

## Years of Potential Life Lost and Cost of Lost Productivity Caused by Road Traffic Crashes: Evidence During the Five Years in Iran (2006-2010)

<sup>1</sup>Behzad Karami Matin, <sup>1</sup>Satar Rezaei, <sup>2</sup>Zahra Nabe, <sup>3</sup>Faramarz Shaahmadi,  
<sup>1</sup>Seyed Younes Hosseini, <sup>1</sup>Mehdi Moradinazar and <sup>4</sup>Touraj Ahmadijouybari

<sup>1</sup>Research Center for Environmental Determinants of Health,  
Kermanshah University of Medical Sciences, Kermanshah, Iran

<sup>2</sup>Department of Health Education, Faculty of Medical Sciences,  
Tarbiat Modares University, Tehran, Iran

<sup>3</sup>Savojbolagh Health Center, Alborz University of Medical Sciences, Karaj, Iran

<sup>4</sup>Imam Khomeini Hospital, Kermanshah University of Medical Sciences, Kermanshah, Iran

---

**Abstract:** Road Traffic Crashes (RTCs) third cause of life year's loss and deaths in Iran. Therefore, this study was aimed to estimate the economic burden of the deaths-related RTCs and its trend in a 5-years period in Iran. Data on mortality due to RTC by sex and age-groups from 2006-2010 were obtained from the Ministry of Health and Medical Education (MoHME). Three measures, namely years of Potential Life Lost (YPLL), Working Years of Potential Life Lost (WYPLL) and the Cost of Lost Productivity (CLP) due to premature mortality were used to estimate the burden of RTC in Iran. The life expectancy method and the human capital approach were used to estimate the YPLL and the value of productivity lost due to cancer-related premature mortality. During the 2006-2010 in Iran there were 59, 231 deaths and 69,523,346 YPLL due to RTC which 80 and 81% of them were related to males, respectively. The highest and lowest YPLL and number of deaths among age groups were related to 20-34 years (38 and 34% of total) and the >65 years (15 and 9.5% of total), respectively. The WYPLL decreased from 243.952-161.067 among males and 44.300-29,720 among females. The total WYPLL was 1,709,096 which 89.6% of them were in the males. As regard burden of the road traffic crashes in Iran is high by investment a small percentage of the accidents economic costs on the education and culture making of the drivers and pedestrians in addition to increasing the effectiveness, we can be able to prevent the imposing of impalpable costs.

**Key words:** Years of potential life lost, burden of the traffic accidents, cost of lost productivity, death, Iran

---

### INTRODUCTION

Each year >50 million peoples injured and 2.1 million killed due to Road Traffic Crashes (RTCs) in the worldwide which 90% of them occur in Low-Middle Income Countries (LMICs) (Hamzeh *et al.*, 2016). It is predicted that if this trend continued, the mortality rate from RTCs increase to 65% from 2000-2020 and nearly 80% of this will occur in developing countries (Hasanzadeh *et al.*, 2014). This led to that the traffic accidents become the third leading cause of life year's loss in these countries (Hasanzadeh *et al.*, 2014; Mahdian *et al.*, 2015). The mortality conditions resulting from the traffic accidents in Iran is worse than the rest of the world countries because in spite of possession less than one hundredth the world populations, more than one fortieth of the world RTCs happen in Iran (Rad *et al.*,

2016). According to the World Health Organization (WHO) reports, published in 2000, the mortality rate of the RTCs in Iran was 30 in 100 thousand peoples while this were 22.6 and 13.9 in 100 thousand peoples in the world and Eastern Mediterranean Region Countries (EMRO), respectively (Soori *et al.*, 2009). In addition, with increasing the mortality from traffic accidents among the 190 countries in 2002, only 4 countries have reported the mortality rates more than Iran (Maracy and Isfahani, 2013).

Epidemiological evidences and national studies indicated that >800 thousand RTCs occurred in Iran annually which every case of death due to these accidents is along with 15 hospitalizations and 70 injuries with outpatient treatments. This caused that Iran have the deadliest traffic disasters in the world (Bidgoli *et al.*, 2013; Soori *et al.*, 2009; Bahadorimonfared *et al.*, 2013). RTCs

are the second cause of death in Iran, followed by cardiovascular diseases. In addition, they have a significant impact on economic of Iran. Rezaei *et al.* (2014) found that the economic burden of RTCs in Iran was 7.2 billion US dollars in 2009 which amounts to 2.19% of Iran's Gross Domestic Production (GDP). In general, losses caused by traffic accidents in Iran are not only enormous and shocking but also every year is growing and therefore, need to deep consider from managers and authorities (Hasanzadeh *et al.*, 2014). As well as, doing epidemiologic researches has been the first step in designing effective interventions (Alavijeh *et al.*, 2015; Hosseini *et al.*, 2016; Jalilian *et al.*, 2016). Furthermore, the first necessity step in health and the prerequisite for the health promotion and life expectancy in Iran is control and reduce the incidence of traffic incidents. To prevent and control of the losses caused by these accidents, we need the proper and precise basic information more than anything else. Therefore, this study was aimed to estimate the economic burden of the deaths related RTCs and its trend in a 5 year period (2006-2010) in Iran.

#### MATERIALS AND METHODS

Data on mortality due to RTC by sex and age-groups for 29 provinces (the data about Tehran province was not available) were obtained from the Ministry of Health and Medical Education (MoHME). The database contains number of deaths by sex and 5 year age-groups (including under one, 1-4, 5-9, 10-14, 15-19, 20-24, 24-29, 30-34, 35-39, 40-44, 45-49, 50-59, 60-64, 65-69, 70-74, 75-79, 80-84 and 85+). In the current, study the age groups were divided into five groups including <20, 20-34, 35-49, 50-64, 65+. Number of deaths during 2006-2010 in all age group used to YPLL. To estimate Cost of Lost Productivity (CLP), number of deaths between the ages of 20 and 64 years were extracted from the database.

To estimate the average life expectancy for each age group, Iran life table from the World Health Organization was used. Data on age-and sex-specific wages came from the Iranian Ministry of Cooperation Labor and Social Welfare. Also, the data on age and sex specific employment and housekeeping rate for the study periods were obtained from the Iranian Statistical Center (ISC). Based on previous studies, the Human Capital Approach was used to estimate the cost of lost productivity due to RTC-related premature mortality in Iran from 2006-2010. Three measures, namely Years of Potential Life Lost (YPLL), Working Years of Potential Life Lost (WYPLL) and the cost of lost productivity (CLP) due to premature mortality were used to estimate the burden of RTC in Iran.

These measures focus on the social and economic impact of premature mortality. The YPLL, WYPLL and CLP attributable to RTC of deaths in both male and female were estimated. Life expectancy method and working age (from 20-64 years) were used to estimate the YPLL and CLP, respectively.

**Years of Potential Life Lost (YPLL):** It estimates the average years a person would have lived if he or she not died prematurely (Gardner and Sanborn, 1990). To estimate YPLL for premature mortality due to RTC, we assumed that all of deaths in each age group occurred in the mid-point of that age group. To calculate YPLL, the number of deaths in each age-group was multiplied by the average of remaining life expectancy for that age-group the following formula was used to calculate the YPLL (Dubey and Mohanty, 2014):

$$YPLL = \sum_{i=0}^{\infty} d_i \times L_i$$

Where:

$i$  = Life expectancy at age  $i$

$d_i$  = The number of deaths at age  $i$

The death are weighted by life expectancy at each age.

**Working Years of Potential Life Lost (WYPLL):** It estimates the loss of years of productive life lost due to death before a cut-off age. The upper age limit varies by countries and researchers (Gardner and Sanborn, 1990). We have used the upper age limit of 65 years (retirement age in Iran). The WYPLL is calculated as follows (Dubey and Mohanty, 2003):

$$WYPLL = \sum_{i=0}^{w-1} d_i \times (U - W) + \sum_{i=w}^N d_i \times (U - i)$$

Where:

$d_i$  = The number of deaths at age  $i$

$U$  = The upper cut-off of age (65 years)

$W$  = The lower cut-off age (15 years)

**Cost of Lost Productivity (CLP):** The calculated WYPLL was multiplied by age and sex-specific annual wages from age of deaths until the retirement age. The estimated cost of lost productivity was adjusted based on the employment and housekeeping rate. Moreover, for obtaining the present value the future, the estimated costs

were discounted at 3% per year. Cost of lost productivity for each death was summed across age groups by sex and cause of death.

**Statistical analysis:** Data were analyzed with Excel and statistical software STATA (Version 14.0; Stata Corp., College Station, TX, USA). In addition to the data description, Poisson regression to determine change in trends in Working Years of Potential Life Lost (WYPLL) and trends in Years of Potential Life Lost (YPLL) due to RTC. Level of significance for all the tests was  $p < 0.05$ .

## RESULTS AND DISCUSSION

During the five years total number of deaths and YPLL over the 5 years period (2006-2010) by age groups and sex. From 2006-2010, there were 59,231 deaths and 69,523,346 YPLL due to RTC in Iran which 80 and 81% of them were related to males, respectively. Based on our results, the overall number of deaths decreased from 15,038 in 2006-9,966 in 2010 while the YPLL decreased from 17,843,027 in 2006-11,839,721 in 2010. During the 5 years studied, the highest and lowest YPLL and number of deaths among age groups were related to 20-34 years (38 and 34% of total) and the >65 years (15 and 9.5% of total), respectively (Table 1).

Figure 1 presents the trends in Working Years of Potential Life Lost (WYPLL) by age groups and sex for the 5 years studied. From 2006-2010, the WYPLL decreased from 243,952-161,067 among males and 44,300-29,720 among females. The total WYPLL was 1,709,096 which 89.6% of them were in the males.

Table 2 shows the trends of Cost of lost productivity (CLP) due to RTC in Iran for the 5 years. From 2006-2010, the CLP declined from 987,569,964-531,243,597 \$US among males and 56,414,589 \$US to 4,905,599 \$US among females. The total CLP caused by RTC was 4,408,908,355 \$US which 94.8% of them were in the males. In all years studied, the highest CLP was in the 35-49 age groups for males and females which this age group accounts for 43.2 and 42.2% of the total CLP for males and females, respectively.

By controlling and reducing the mortality from infectious diseases, mortality index cannot properly reflect the health condition alone, therefore, Summary Measures of Population Health (SMPH) by combining the mortality and non-fatal diseases consequences or injuries data can state the health conditions of a population as a number. Burden due to the health problems can be measured by different ways such as physical disabilities, diseases and deaths, emotional problems, falling away from the communities and financial or economic losses. Also, the

burden of diseases can be estimated by a category of health criteria such as the number of deaths and years of life that lost due to the disease or in terms of monetary values such as cost of the health problems. In the developing countries the traffic accidents known as major health problem, economic costs resulting from road accidents allocated 2 and 15% of Gross National Product (GNP) in High Income Countries (HICs) and LMICs, respectively. In Iran during the year 2009 these costs reached to 2.5% of GNP (Rezaei *et al.*, 2014).

Findings of the study showed that, trend of mortality rate Road Traffic Crashes (RTCs) among men and women are slightly decreasing. trend of Road Traffic Crashes (RTCs) in most all high-income countries have decreasing death rates while the majority of low-income countries having increasing death rates due to traffic collisions. Middle-income countries have the highest rate with 20 deaths per 100,000. In habitants, 80% of all road fatalities by only 52% of all vehicles. While the highest mortality rate in middle east and Africa with 45 and 24.1 per 100,000, respectively and the lowest rate with 10.3 per 100,000 in Europe countries (Hasanzadeh *et al.*, 2014).

The results of present study showed that the Working Years of Potential Life Lost (WYPLL) due to the RTCs in all age groups of men were more than and totally 4 times the women. In similar studies in other parts of the world, an economic burden of the RTCs in men was reported to be 3-5 times the women (Dubey and Mohanty, 2014; Polinder *et al.*, 2007; Lapostolle *et al.*, 2009; Ditsuwan *et al.*, 2011). According to the cultural situations in Iranian community, men are often the main source of income and lack of the min addition to facing the family with financial and economic indivisible crises has the social adverse effects which cannot be express in terms of cost and numbers. It is recommended that appropriate interventions programs must be applied to prevent the incidence of the RTCs, to minimize the injuries and their complications. The evaluation the final results of these programs can be useful at different levels, particularly in men.

Most of the lost potential years (37.8%) allocated to the age group of 20-34 year sold, the contribution of this ratio for men and women were 40.1 and 28.5%, respectively. This age group is <30% of the studied population and as productive forces in human society plays an important role in the national economy, national per capita income and GNP. On the other way, studies shows that >63% of deaths from Iranian traffic accidents are caused by trauma to the head and neck of the passengers (Hamzeh *et al.*, 2016). According to these statements, training and strict rules for the use of seat belts and proper adjustment of the head restraints can

Table 1: Trends in number of deaths and Years of Potential Life Lost (YPLL) due to RTC by age groups and sex in Iran (2006-2010)

Age groups	Criteria	2006	2007	2008	2009	2010
<b>Male</b>						
<20	No. of death	2,088	1,642	1,432	1,472	1,241
	YPLL	1,636,030	1,264,670	1,117,231	1,107,612	916,391
20-34	No. of death	4,464	3,488	3,224	3,204	2,914
	YPLL	5,826,382	4,549,544	4,204,503	4,196,307	3,836,093
35-49	No. of death	2,416	1,901	1,682	1,809	1,628
	YPLL	3,719,976	2,939,906	2,604,806	2,806,700	2,516,240
50-64	No. of death	1,495	1,195	1,109	1,200	1,122
	YPLL	1,996,972	1,602,839	1,484,434	1,601,966	1,502,498
>65	No. of death	1,601	1,355	1,208	1,208	1,085
	YPLL	1,215,671	1,015,919	887,074	918,013	795,447
<b>Female</b>						
<20	No. of death	675	526	484	489	406
	YPLL	420,949	302,311	267,344	267,350	211,092
20-34	No. of death	707	588	515	542	468
	YPLL	988,373	824,798	717,979	761,856	656,386
35-49	No. of death	551	429	411	415	377
	YPLL	904,357	183,190	665,007	680,529	610,720
50-64	No. of death	502	420	383	474	355
	YPLL	699,730	583,127	535,589	661,804	497,743
>65	No. of death	539	477	447	443	370
	YPLL	434,587	385,968	351,124	351,098	297,111

Table 2: Trends in Cost of lost Productivity (CLP) due to RTC by age groups and sex in Iran, 2006-2010 (\$US)

Age groups	2006	2007	2008	2009	2010
<b>Male</b>					
20-34	249,152,198	209,578,612	232,312,875	232,207,072	16,359,420
35-49	412,218,863	342,442,036	376,386,795	387,524,618	284,722,209
50-64	326,198,903	272,194,478	298,625,314	312,608,012	230,161,968
<b>Female</b>					
20-34	15,167,348	13,530,711	14,251,123	15,352,517	703,867
35-49	24,827,003	21,616,749	22,374,850	24,872,281	1,740,383
50-64	16,420,238	16,251,079	17,186,158	19,459,326	2,461,349

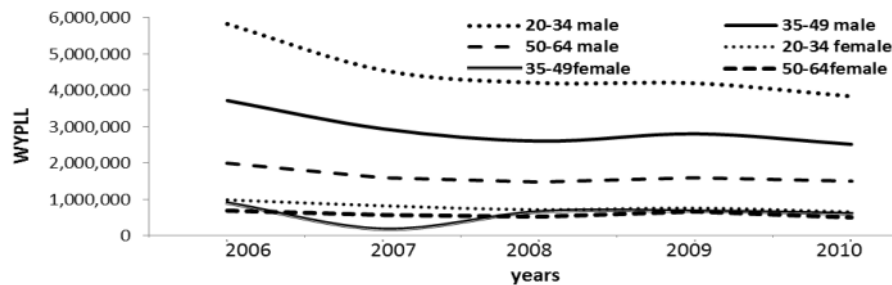


Fig. 1: Trends in Working Years of Potential Life Lost (WYPLL) by age groups and sex in Iran (2006-2010)

The findings showed that nearly 80% of traffic accidents occur in men, 94% of the economic costs of the road accidents are dedicated to men. In general, 10 and 5% of deaths were occurred in men and women, respectively due to the traffic accidents. These accidents due to the relation with nearly 8% of the population deaths was the second cause of death in Iran (Polinder *et al.*, 2007). While, traffic accidents are the fourth cause of deaths in USA and the fifth cause of deaths in Canada with 5.02 and 4.6% of the total deaths, respectively. According to the WHO in 2012, traffic accidents were account for 2.2% of the total deaths. The results of the other studies

conducted in different countries showed that the burdens of the injuries from road accidents were varied. Among these countries, Australia had the most number of lost years due to the premature death with 25 per thousand disabilities and United Kingdom and New Zealand had the lowest rate of lost years with 12 per thousand. The traffic accidents were the third leading cause of the lost years among Iranian men (Naghvi, 2003). Though these accidents were the eighth major factor of the potential lost years in developed countries and with 12% of total diseases burden were the tenth cause of the potential lost years in the world wide (Murray *et al.*, 2013).

## CONCLUSION

Given the high burden of the traffic accidents in Iran, by investment a small percentage of the accidents economic costs on the education and culture making of the drivers and pedestrians in addition to increasing the effectiveness, we can be able to prevent the imposing of impalpable costs (Stress and psychological pressures resulting from the death of a family member, etc.) on society body. Also, if the preference of the prevention to treatment can be taking into consideration and cross-sectorial coordination to reduce the road accidents be established, in addition to reducing mortality, referencing of injured peoples requiring medical intensive care to hospitals is decreased and this can diminish the treatment and rehabilitation costs and thus less expensive primary prevention measures.

## ACKNOWLEDGEMENTS

The researchers gratefully acknowledge the Research Center for Environmental Determinants of Health (RCEDH), Kermanshah University of Medical Sciences, for the financial support.

## REFERENCES

- Alavijeh, M.M., M. Mahboubi, F. Jalilian, A. Aghaei and A.T. Jouibari, 2015. Factors related to self-breast examination based on health belief model among Iranian women. *Res. J. Med. Sci.*, 9: 105-108.
- Bahadorimonfared, A., H. Soori, Y. Mehrabi, A. Delpisheh and A. Esmaili *et al.*, 2013. Trends of fatal road traffic injuries in Iran (2004-2011). *PloS one*, Vol. 8.
- Bidgoli, H.H., S. Saadat, L. Bogg, M.H. Yarmohammadian and M. Hasselberg, 2013. Factors affecting hospital length of stay and hospital charges associated with road traffic-related injuries in Iran. *BMC. Health Serv. Res.*, 13: 1-1.
- Ditsuwan, V., L.J. Veerman, J.J. Barendregt, M. Bertram and T. Vos, 2011. The national burden of road traffic injuries in Thailand. *Popul. Health Metrics*, 9: 1-1.
- Dubey, M. and S.K. Mohanty, 2014. Age and sex patterns of premature mortality in India. *BMJ. Open*, Vol. 4.
- Gardner, J.W. and J.S. Sanborn, 1990. Years of potential life lost (YPLL)-what does it measure?. *Epidemiol.*, 1: 322-329.
- Hamzeh, B., F. Najafi, B. Karamimatin, T. Ahmadijouybari and A. Salari *et al.*, 2016. Epidemiology of traffic crash mortality in west of Iran in a 9 year period. *Chin. J. Traumatology*, 19: 70-74.
- Hasanzadeh, J., M. Moradinazar, F. Najafi and T.A. Jouybary, 2014. Trends of mortality of road traffic accidents in Fars Province, Southern Iran, 2004-2010. *Iran. J. Public Health*, 43: 1259-1265.
- Hosseini, S.N., M.M. Alavijeh, B.K. Matin, B. Hamzeh and H. Ashtarian *et al.*, 2016. Locus of control or self-esteem which one is the best predictor of academic achievement in Iranian college students. *Iran. J. Psychiatry Behav. Sci.*, Vol. 10.
- Jalilian, F., H. Joulaei, M.M. Alavijeh, B. P. Samannezhad *et al.*, 2016. Cognitive factors related to cigarettes smoking among college students: An application of theory of planned behavior. *Social Sci.*, 11: 1189-1193.
- Lapostolle, A., B. Gadegbeku, A. Ndiaye, E. Amoros and M. Chiron *et al.*, 2009. The burden of road traffic accidents in a French Departement: The description of the injuries and recent changes. *BMC. Public Health*, 9: 1-1.
- Mahdian, M., M.R. Fazel, M. Sehat, M. Mohammadzadeh and H. Akbari, 2015. Years of life lost and mortality rate due to road traffic injuries in Kashan Region, Iran, during 2012-2013. *Biosci. Biotech. Res. Asia*, 12: 741-746.
- Maracy, M.R. and M.T. Isfahani, 2013. The burden of road traffic injuries in Isfahan, Iran in 2010. *J. Kerman Univ. Med. Sci.*, 20: 505-519.
- Murray, C.J.L., T. Vos, R. Lozano, M. Naghavi and A.D. Flaxman *et al.*, 2013. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990-2010: A systematic analysis for the Global burden of disease study 2010. *Lancet*, 380: 2197-2223.
- Naghvi, M., 2003. *Prospective of Mortality in 18 Provinces of Iran*. Publishing Tandice, Tehran, Iran.
- Polinder, S., W.J. Meerdling, S. Mulder, E. Petridou and E.V. Beeck, 2007. Assessing the burden of injury in six European countries. *Bull. World Health Organiz.*, 85: 27-34.
- Rad, M., A.L. Martiniuk, A.A. Moghaddam, M. Mohammadi and F. Rashedi *et al.*, 2016. The pattern of road traffic crashes in South East Iran. *Global J. Health Sci.*, 8: 149-149.
- Rezaei, S., M. Arab, B.K. Matin and A.A. Sari, 2014. Extent, consequences and economic burden of road traffic crashes in Iran. *J. Inj. Violence Res.*, 6: 57-63.
- Soori, H., A. Nasermoadehi, M. Movahedi, M.R. Mehmandar and H.R.H. Abady *et al.*, 2009. The effect of mandatory seat belt use legislations on mortalities from road traffic injuries in Iran. *Hakim Res. J.*, 12: 48-54.