

Decomposition of potential gains in life expectancy by elimination of unintentional accidents in Iran

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ABSTRACT

Background and aims: Recent studies on mortality in Iran, in recent years clearly emphasize that unintentional injuries are the main cause of reducing Iranian life expectancy in Iran. This article aimed to assess the role of major causes of death for mortality patterns in the country by sex in 2010.

Methods: Experimental results of this study are based on death registration system of Ministry of Health (MOH). Using multiple decrement and single decrement life tables, years of life which could be saved are calculated if unintentional accidents were to be eliminated from causes of death. Then the composition of age groups is decomposed.

Results: The results showed that unintentional injuries are cause of reduction of 2.3 years of Iranian men's life and 0.8 years for women. More detailed results show that mortality from unintentional accidents in active age groups (15-64 years old), have a great role in reducing the life expectancy of the people. The men's share is more than 70%, but for women the share of age groups of 15-65 years old is less than men, in return, it is more for women under 15 years old is more.

Conclusion: Since high rate of deaths due to unintentional accidents are preventable, control and intervention, especially among young people, and society development needs to improve the health of the main age groups, mean young, so investments to increase productivity and improve the health of young people is necessary.

Keywords: Life expectancy at birth, Unintentional accidents, Multiple decrement life tables, Decomposition.

Original article

INTRODUCTION

Life expectancy at birth is one of the three indicators, which along with the literacy rate and national gross production, are used to calculate the human development synthetic index by the United Nations Development Program. Human development index is one of the indicators to monitor and evaluate the achievement of the millennium development

goals that world leaders, have committed their countries to achieve them by 2015.^{1,2} In this regard, the calculation of life expectancy index, which represents the health status of the community, seems essential. This index is used as a summary indicator of the status of population mortality and is an indicator of health status which is often used by

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politicians to set up national strategies in the field of public health.^{3,4}

One of the important factors affecting the life expectancy is deaths of children, particularly of children under one year old. So that, the reduction of child mortality in the age groups of 0-4 years, was in fact the main cause of improvement of life expectancy during the death transition process (1956-1986).^{5,6} Achieving high life expectancy up to a specific level is associated with the advancement of technology and the improvement of medical services, but it increasingly requires a degree of socioeconomic development. In Iran, the increase process of life expectancy has slowed down from 1991 onwards and earning more years of life expectancy will be achieved primarily with the comprehensive development in the country. However, the observed improvement in the life expectancy is not attributable to all causes and all ages. Especially with the increase in deaths from unintentional incidents among young and middle-aged people, this important point, due to its impact on socio-economic development of the society, has been the focus of many researchers.⁷

One of the most important health challenges in all countries of the world today, is the events that caused 5 million people annually and 16,000 people daily lose their lives because of it. According to the World Health Organization estimates, 3.9 million deaths in 2004 occurred as a result of unintentional injuries. Also, one-third of the deaths that occur between the ages of 15-29 years is due to unintentional accidents (including traffic accidents, drowning, burns, poisoning and falls).⁸ Traffic accidents have large shares in unintentional injuries worldwide. It is estimated that 2 million people worldwide die as a result of traffic accidents each year

and 50 million get injured.⁹ It is forecasted that in case of continuance of this situation (in case of non-intervention) by 2020 traffic accidents will be the third leading cause of loss of years of life.⁹ Unintended events in Iran after cardiovascular diseases, with a share of about 18%, is the most important (the second) cause of death in men and is about 8% is the third leading cause of death in women.⁶ Although according to the numbers, deaths due to unintentional accidents is in the second place after cardiovascular diseases, its importance is because of the position of this reason in having the first place in the loss of the early years of life in the country. In 2002, in the age group of 15 to 29 years, 59% of the lost and gone years with disabilities ((DALYs) in men and 27% DALYs in women have been due to intentional and unintentional events. In this year, 36% of DALYs in men and 14% of DALYs in women in all ages was due to unintentional injuries.¹⁰

Given that deaths from unintentional injuries mostly affects the lower in middle ages. It is expected that they have a significant impact on life expectancy at birth and thus on the economy and society. This paper aims to study the impact of unintentional injuries on life expectancy in the country in 2010 in all the areas of life and with an emphasis on the time of work ages. Awareness of the degree and consequences of demographic of deaths from unintentional injuries and their impact on life expectancy at birth, can provide useful information to plan for future resource allocation for research activities and public health programs and will assist planners and researchers to gain more and better understanding about the causes and patterns of mortality, that in turn, will help to design new priorities in health programs and in general the socioeconomic development programs.

METHODS

The method used in this study is secondary analysis. The required data is the statistics of death causes based on age groups and gender in time period of the year 2010 which are obtained from the record system of Ministry of Health, Treatment and Medical Education. Regarding the used data, it should be noted that the used data have been obtained from a collection that does not include the statistics of death in the province of Tehran and Alborz and Isfahan, because the program of collecting and recording the deaths in Tehran city are not carried out by the Ministry of Health, Treatment and Medical Education and the information for Isfahan province in 2010 was not available, so this study examined the data from 28 provinces and was assumed that the distribution of the population and the death of 28 selected provinces do not have any difference with those of the whole country. Also, the population data by age groups and sex to calculate the mortality rates of the year 2010 from the predicted population was obtained by the statistic center.

To correct the most important problem of bad record of deaths in the country means null and vain codes, an algorithm was used. The conceptual framework of which is based on the assumption that deaths attributable to the absurd codes in all age groups and sex, follows the distribution of causes of death of its same age, sex and regional group. Therefore absurd codes based on the mentioned algorithm were redistributed in the country's deaths.

By assessing the impact of unintentional events on the deaths in the country, under the assumption that unintentional incidents are to be omitted from the deaths numbers of the country, the number of years that can be added to life expectancy were calculated. The impact of unintentional events was assessed using the techniques of multiple-reduction

life table and single-reduction life table. These methods emphasize the assessment of net impact of competing risks of death different causes, means unintentional accidents against other factors, with the assumption that different causes act independently from each other.^{11,12}

The basic assumption of this principle is based on the point that different causes of death are in the manner of double-sided barrier (meaning two events do not happen at the same time) and their total is comprehensive (meaning sum of events include all possible events).^{13,14} Because in the real world, the single-reduction processes are not directly observable (a process in which there is one cause of death), certain functions of ordinary life table is generalized to the corresponding single-reduction life table. In general, the rate of decline of cause i , if i is the only cause of the decline, is different from the case where i acts in the presence of other causes. Here the aim is to make a corresponding single-reduction life table which indicates that only unintentional accidents reduce the population of the country. The considered reduction here is all the reductions except the reduction due to the cause of unintentional events (i). Therefore, we want to make a life table based on $\mu^{-1}(x)$ in which the cause i is omitted voluntarily from the multiple-reduction collections.

In the analysis of multiple-reduction life table, the calculation of life table column ${}_nq_x$, ${}_nq_n$, ${}_nd_x$, ${}_nL_n$ and etc. is simple based on the life table approach. The possibility of death due to unintentional injuries ${}_nq_x^i$, is calculated based on the proportion of death due to unintentional incidents to the possibility of the total death between age x and $x + n$:

$${}_nq_x^i = {}_nq_x \frac{{}_nD_x^i}{{}_nD_x}$$

In making the related single-reduction life table, it is necessary to remove every

cause and the proportion of death due to all causes except the considered cause in all age groups (for example unintentional injuries) which is shown by R^{-1} , is calculated using the following formula:

$$R^{-i} = \frac{{}_nD_x - {}_nD_x^i}{{}_nD_x}$$

The likelihood of survival from age x to $x + n$ by eliminating unintentional injuries was calculated using Chiang formula:

$${}_n p_x^{-i} = [{}_n p_x]^{R^{-i}}$$

To determine the age groups that have a larger share of the general difference in life expectancy at birth, as a result of eliminating the specific causes (unintentional injuries), the life expectancy changes in specific groups were analyzed using the method proposed by Aryaga:¹⁵

$${}_n \Delta_x = \frac{l_x^{all}}{l_0^{all}} \cdot \left(\frac{{}_n l_x^{-i}}{l_x^{-i}} - \frac{{}_n l_x^{all}}{l_x^{all}} \right) + \frac{T_{x+n}^{-i}}{l_0^{all}} \cdot \left(\frac{l_x^{all}}{l_x^{-i}} - \frac{l_{x+n}^{all}}{l_{x+n}^{-i}} \right)$$

The first part of the equation is the direct assessment of changes in the rate of deaths between ages x and $x + n$, while the second part of the equation is related to the collection of indirect and interactive effects of the share of number of added years due to the added survivors in the age $x + n$ which

are in the conditions of new deaths. This equation for the last age group is as follows:

$${}_{\infty} \Delta_x = \frac{l_x^{all}}{l_0^{all}} \cdot \left(\frac{T_x^{-i}}{l_x^{-i}} - \frac{T_x^{all}}{l_x^{all}} \right)$$

Figure 1 shows a percentage distribution of main causes of death in terms of gender. As can be seen, three main groups of causes of death, including cardiovascular disease, unintentional injuries and cancers constitute more than two-thirds (70%) of total deaths causes of two genders in the country. The results indicate the fact that in 2010 more than 40% of the deaths means the largest share of the total deaths occurred in the country for both sexes are related to cardiovascular diseases. Gender differences in the proportion of deaths caused by cardiovascular diseases from the total deaths in the used data in this research; clearly show the women deaths are due to this cause. At the same time, cancers are the second leading cause of death in the country after cardiovascular diseases. However, the pattern of mortality in men and women in this cause do not show a significant difference. The third main cause of death in the country is related to unintentional accidents. Unintentional accidents are responsible for a greater proportion of deaths among men (means 16%), and in particular are the second cause of death among men, while only 7% of women's deaths in 2010 was due to unintentional accidents.

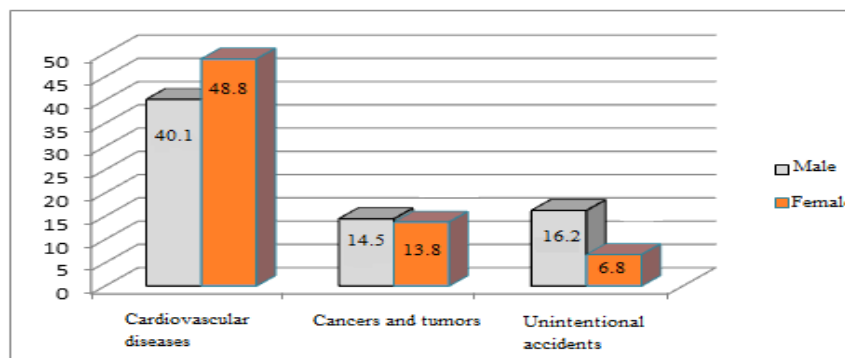


Figure 1: Percentage distribution of causes of death by sex in the country in 2010

According to the average figures of age of death (Table 1), age distribution of deaths from unintentional accidents show a completely different combination with age distribution of dead people in general. The age distribution of deaths caused by unintentional accident differs more than 20 years with the total and has a younger structure compared to age distribution of two other main causes. As the average age of death from unintentional incidents is less

than 40 years, while the average age of death is 60 years in general. Age distribution of deaths from cardiovascular diseases as the main cause of death in the country, is more oriented toward the old age. The average age of death from such diseases is about 70 years, the age distribution of deaths from cancers are also tended to the old ages, although it shows a younger age distribution compared to cardiovascular diseases.

Table 1: Average age of death of all main causes of death by sex in 2010

Causes	Female	Male	Male and female
Cardiovascular diseases	73.9	71.1	72.4
Cancers and tumors	61.8	65.2	63.9
Unintentional injuries	39.5	37.9	38.2
Total	63.7	58.4	60.5

Table 2: Results of related multiple-reduction and single-reduction life tables by eliminating unintentional incidents from deaths based on sex in 2010

Age	nq_x		e_x		R^{-i}		nq_x^{-i}		e_x^{-i}		Differential	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
0	0.0098	0.0131	78.2	73.9	0.965	0.973	0.009	0.013	79.0	76.2	0.84	2.31
1-4	0.0027	0.0034	78.0	73.9	0.636	0.585	0.002	0.002	78.8	76.2	0.82	2.31
5-9	0.0017	0.0023	74.2	70.1	0.532	0.472	0.001	0.001	74.9	72.3	0.74	2.22
10-14	0.0014	0.0022	69.3	65.3	0.679	0.464	0.001	0.001	70.0	67.4	0.69	2.14
15-19	0.0020	0.0054	64.4	60.4	0.673	0.399	0.001	0.002	65.0	62.5	0.66	2.06
20-24	0.0027	0.0080	59.5	55.7	0.664	0.423	0.002	0.003	60.1	57.6	0.62	1.88
25-29	0.0026	0.0087	54.7	51.2	0.690	0.480	0.002	0.004	55.2	52.8	0.57	1.63
30-34	0.0033	0.0093	49.8	46.6	0.735	0.511	0.002	0.005	50.3	48.0	0.53	1.42
35-39	0.0041	0.0109	44.9	42.0	0.767	0.579	0.003	0.006	45.4	43.2	0.49	1.22
40-44	0.0054	0.0129	40.1	37.4	0.811	0.668	0.004	0.009	40.6	38.5	0.45	1.04
45-49	0.0090	0.0183	35.3	32.9	0.869	0.749	0.008	0.014	35.7	33.8	0.41	0.90
50-54	0.0150	0.0282	30.6	28.5	0.902	0.821	0.014	0.023	31.0	29.2	0.37	0.76
55-59	0.0245	0.0429	26.1	24.2	0.929	0.874	0.023	0.038	26.4	24.9	0.33	0.64
60-64	0.0427	0.0651	21.6	20.2	0.949	0.898	0.041	0.059	21.9	20.7	0.29	0.53
65-69	0.0690	0.0932	17.5	16.4	0.958	0.925	0.066	0.086	17.7	16.8	0.25	0.43
70-74	0.1320	0.1611	13.6	12.8	0.971	0.941	0.128	0.152	13.8	13.2	0.20	0.34
75-79	0.2115	0.2362	10.3	9.8	0.977	0.956	0.207	0.227	10.4	10.1	0.15	0.25
80-84	0.4089	0.4449	7.4	7.1	0.983	0.972	0.403	0.436	7.5	7.3	0.09	0.17
85+	1	1	5.8	5.8	0.987	0.976	1.000	1.000	5.8	5.9	0.08	0.14

Table 2 shows the results of multiple-reduction and single-reduction life tables based on the elimination of the causes of unintentional accidents in the country in 2010. In this table, by considering the influence of all factors on mortality, life expectancy at birth is obtained 73.9 years and for women 78.2 years. As can be seen by removing the cause related to unintentional incidents, the degree of life expectancy is calculated to be 76.3 years for men and 79 years for women. The results of analysis of the increase in life expectancy at birth, by the assumption of removal of unintended incidents show that among males, deaths of middle age groups, especially the age groups 15 to 40 years have a significant share in the increase of life expectancy. According to the results of

this study which are presented in table 3, the increase of life expectancy by 2.3 years at birth, in case of elimination of unintentional incidents from deaths in men, is about 73%. On the other hand, the share of age groups under 15 and 65 and over, are estimated around 13% and 15% respectively. As it was expected, in the middle age groups, the age group of 20-24 years with about 11% and 25-29 years with about 10%, have allocated the largest share in the increase of life expectancy in men, but among women, the situation is quite different. With the elimination of female deaths due to unintentional incidents, female life expectancy at birth only increased 0.8 years and this suggests the fact that unintentional incidents are not an important factor in women's mortality.

Table 3: Analysis of the life expectancy increase at birth by eliminating the unintentional incidents from men's causes of death in the country in 2010

Age	lx	nLx	Tx	ex	lx-i	nLx-i	Tx-i	ex	Changes	%
0	100000	98796	7388565	73.9	100000	98829	7619635	76.2	0.027	1.19
1-4	98691	393968	7289769	73.9	98726	394440	7520806	76.2	0.103	4.46
5-9	98358	491216	6895801	70.1	98531	492385	7126366	72.3	0.085	3.66
10-14	98128	490096	6404585	65.3	98423	491880	6633981	67.4	0.076	3.3
15-19	97910	488220	5914489	60.4	98321	491119	6142101	62.5	0.193	8.33
20-24	97378	484935	5426270	55.7	98107	489743	5650982	57.6	0.249	10.78
25-29	96596	480872	4941334	51.2	97773	487867	5161239	52.8	0.222	9.58
30-34	95752	476532	4460463	46.6	97363	485695	4673373	48.0	0.199	8.63
35-39	94861	471715	3983930	42.0	96898	483036	4187678	43.2	0.179	7.74
40-44	93826	466107	3512215	37.4	96285	479495	3704642	38.5	0.146	6.33
45-49	92617	458847	3046109	32.9	95455	474276	3225146	33.8	0.137	5.92
50-54	90922	448192	2587261	28.5	94143	465695	2750870	29.2	0.129	5.57
55-59	88355	432300	2139070	24.2	91956	451761	2285175	24.9	0.114	4.95
60-64	84565	409057	1706770	20.2	88498	430285	1833414	20.7	0.113	4.88
65-69	79058	376875	1297713	16.4	83304	399846	1403129	16.8	0.096	4.15
70-74	71692	329589	920838	12.8	76101	353080	1003283	13.2	0.094	4.06
75-79	60144	265196	591249	9.8	64510	288041	650203	10.1	0.074	3.18
80-84	45935	178579	326053	7.1	49862	195399	362162	7.3	0.039	1.71
85+	25497	147473	147473	5.8	28137	166763	166763	5.9	0.036	1.58
Total	-	-	-	-	-	-	-	-	2.31	100

Table 4: Analysis of the life expectancy increase at birth with eliminating unintentional events from the causes of death in women in the country in 2010

Age	lx	nLx	Tx	ex	lx-i	nLx-i	Tx-i	ex	Changes	%	ex
0	100000	99096	7817436	78.2	100000	99127	7901252	79.0	0.027	3.23	79.01
1-4	99017	395389	7718340	78.0	99051	395771	7802124	78.8	0.076	9.13	78.77
5-9	98745	493300	7322951	74.2	98878	494162	7406353	74.9	0.058	6.88	74.9
10-14	98575	492529	6829651	69.3	98787	493709	6912191	70.0	0.03	3.59	69.97
15-19	98437	491700	6337122	64.4	98693	493155	6418482	65.0	0.04	4.74	65.03
20-24	98243	490564	5845422	59.5	98562	492387	5925327	60.1	0.051	6.04	60.12
25-29	97982	489262	5354858	54.7	98388	491505	5432940	55.2	0.043	5.09	55.22
30-34	97723	487818	4865595	49.8	98209	490482	4941435	50.3	0.041	4.85	50.32
35-39	97404	486026	4377778	44.9	97973	489139	4450953	45.4	0.04	4.82	45.43
40-44	97006	483713	3891752	40.1	97666	487349	3961814	40.6	0.039	4.63	40.56
45-49	96480	480221	3408039	35.3	97236	484453	3474465	35.7	0.04	4.74	35.73
50-54	95609	474463	2927818	30.6	96472	479393	2990013	31.0	0.043	5.15	30.99
55-59	94176	465105	2453355	26.1	95167	470923	2510620	26.4	0.045	5.32	26.38
60-64	91866	449524	1988250	21.6	92996	456325	2039697	21.9	0.047	5.62	21.93
65-69	87944	424559	1538725	17.5	89223	432803	1583373	17.7	0.054	6.5	17.75
70-74	81880	382387	1114166	13.6	83321	391761	1150570	13.8	0.056	6.71	13.81
75-79	71075	317792	731780	10.3	72621	328081	758809	10.4	0.056	6.63	10.45
80-84	56042	222920	413988	7.4	57568	230012	430728	7.5	0.028	3.31	7.48
85+	33126	191068	191068	5.8	34340	200716	200716	5.8	0.026	3.05	5.84
Total	-	-	-	-	-	-	-	-	0.838	100	

DISCUSSION

In this study, we worked on the added years to life expectancy at birth in the country, with the assumption of the removal of unintentional events from the cause of death and also the share of age groups of this increase was calculated. Before using data, their bad record, empty and vain codes, were investigated and were redistributed in the country deaths. According to the results of this study, the life expectancy of Iranian men is about 74 years and is estimated to be about 78 years for women and this figure is somehow higher than the figures that have been calculated for the country in recent years. It shows that in the year of the study, the record of mortality in the country has been experiencing a low record. There are different demographic methods to assess coverage of deaths record that are based on the assumption of constant population and only suggest one correction coefficient for all

ages. While it is not hidden from any professional demographer that accuracy and error in coverage of death record in Iran is dependent on gender and age function. Also, the population of Iran is out of the stable population. On the other hand, these methods provide a correction coefficient for total mortality. But given that coverage of death record of unintentional incidents is not the same with other death causes and one cannot apply this correction coefficient, which is applied to the total mortality, to unintentional incidents. Therefore, in this study, the low record of death causes is not corrected. Since the objective of this article is the study of the cause of death, the results show that finally the error in estimating mortality levels does not have a determining effect on the results of this study. In other words, the share of causes of death of all deaths occurred, which is obvious in the

estimated fatality rate, is not dependent to the number of estimated deaths.¹⁶

While the average age of death in the country reached over 60 years, this average for unintentional injuries is less than 40 years. The analysis of multiple-reduction life table shows that about 50% of deaths from unintentional injuries among men have occurred in the ages 20 to 60 years meaning the age of economic activity and being head of household. This proportion for women was about 35%. The collection of unintentional injuries wastes about 3.2 years of life expectancy of any Iranian man and about 0.8 years of life expectancy of every Iranian woman. On the other hand, the results showed that the share of the middle age group, especially in men, is of special importance in this decline, therefore, although in terms of rate of death, unintentional accidents and events are the third leading cause of death in the country, but because death from this cause, and with the same importance of unaccounted injuries in dead statistics, involve young and middle aged people more than other age groups, has more socioeconomic importance compared to the causes such as chronic illnesses (for example, cancers). Demographically, since the socio-economic value and consequences of the lost years of life due to unintentional and road traffic incidents in middle ages is more than that of in older and younger ages, the death and injuries from these causes is of high importance.

The effect of unintentional accidents on the chances of survival of generations differs by sex. This group of death causes leads to reduced life expectancy by 1.5 years in men more than that in women. Proportions of these numbers of died men as the head of household, were either married, or had children, so every year a significant number of these families become unsupervised and get exposed to various socio-economic and psychological damages which cause many social damages and will bring many economic

costs to the community. Since the promotion of community requires improvement of the health of the most important economically beneficial age group, namely young people, and the majority of deaths due to accidents are preventable, controllable and interventional, without doubt, investment to increase productivity and improve the health of young people is essential.

This study is one of the few studies which uses more advanced methods of analysis of mortality data, investigated the share of one death cause from total mortality in the country. This is while in the developed countries, special attention has been paid to mathematical demography particularly life tables based on causes of death. Among the clear studies in this field, are the studies conducted by the Vital Statistics Center of America. Therefore, it is suggested that, especially at the university level, special attention must be paid to more developed methods of data analysis of total combined causes of death and also based on special causes of death so that we can have a better understanding of share of each of death causes and its consequences.

CONCLUSION

Since high rate of deaths due to unintentional accidents are preventable, control and intervention, especially among young people, and society development needs to improve the health of the main age groups, mean young, so investments to increase productivity and improve the health of young people is necessary.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest.

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