Ao" is the average age of onset, "De" is the disability weight of injury, and "Dt" is the duration of disability.

Parameters and Data Sources

Population, Life expectancies, and Age-sex distribution

Population and age-sex distribution was based on the 2010 Philippine census. The 2014 population was estimated using exponential growth rates. Life expectancy at birth and for each age quintile were obtained from the 2000 Philippine life tables.

Incidence and Types of Road Traffic Injuries and Deaths

Several sources of incidence of RTIs that were reviewed included the 2013 National Demographic and Health Survey,[10] the rider survey in the National Baseline Survey for Violence against Children (NBS-VAC)[11], ONEISS,[12] PhilHealth database,[13] PNP database,[14] and the Philippine Statistics Authority vital statistics.[15]

Each source has its own strengths and weaknesses. The NDHS provided a national estimate for all-causes injury incidence in the Philippines but it is not RTI-specific. The rider survey provided a specific estimate but yielded very low and unrealistic estimates. The PSA was the main source for death rate per sex-age quintile. PNP data were not included in the modeling due to issues of underreporting as well as lack of details about the physical injuries of victims. Similar to the NBS-VAC, PNP data had unrealistically low incidence and death rates. The ONEISS and PhilHealth databases were useful for patterns of injuries but not for incidence estimates. ONEISS covered both admitted and ER cases but not for all hospitals; PhilHealth only covered admitted cases but it covers all PhilHealth-accredited hospitals and has a larger coverage than the ONEISS.

For the modeling, the 2013 NDHS injury incidence were converted to an RTI incidence by multiplying the proportion of injuries due to RTI reported in ONEISS. Because it covered both ER and admissions, the ONEISS was chosen for DALY parameters (see below). The ONEISS injury categories were re-classified to GBD categories by one of the authors (ASR).

Economic Cost of RTIs

To estimate costs of road traffic injuries, chart reviews and patient interviews were conducted – full results of which were published elsewhere[16] but the following is a brief overview: The chart review was conducted in 21 hospitals in the Philippines. Charts and bills of patients seen only at the emergency room and admitted were reviewed. The patient interviews were done by recruiting patients previously seen in the study hospitals and those who sought care at the study hospitals during the data collection period. Respondents were asked about direct medical costs and indirect medical costs (e.g. duration of absence in work). Finally, to augment the limited number of ER bills retrieved and to validate findings, costing exercises were conducted with representatives of study hospitals.

Cost per case in the model comprised of direct medical cost, opportunity cost due to injury, and opportunity cost due to premature death. For direct medical costs, median direct costs obtained from the chart review and patient survey were used. Productivity loss due to injury was computed by multiplying average daily income to days of work lost due to injury based on the NBS-VACS rider survey. Productivity loss due to premature death was expressed as the expected income of a person given the expected remaining productive life (counting only ages 18 to 65 as productive years) in net present value with a discount rate of 3%.

Disability weights for DALYs

Disability weights and durations of injuries for each type of injury were based on weights obtained through correspondence with the Global Burden of Disease (GBD) study group. This was supplemented with review of published literature using the GBD methodology.

To facilitate YLD computation, as victims of RTI presented with various GBD injury types, we computed short- and long-term YLD lost per RTI case. This was done by getting the weighted average DW of all GBD injury types exhibited by RTI cases detected in ONEISS for 2014. Weighting was based on the occurrence of the injury type being reported in ONEISS RTI cases relative to the total number of RTI injuries reported.

Sensitivity Analysis

Due to uncertainty in incidence estimates, sensitivity analysis was performed by using alternative incidence estimates such as those from PNP and PSA-adjusted for underreporting. The adjustment factors for underreporting were determined using capture-recapture analysis conducted in three cities in the Philippines. Details of this analysis have been published elsewhere.[17]

RESULTS

Epidemiology of RTIs and Deaths

In 2013, PSA reported that RTIs accounted for 8,719 deaths or 21.8% of all registered deaths leading to a death rate of 9.85 per 100,000 population. Majority (81.0%) of the deaths were male. Road traffic death was the top cause of death due to injuries among males and second among females. Mean age of death was 36.2 years (SD: 17.4) for males and 44.0 years (SD: 23.9) for females. In males, most deaths occurred at ages 15 to 34 years; this pattern is absent among females.

The ONEISS 2014 dataset contained records from 44,840 individuals seen in 192 different hospitals with 14,485 (32.0%) cases due to RTIs. Of these cases, 2,445 (16.9%) were admitted. There were 98 road traffic deaths registered in ONEISS leading to a CFR of 0.7%. Similar to PSA data, there is a male predominance among victims especially in the young adult age groups.

Analysis of the NDHS yielded an estimated injury incidence of 86.48 per 1,000 individuals per year. Assuming that 32% of NDHS reported injury cases were RTI based on the ratio from the ONEISS, the resulting incidence was computed as 27.68 per 1,000 population per year. This served as the base case incidence in the model.

Lastly, the NBS-VAC rider survey reported an unrealistically low incidence of 129 RTI among 24,074 individuals; it was not used in the modeling.

Unit Costs of RTIs

Based on chart review of 608 admitted patients, the mean gross bill was PhP 20,665.87 (SD: PhP 33,409.80) and the median was PhP 10,129.25 with a range of PhP 360.00 to PhP 352,202.60. To exclude healthcare provider profit in the estimation, only data from government hospitals were included in the model which resulted in a median cost per admitted RTI case of PhP 9,408.63. For ER cases, only 138 bills were retrieved with the mean expense at PhP 859.62 (SD: PhP1,374.68) and the median expense was PhP 450.00, with a range of PhP 50.00 to PhP8,546.60.

Due to the low number of RTI cases, data for opportunity cost in the rider survey was based on data from all injury respondents, the median days of lost work was 14 days. This was used for admitted cases. An assumption was made that those seen in the ER lost 1 day of work.

ONEISS revealed heterogeneity of injury patterns among RTI victims. The top five most severe injuries in a person among admitted cases were (1) open wounds, (2) minor traumatic brain injury (TBI), (3) moderate-severe TBI, (4) superficial injury of any part of the body, and (5) fracture of patella, tibia or fibula, or ankle. For ER-only cases, the top five were (1) open wounds, (2) superficial injuries, (3) fracture of patella, tibia or fibula, or ankle, (4) fracture of clavicle, scapula, or humerus, and (5) fracture of hand (wrist and other distal part of the hand).

The following YLD per case were computed from the injury patterns: 0.002 short-term YLD and 0.047 long-term YLD. We assumed a loss of 0.000064 YLD per non-consulting case using the disability weight for open wounds.

These base case parameters for economic and DALY computations are presented in Table 1.

Estimated Burden

Applying the 2013 age-sex specific death rates and published underreporting rate of the PSA (72%)[18] to the 2014 population, 12,336 road traffic deaths for year 2014 was estimated. This was equivalent to 454,650.1 YLL after accounting for age-distribution of the deaths. Applying the NDHS 2013 incidence rates to the 2014 population, there were 2,798,088 RTI injury episodes with 186,174 leading to admissions. This translates to 56,223.93 YLD. The total DALY loss due to RTI in 2014 therefore was estimated at 510, 874.

Table 1. Base case parameters for Economic and DALY computations

Parameter	Base case value	Source
Incidence	27.67 per 1,000	NDHS 2013[17], ONEISS 2014[13]
Death rate	8.8 per 100,000	PSA 2013[10]
Underreporting of deaths	72%	Carter et al 2011[18]
Consultation rate	41.22%	NDHS 2013[17]
Admission rate	6.65%	NDHS 2013[17]
Mean age of consulting	29.16	ONEISS 2014[13]
YLD (short) per consulting case	0.002	Computed from ONEISS 2014[13]
YLD (long) per consulting case	0.047	Computed from ONEISS 2014[13]
YLD per non-consulting case	0.000064	Disability weight for Open wound
Cost per ER/OPD only case	PhP 450.00	Chart review
Cost per admitted case	PhP 9,408.63	Chart review
Annual income	PhP 115,705.00	DOLE 2014[19]
Day lost due to ER/OPD only case	1	Community survey
Day lost due to admitted case	14	Community survey
Discount rate	3%	PSA 2013[10]

Table 2. Parameters for HeaLY computations

Parameter	Value	Source
Incidence rate per 1,000 pop (I)	27.67	NDHS 2013[17], ONEISS 2014[13]
Mean age of onset (Ao)	29.16	ONEISS 2014[13]
Mean age at death (Ad)	37.7	PSA 2013[10]
Expectation of life at age of onset of injury (E(Ao))	48.45	WHO 2010[20]
Expectation of life at age of onset of death (E(Ad))	39.43	WHO 2010[20]
Case fatality rate (CFR)	0.68	Estimated deaths from PSA 2013[10] / Estimated injuries from NDHS 2013[17]
Case disability rate (CDR)	3	Community survey
Disability weight of injury (De)	0.022	Weighted mean of disability weights of GBD[16]
Duration of disability (Dt)	1.49	Estimated: duration of temp x proportion with temp + duration of permanent x proportion with permanent as per community survey

The deaths and injuries led to monetary costs: PhP 1,213,406,875 in direct medical costs, PhP 24,620,409,206.32 in opportunity cost due to premature death, and PhP 685,260,912.43 opportunity cost due to absence in work.

Using the formula and the parameters obtained from various sources summarized in Table 2, the estimated HeaLY per 1,000 population lost due to injuries was 753.8 per 1,000 population. This translated to 76,215,477.4 HeaLYs lost for the entire population in 2014.

Accounting for uncertainty in incidence and death rates

EFs obtained from the capture-recapture analysis and using PSA and police data for incidence showed baseline with updated uncertainty ranges. There were an estimated number of RTI deaths of 12,336, ranging from 8,882 to 29,323, with a corresponding YLL of 454,650 (202,719 to 1,080,670). The estimated number of RTI injuries was 2,798,088 (825,673 to 12,246,663), with a corresponding YLD of 56,224 (16,073 to 238,396).

These led to the following monetary costs: PhP 1,213,406,875.79 (PhP 358,057,656.70 to 5,310,835,460.37) for direct medical costs, PhP 24,620,409,206.32 (PhP 10,977,713,563.69 to 58,520,889,512.31) for productivity loss due to premature death, and PhP 685,260,912.43 (PhP 202,209,927.63 to 2,999,247,841.70). There was a combined total economic cost to society of PhP 26,519,076,994.54 (PhP 11,537,981,148.02 to 66,830,972,814.38) (Table 3).

DISCUSSION

This is the first study to estimate the burden of road traffic injuries in the Philippines in both economic and health terms. We found that the RTIs have tremendous economic impact leading to PhP 26.519 B lost in 2014. There is also huge health burden at 510,874 DALYs and 76,215,477.4 HeaLYs lost. The high burden is driven by the disproportionately high occurrence of RTI among young and economically productive males.

Our estimate was lower but generally agrees with the Institute of Health Metrics GBD estimate for the country (581,697.12 DALYs lost in 2014). [19] The difference was probably due to the data sources that the GBD group uses as well as their estimation methods for incidence. Unlike our approach of selecting a source that seems most reliable, they pool estimates using Bayesian modeling.[20]

A strength of this paper is the use of various data sources to triangulate and provide a realistic estimate of the burden. We also introduced ways to address possibility of underreporting of government databases. Finally, we also included a form of sensitivity analysis to address uncertainty although we focused more on incidence as it is the main

Table 3. Estimated socioeconomic burden of violence and injuries in the Philippines

Item	Base	Range	
		Min	Max
Cases			
a. Deaths	12,336	8,882	29,323
b. Injuries	2,798,088	825,673	12,246,663
c. Admitted cases	186,174	54,937	2,368,032
DALY			
d. YLL	454,650	202,719	1,080,670
e. YLD	56,224	16,073	238,396
Economic cost (PhP)			
f. Direct medical	1,213,406,875.79	358,057,656.70	5,310,835,460.37
g. Productivity loss due to premature death	24,620,409,206.32	10,977,713,563.69	58,520,889,512.31
h. Productivity loss due to illness	685,260,912.43	202,209,927.63	2,999,247,841.70
i. Total economic cost	26,519,076,994.54	11,537,981,148.02	66,830,972,814.38

driver of the burden and the one which seems to vary most among data sources.

Our study, however, had some limitations. Our estimates were highly reliant on the quality of data sources used. We mitigated this by assessing the data sources as well as doing sensitivity analyses. The cost data was also more representative of a government perspective and did not include some cost parameters such as emotional stress or rehabilitation costs. Inclusion of these costs would no doubt increase the estimate. One should view our estimate then to be a more conservative one. We also had to do some recoding of the ONEISS to GBD categories that was based on the author's clinical experience and not on official cross-mapping guidelines. Finally, we applied some assumptions that should be tested in future studies such as consultation rates and injury patterns of those not consulting health facilities.

Through this paper, we demonstrated the use of existing data sources for estimating the burden of a disease in the Philippines. This can be replicated for subsequent years as well as for other diseases. The model and calculation used in this study were designed such that it can be repeated every year whenever there are updated data. The secondary data sources release new data every year and can be plugged in the model. The only data that will need more resource intensive data collection would be cost and the degree of underreporting. In the absence of a new comprehensive database on injuries, the DOH can develop and cascade the methods developed in this study to the DOH regional offices and provincial and municipal institutions to monitor RTI-related health outcomes. Monitoring will enable the DOH to annually access success or failure of interventions.

CONCLUSIONS

RTI is an important public health concern in the Philippines that causes tremendous economic and health burden to the population. Investing in prevention efforts will likely translate to major economic and health gains for Philippine society.

Statement of Authorship

All authors have approved the final version submitted.

Author Disclosure

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