PRODUCTIVITY LOSSES FROM ROAD TRAFFIC DEATHS IN CROATIA

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Abstract

The importance of road traffic injuries in Croatia is not generally appreciated due to lack of knowledge of its economic burden. The total years of potential life lost (YPLL), potentially productive years of life lost (PPYLL) and the valued years of potential life lost (VPYLL) from road traffic mortality are calculated in order to estimate the cost of productivity losses from road traffic deaths in Croatia. Road traffic deaths costed Croatia approximately 62,694,077.4 € in 2011 in productivity losses alone. Croatia needs to implement cost-effective interventions to reduce the economic burden of fatal and non-fatal road traffic injuries.

JEL Classification: I11, I13, I15, I18

Keywords: Croatia; road traffic deaths; cost of road traffic deaths; productivity loss

Introduction

Injury is a major, preventable public health problem in terms of morbidity, premature mortality or disability. Worldwide about 5.8 million people die every year as a result of an injury and the projections for 2020 show that 8.4 million deaths are expected annually (Alexandrescu et al.; 2009, 226). Moreover, injuries are an important source of direct medical costs as well as indirect costs resulting from economic production losses; in the Netherlands for example, the direct costs of injury represents 5% of the health care budget whereas in Spain the total costs associated with road traffic crashes alone account for 1.35% of the gross national product (Alexandrescu et al.; 2009, 226).

Within the EU-region, each year injuries result in an estimated 256,000 deaths, 7,200,000 hospital admissions, a further 34,800,000 emergency department attendances and 18,600,000 other medical treatments, totaling 60,600,000 medical treatments (Rogmans; 2012, 19). Injuries are commonly defined as being "caused by acute exposure to physical agents such as mechanical energy, heat, electricity, chemicals, and ionizing radiation interacting with the body in amounts or rates that exceed the threshold of human tolerance. In some cases (e.g. drowning and frostbites) injuries result from sudden lack of essential agents such as oxygen or heat" (Rogmans; 2012, 19).

In the Republic of Croatia, in year 2009 injures were on third place within the mortality cause scale just behind the cardiovascular diseases and malignant neoplasm's. That year in Croatia there were 2,986 deaths caused by injuries, accounting for 5.7% of the total mortality (Brkić Biloš; 2011).

Among all injuries, traffic injuries is one of the most common preventable causes of death and disability worldwide with great burden on communities and health care systems worldwide (Lindqvist & Dalal; 2012, 216). Traffic injuries present a higher than average rate of serious injury than any other type (Lindqvist & Dalal; 2012, 216).

Road traffic injuries continue to be a major public health problem worldwide (Naci & Baker; 2008, 19). Annually, road traffic crashes kill over 1.2 million people and cause over 50 million injuries worldwide (WHO; 2009, 1-2). Of these, over 90% of the deaths occur in low and middle income countries (Nguyen et al., 2013, 79). According to the World Health Organization road traffic injuries are the eighth leading cause of death globally, and the leading cause of death for young people aged

15–29 years. Road traffic injuries are increasing, notably in low- and middle-income countries, where rates are twice those in high-income countries. Current trends suggest that road traffic injuries will become the fifth leading cause of death by 2030, with the disparity between high- and low-income countries further accentuated (WHO; 2013, 1).

In Croatia, traffic injuries are a significant public health problem. They are the leading cause of death in children and young adults, and the leading cause of premature mortality per person. In year 2011, there were 418 deaths due to traffic injuries in Croatia (Volarević; 2012, 3). According to the World Health Organiza-

tion data estimated road traffic death rate per 100,000 population in Croatia is 10.4/100,000 which place Croatia in the middle of the European mortality scale from road traffic accidents (WHO; 2013, 244).

The economic cost of road traffic crashes globally has been estimated at US$ 518 billion. Road traffic crashes cost most countries between 1–2% of their gross national product, although this can reach up to 5% (for example, in the cases of Malawi and Vietnam) (WHO; 2010, 12).

To the authors' knowledge, there have not been any attempts to estimate the economic burden of the road traffic injuries in Croatia. The aim of this study is to estimate the true financial burden of productivity losses due to road traffic deaths in Croatia. The total years of potential life lost (YPLL), potentially productive years of life lost (PPYLL) and the valued years of potential life lost (VPYLL) from road traffic mortality are calculated in order to estimate the cost of productivity losses from road traffic deaths in Croatia.

Methods

In order to estimate the true scope of the financial burden of productivity losses from road traffic deaths in Croatia, the Croatian road traffic fatality data for year 2011 obtained from Ministry of Interior of the Republic of Croatia were analyzed.

This study employed three different methods to estimate the impact of premature mortality and productivity losses caused by road traffic deaths in Croatia. These methods were: 1) YPLL; 2) PPYLL; 3) VPYLL. All three methods were used in an effort to improve the robustness and comparability of the findings. YPLL, PPYLL and VPYLL were calculated for deaths due to road traffic injuries. Age specific death estimates used in all three analyses were provided by the Ministry of Interior of the Republic of Croatia.

1) Years of potential life lost - YPLL

YPLL was used to estimate premature mortality due to road traffic deaths in Croatia. YPLL is a method developed by the United States Centers for Disease Control. It is a function of the age at death and the number of deaths at that age. In order to calculate YPLL, 65 years was used as the cut-off age for premature mortality. The number of deaths at each age group was multiplied by the number of years of potential life remaining for the mid-year of that age group. Then, total years of

potential years of life lost were summed up. With this method, deaths at younger age groups receive a much greater weight in calculating the YPLL than do deaths at older age groups. With YPLL, only those deaths occurring before a fixed age limit are considered premature.

The following formula was used to calculate the YPLL:

$$\sum_{i=0}^{N} di(N - i_a)$$

where i = age group, i_a = mid-age of age group, di = number of deaths at age group and N = upper cut-off age.

Information used in the calculation of YPLL is shown in Table 1.

2) Potentially productive years of life lost - PPYLL

In order to assess the economic impact of road traffic deaths on the Croatian economy, PPYLL were calculated (Zhou et al.; 2003, 125). This method makes it possible to see the productivity losses caused by road traffic deaths, which is useful in calculating the indirect cost of fatal motor vehicle crashes on the Croatian economy. In PPYLL calculations, the age limit was also 65 years. The PPYLL method assumes that productive years are from 18 to 65 years; i.e. 18 years of age is the start of the working age period and 65 years is the end, with a total of 47 working years. The assumption is that children who lost their lives due to road traffic crashes before age 18 would have worked for a total of 47 years if the crash had not occurred. The loss of potentially productive years of life for children is discounted back to the midpoint of their age group. Recognizing the economic principle that years in the future are worth less than years in the present, the PPYLL method applies a 3% discount rate, compounded, for years of life in the future lost to premature death. A compounded annual discount rate of 3% is used, which is the standard level used by the World Bank and World Health Organization (World Bank; 1993, 26). The method calculates future years lost from deaths in each 10 year age group from the midpoint of that period. The PPYLL calculations are exactly the same as the YPLL calculations, except that future years are discounted in the calculation of the PPYLL for each age group and the non-working years below age 18 years are not counted. Details of the calculation were tabulated in Table 1 and Table 2.

3) Valued years of potential life lost - VPYLL

The VPYLL has incorporated a refined concept of economic productivity according to the lifetime development of individuals. In this model, the lifetime of each individual is divided into three segments: investment years, production years, and consuming years. The investment and the consuming years represent the amount of economic resources the individual receives from society, whereas during the production years the individual gives back to society. The VPYLL is the result of a balance among these three components (Lam; 2004, 555).

Lost economic productivity is addressed fully by valued years of potential life lost calculation (Šelb Šemerl & Šešok; 2002, 440). For the purpose of our analysis, we used the following formula:

$$\sum_{i=0}^{\infty} di \left[\sum_{j=i}^{i+Li} I(j) \right]$$

where i = age group, Li = life expectancy at age group, I(j) = value at age j, and di = number of deaths at age group.

The value of I(j) is addressed by investment-producer-consumer model. According to economic productivity, the lifetime of each individual is divided into three segments: investment years (aged 0-19), producer years (aged 20-64), and consumer years (aged > 65). We considered the value of each year to be equal. During investment and consumer years the individual is receiving from society (negative value for society), whereas during the producer years the individual is giving back to society (positive value for society). We calculated the valued years of potential life lost weights for each age group in Croatia 2011 (Table 1), using life expectancies model. The net investment made by society is the amount received by the individual during years 0-19 and over 65, less the amount produced during age 20-64. The total potential loss to society is the net investment at death plus the potential years in which deceased would not have been a producer, less the additional amount of years in which he or she would not have been a consumer, up to life expectancy year. We used this model with a cut-off point at age 65.

Table 1. Information used in the calculation of YPLL, PPYLL and VPYLL.

Demographic data			Lifetime segments (years) according to economic productivity[a]							
			0-17		18-64		65 or >		Net investment	Potential loss
Age (yrs)	Midage (yrs)	Life expectancy[b] (yrs)	Received	Did not receive	Produced	Did not produce	Consumed	Did not consume		
0-6	3.0	74.0	3.0	15.0	0	47.0	0	12.0	3.0	23.0
7-13	10.0	67.0	10.0	8.0	0	47.0	0	12.0	10.0	37.0
14-17	15.5	61.5	15.5	2.5	0	47.0	0	12.0	15.5	48.0
18-24	21.0	56.0	18.0	0	3.0	44.0	0	12.0	15.0	47.0
25-34	29.5	47.5	18.0	0	11.5	35.5	0	12.0	6.5	30.0
35-44	39.5	37.5	18.0	0	21.5	25.5	0	12.0	-3.5	10.0
45-54	49.5	27.5	18.0	0	31.5	15.5	0	12.0	-13.5	-10.0
55-64	59.5	17.5	18.0	0	41.5	5.5	0	12.0	-23.5	-30.0

[a]Lifetime segments: investment years (aged 0-19), producer years (aged 20-64), and consumer years (aged > or =65)
[b] Life expectancies taken at midpoint age from Croatian 2011 life tables.
[c]Net investment = (received) + (consumed) – (produced).
[d]Potential loss = (net investment) + (did not produce) – (did not receive) – (did not consume). *Note*: negative investments and negative losses are gains to society.

Table 2. PPYLL, discounted PPYLL, YPLL and VYPLL by age group.

Age group (yrs)	PPYLL	Discounted PPYLL	YPLL	VYPLL
0-6	47.0	17.0	248.0	620.0
7-13	47.0	17.0	495.0	1,188.0
14-17	47.0	17.0	742.5	1,425.0
18-24	44.0	25.0	3,564.0	3,807.0
25-34	36.0	22.0	2,449.5	0
35-44	26.0	18.0	1,785.0	-2,100.0
45-54	16.0	13.0	1,007.5	-2,600.0
55-64	6.0	5.6	170.5	-930.0

Indirect costs of road traffic injuries

Indirect cost was defined as foregone contributions to Croatian economy and society as a whole. Therefore, indirect costs include not only foregone earnings of

those employed in the formal sector, but also the contributions of individuals who are not formally employed, such as those involved in farming.

The indirect costs of loss of contributions from premature mortality were calculated. The indirect cost of road traffic deaths were estimated by taking the human capital approach since this has been the most widely applied framework in economic evaluation studies. According to this theory, individuals provide the society with services and goods, which are in turn valued by the society. In this study, these goods and services were valued using average annual labor cost levels. The value of years of potentially productive life is then the discounted future contributions.

According to the Central Bureau of Statistics of the Republic of Croatia the average monthly gross earning per person in paid employment in Croatia in 2011 was 1,036.3 €, yielding the average annual gross earning per person in paid employment of 12,435.6 €. The indirect cost associated with road traffic deaths was calculated by multiplying the mentioned annual gross earning per person by discounted PPYLL from premature mortality. The findings were adjusted based on the formal unemployment rate of 13.4% in 2011 (World Bank; 2012) in an attempt to derive a more conservative estimate.

Results

Mortality data

According to the Central Bureau of Statistics of the Republic of Croatia, in year 2011 traffic injuries are the third leading cause of death from injury with a share of 18% behind the falls and suicides with age-specific rate of 11.3/100,000. In Croatia, from traffic injuries dye nearly four times more men than women. The highest mortality rates were observed in age over 65 years (19.8/100,000) and aged 15-24 years (16.0/100,000), and in all age groups were significantly higher in men than in women.

According to the Ministry of Interior of the Republic of Croatia data among 418 persons killed in Croatia in 2011 due to the traffic injuries the majority of them were from age group 18-24 years 81/418 (19.4%). It is also important to emphasize that majority of killed persons were from active, working population aged 18-64 years 316/418 (75.6%) (Table 3).

Table 3. Persons killed due to the traffic injuries in Croatia in 2011 according to the age group.

Age group	Persons killed due to the traffic injuries	
	N	%
0-6 years	4	1.0
7-13 years	9	2.2
14-17 years	15	3.6
18-24 years	81	19.4
25-34 years	69	16.5
35-44 years	70	16.7
45-54 years	65	15.6
55-64 years	31	7.4
65 or more years	74	17.7
Total	418	100.0

Source: Ministry of Interior of the Republic of Croatia

YPLL, PPYLL and VPYLL

Table 4 summarizes the results of YPLL, PPYLL and VPYLL calculation in Croatia for the year 2011.

Table 4. Years of life lost (YLLs) and rates of years of life lost (/100,000 persons) due to road traffic deaths in Croatia in 2011 expressed through different quantitative measures (YPLL, PPYLL and VPYLL).

Road traffic deaths	YLLs			Rate/100,000		
	YPLL	PPYLL	VPYLL	YPLL	PPYLL	VPYLL
	10,462.0	6,297.6	1,410.0	296.7	178.6	40.0

Productivity losses from road traffic deaths

Road traffic deaths costed Croatia approximately 62,694,077.4 € in 2011 in productivity losses alone.

Discussion

The results of this study have confirmed that traffic injuries are significant cause of mortality in Croatia with very important implications regarding productivity losses. The results of this study are similar to the results of similar study conducted in Slovenia (Šelb Šemerl & Šešok; 2002, 442) and lower in comparison to study conducted in China (Zhou et al.; 2003, 125) and study conducted in Turkey (Naci & Baker; 2008, 22).

The three quantitative measures used in this study are rooted in the same fundamental concept but represent slightly different outcome assessments. While the YPLL has been recognized as the standardized assessment of the impact and burden of premature death on the community, it only represents the magnitude of loss of life in terms of years of healthy living. Embedded in this measure is the assumption that every healthy living year has an equal value disregarding the characteristic of the individual, including age and sex, at his/her time of death. The PPYLL takes in the consideration the economic value of the healthy living years of an individual. The emphasis is the probable years of economic production if the person had survived the premature death. Utilizing the economic model of investment-production-consumption years of an individual's life span, the VPYLL is a refined measure that provides a more realistic estimation of the economic value of the healthy living years of an individual (Lam; 2004, 557-558).

The economic implications regarding road traffic deaths in Croatia have not been studied thus this study gives first insight in this subject. In terms of public health policy and economic strategies for future national productivity development, the benefits of investing in injury prevention are certain.

Some limitations have been identified in this study. One is that it contains only mortality information and thus it only reflects the burden of death due to injury. Without any assessments on morbidities, direct and indirect costs on disability, the economic impact of injury cannot be fully estimated. The calculation of productivity lost is based on the assumption that there is not differential value of productivity among different subgroups in the population according to certain characteristics such as gender and economic classes. There is also an implicit assumption that an individual would provide full productivity and enjoy the benefit of healthy life if the premature death is prevented without further risk of premature death later in his/her life. This assumption may not be true in reality, and the current model has no consideration of this scenario. These issues should further be explored in future studies.

Conclusion

This study has shown that traffic injuries are significant cause of mortality in Croatia with very important economic implications in terms of productivity losses. These findings are even more important bearing in mind that those road traffic deaths can be successfully prevented through cost-effective public health interventions.

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