

# Top Ten Causes of Death and Life Expectancy in Zahedan (South-East Iran) in 2014

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## Abstract

**Introduction:** Life expectancy is an overall measure of population health. Sistan and Balouchestan is the biggest in terms of geographical size and one of the least developed provinces in Iran. We tried to determine the top 10 causes of death and life expectancy in Zahedan in 2014 and compare them with other parts of Iran and global pattern.

**Methods:** It is a cross-sectional study. Our population included residents of Zahedan in 2014. We used data from the death registration system according to ICD10 codes to determine the top 10 causes of death in Zahedan. We tried in this study to apply William Brass method to modify mortalities undercount. Then we estimated the life expectancy for men and women in Zahedan by providing lifetime tables.

**Results:** The top ten causes of death in Zahedan were, respectively: 1- injury, poisoning and other certain consequences of external causes, 2- certain conditions originating in the prenatal period, 3-strokes, 4- ischemic heart diseases, 5-neoplasm, 6- Alzheimer disease, 7- hypertension-related diseases, 8- congenital malformations, deformations and chromosomal abnormalities, 9- certain infectious and parasitic diseases and 10- respiratory system infections. The death registration coverage in Zahedan had been 83% for men and 73% for women in 2014 based on William Brass method. After applying undercount deaths and based on life table calculation we determined life expectancy 64.39 years and 67.51 years respectively for men and women in Zahedan city in 2014.

**Conclusion:** In regard to ranks of strokes, ischemic heart disease, road accidents and cancers in our study; our results are similar to countries with middle income and higher income. Also, it is pertinent to also state it that the second rank of prenatal disease in our population is similar to that of the low-income countries. The relatively low life expectancy in Zahedan indicates the less developed condition and a purposeful intervention to improve the development condition and the prevention of the main causes of death in Zahedan are necessary to improve life expectancy in this region.

**Keywords:** life expectancy, cause of death, life table

## 1. Introduction

Life expectancy is an overall measure of population health. The approximate doubling of life expectancy over the last century is a demonstration of substantial scientific and public health progress (Hum, Verguet, Cheng, McGahan, & Jha, 2015).

Life expectancy is the average number of years a person can expect to live given the current age-specific mortality rates (WHO, 2015a).

Based on WHO report 2013, Kiribati has the least life expectancy (46 years) and Japan has the highest life expectancy (84 years) among countries (WHO, 2013).

Significant variations in life expectancy still persist between high and low-income communities. Life expectancy is increasing and this has been attributed to improvements in sanitation and access to safe water; medical advances, including childhood vaccines, and massive increases in agricultural production. Life expectancy reflects the health status of a country's people and the quality of health care they receive.

Life expectancy at birth has been increasing for both sexes in recent decades in Iran. It has steadily increased from 37.5 years in 1956 to 47.5 years in 1966, 55.7 years in 1976 to 58.9 years in 1986, 64.7 years in 1996, 71 years in 2006 and 74 years in 2012 (WHO, 2011, 2013).

According to the WHO reports (2013), the mortality pattern has changed in Iran and in the world and the causes of death have transformed from infectious diseases like AIDS and malaria to chronic ones like cardiovascular diseases and cancers (WHO, 2013). The four main causes of death according to the prediction of WHO, for the future will be heart failure, stroke, chronic lung obstructive diseases and the lower respiratory system infection in 2030. Coronary artery diseases and cancers incidence due to aging population indicates the lower mortality rate due to infectious diseases (Heidari & Heidari, 2009).

Naghavi et al during a period of 1990-2010 in Iran found a decreasing trend in age-specific mortality rate for both sexes, this mortality rate reduction was more significant in women (Naghavi et al., 2014).

Abdollahzade et al performed a study for classifying regional development in Iran. They used several indicators such as; social, population and cultural (14 indicators), economics (13 indicators), infrastructural and services (14 indicators). They concluded that Tehran, Semnan and Esfahan provinces were ranked in the first position and Kohkiluyeh-Boyerahmad, Lorestan and Sistan-Baluchestan provinces were ranked in the last position. (Abdollahzade & Sharifzadeh, 2012)

Another study by Zarrabi and Shaykh Baygloo at 2011 compared health indicators between Iran provinces. They applied five main indices that included, expert human resources, rural health services, medical facilities, governmental health services and private sector services. They showed that Tehran is the most developed and Ilam, Kohkiluyeh-Boyerahmad, South Khorasan and Sistan-Baluchestan provinces are the most deprived provinces in Iran based on health indicators (Zarrabi & Shaykh Baygloo, 2011).

Sistan and Baluchestan is the widest and one of the least developed provinces in Iran (southeast). Based on 2011 Iran statistics center, it had the lowest life expectancy as compared to the other provinces (Teyfoury & Akbari, 2013). Also, Tehran and Gilan provinces have the highest and Sistan and Baluchestan province has the least life expectancy based on the results of the last ministry of health researches in Iran (Teyfoury & Akbari, 2013).

Zahedan is the capital of Sistan and Baluchestan province and it had more complete and more reliable death registry system in comparison with other cities in the province. Then we went further to design our study only on the Zahedan population.

We tried to determine the top 10 causes of death and life expectancy in Zahedan in 2014 and compare them with Iran and global pattern.

## 2. Materials and Method

It is a cross-sectional study. Our population included residents of Zahedan in 2014. Population statistics obtained from population and housing census in 2011 that was carried out by Iran statistics center, and then we estimated it for 2014 by applying population growth rate.

Mortality data was extracted out of the death registration system in the provincial health center. We used data from the death registration system according to ICD10 codes to determine the top 10 causes of death in Zahedan.

ICD10 is the 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD), a medical classification list by the World Health Organization. It contains codes for diseases, signs and symptoms, abnormal findings, complaints, social circumstances, and external causes of injury or diseases (WHO, 2014).

There is a death registration system software has been designed by Iran ministry of health. All death data after being adjusted with the information of civil registration organization and also the cemeteries were recorded in this software.

Taking cognizance of mortalities undercount and the existence of unofficial graveyards, we tried in this study to apply William Brass method (Mathers, Vos, Lopez, Salomon, & Ezzati, 2001) to modify mortalities undercount. In 1975 William Brass introduced a method to estimate the completeness of adult death registration. In this method we should use the number of death registered by age in a five-year period, also we need mid-year population size

by every period of age. The outcome of this method is an average estimate of the extent of under-reporting of death above age 5. Separate calculations have been done for male and female as under-reporting had been calculated for both sexes. Then we proceeded by estimating the life expectancy for men and women in Zahedan by providing lifetime tables.

**3. Results**

We evaluated 2890 registered deaths in 2014 that included 1710 men and 1180 women. The most common causes of death are summarized in table 1 based on the ICD 10 classification.

Table1. Top ten causes of death in Zahedan population in 2014

Rank	ICD 10 classification	Percent	Frequency
1	Injury, poisoning, and other certain consequences of external factors: <ul style="list-style-type: none"> <li>• Traffic accidents</li> <li>• Nontraffic accidents</li> </ul> Total	7.92 4.43 12.35	229 128 357
2	Certain conditions originating in the prenatal period	12.21	353
3	Strokes	8.16	236
4	Ischemic Heart Diseases	8.02	232
5	Neoplasm	5.91	171
6	Alzheimer disease	4.94	143
7	Hypertension related diseases	4.84	140
8	Congenital malformations, deformations, and chromosomal abnormalities	4.56	132
9	Certain infectious and parasitic diseases	2.56	74
10	Respiratory system infections	2.42	70

The top ten causes of death in Zahedan based on main groups of diseases in ICD10 coding are shown in Table1.

We used life-table calculations based on available death registration system data, and life expectancy was calculated 68.3 years in Zahedan (66.8 years for men and 70.4 years for women). But due to the undercount of available data in the death registration system center, we tried to estimate the undercount percent by using the brass method. Tables 2, show Brass method calculations for the determination of undercount percent for both sexes.

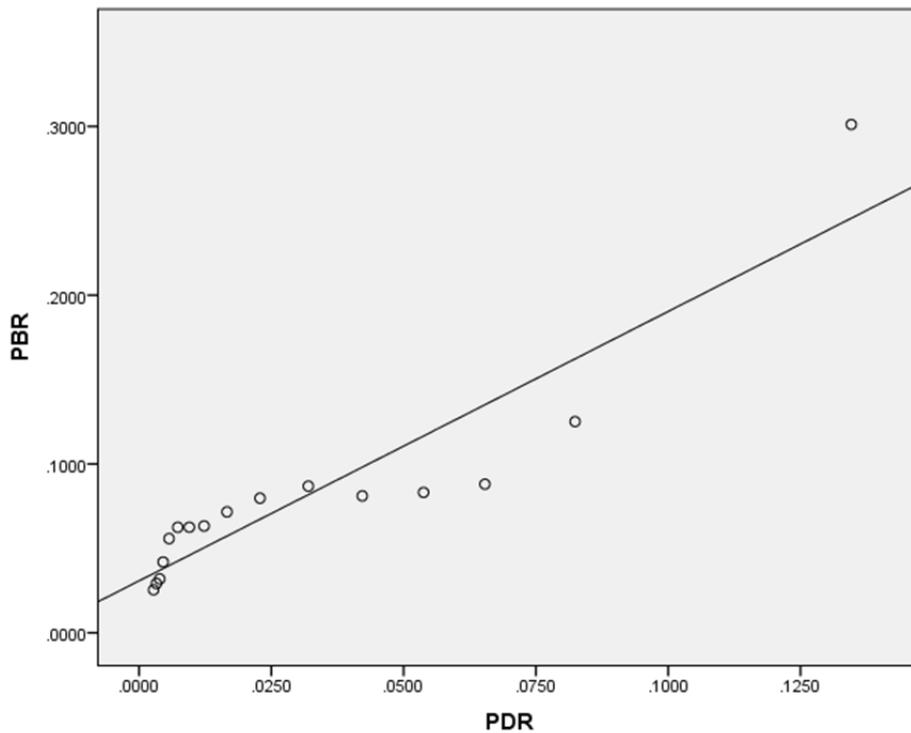
Table 2. William Brass calculations for the determination of undercount percent for both sexes

Male			Female		
Age	Partial death rate	Partial birth rate	Age	Partial death rate	Partial birth rate
X	$D(x+)/N(X+)$	$N(X)/N(X+)$	X	$D(x+)/N(X+)$	$N(X)/N(X+)$
Group1			Group1		
5	0.0040	0.0270	5	0.0027	0.0254
10	0.0051	0.0312	10	0.0032	0.0291
15	0.0059	0.0339	15	0.0039	0.0318
20	0.0068	0.0424	20	0.0045	0.0419
25	0.0081	0.0542	25	0.0056	0.0558
30	0.0100	0.0597	30	0.0073	0.0624
35	0.0123	0.0602	35	0.0095	0.0625
40	0.0158	0.0634	40	0.0122	0.0632

Mean	X1=0.00851	Y1=0.0465	Mean	X1=0.0061	Y1=0.0465
Group2			Group2		
45	0.202	0.0684	45	0.0166	0.0716
50	0.0260	0.0762	50	0.0228	0.0797
55	0.0354	0.0892	55	0.0319	0.0868
60	0.481	0.0981	60	0.0421	0.0810
65	0.0604	0.0834	65	0.0537	0.0831
70	0.0725	0.0878	70	0.0653	0.0880
75	0.0911	0.1055	75	0.0823	0.1251
80	0.0970	0.2349	80	0.1346	0.3011
Mean	X2=0.0563	Y2=0.1040	Mean	X2=0.0562	Y2=0.1146
$K = \frac{Y_2 - Y_1}{X_2 - X_1} = 1.202$ $C = \frac{1}{K} = 0.83$			$K = \frac{Y_2 - Y_1}{X_2 - X_1} = 1.359$ $C = \frac{1}{K} = 0.73$		

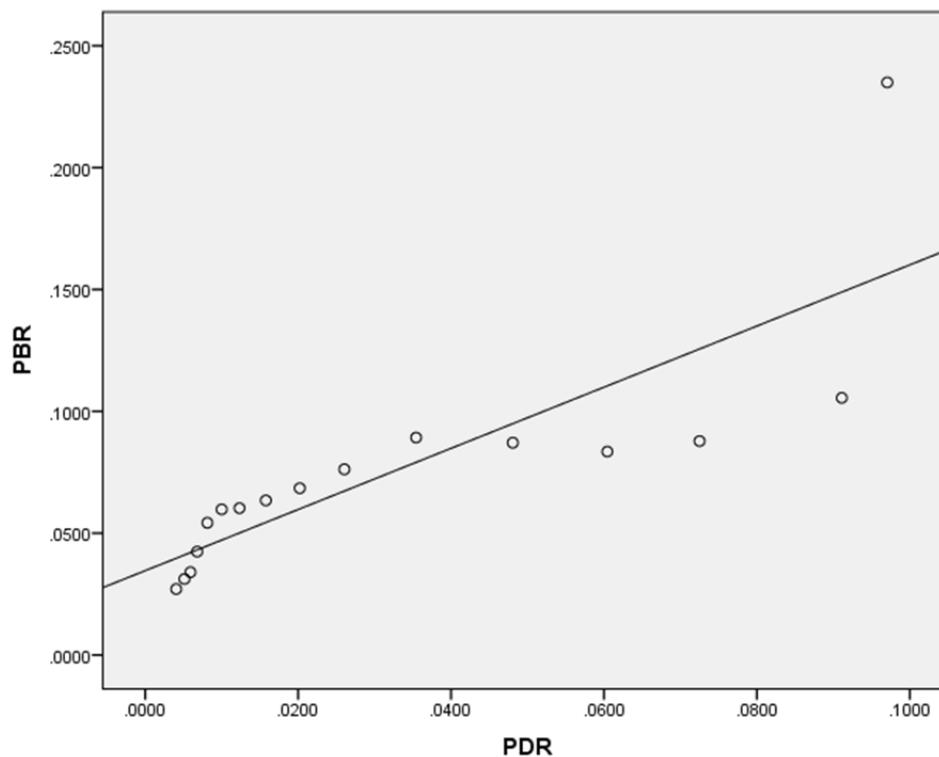
D (x): registered Death for any age period; N(X): reported population for any age period; D(X+): registered death over age X; N(X+): population aged X and over. C: the final estimate of the completion of death registration.

As we can also see in Table 2, death registration completion in Zahedan had been 83% (17% undercount) for men and 73% (27% undercount) for women in 2014 based on William Brass method. Also, we can see in figure1 and 2; outlier data that indicate the incompleteness of death registration.



PBR: Partial Birth Rate, PDR: Partial Death Rate

Figure 1. Completeness of Death Registration using Brass Growth Balance Method for male in Zahedan, 2014



PBR: Partial Birth Rate, PDR: Partial Death Rate

Figure 2. Completeness of Death Registration using Brass Growth Balance Method for female in Zahedan, 2014

To calculate the life expectancy, we first multiplied the number of deaths by K (1.202 for men and 1.359 for women), then life expectancy for men and women was calculated based on lifetime table (Tables 3 and 4).

Table 3. Life table for men in Zahedan (2014)

age	n(x)	a(x)	p(x)	d(x)	m(x)	l(x)	D(x)	L(x)	T(x)	e(x)
<1	1	0.0289	9643	258	0.0268	100000	2676	101960.1	6439831	64.3983
1-4	4	0.1110	36995	86	0.0093	99070.14	921	438852.6	6337871	63.9736
5-9	5	0.1218	40606	29	0.0036	98716.37	353	551928.7	5899018	59.7572
10-14	5	0.1087	36223	26	0.0036	98362.09	353	540861.1	5347089	54.3613
15-19	5	0.1054	35136	63	0.0090	97480.26	874	532653.3	4806228	49.3046
20-24	5	0.1171	39023	98	0.0126	96256.23	1209	530136.5	4273575	44.3979
25-29	5	0.1039	34640	108	0.0156	94755.7	1477	514097.4	3743438	39.5062
30-34	5	0.0774	25799	97	0.0188	92974.37	1748	494095.4	3229341	34.7337
35-39	5	0.0588	19606	57	0.0145	91622.86	1332	472972	2735246	29.8533
40-44	5	0.0472	15739	83	0.0264	89206.99	2352	451366.1	2262273	25.3598
45-49	5	0.0349	11632	82	0.0352	86062.65	3034	423303.7	1810907	21.0417
50-54	5	0.0299	9963	102	0.0512	81657.16	4180	391946.5	1387604	16.9930
55-59	5	0.0193	6436	90	0.0699	75947.75	5310	335350.5	995657.1	13.1098
60-64	5	0.0119	3965	108	0.1362	65604.3	8935	261277.9	660306.7	10.0650
65-69	5	0.0081	2693	116	0.2154	51474.89	11086	198620.4	399028.7	7.7519
70-74	5	0.0058	1946	92	0.2364	39307.14	9292	137155.1	200408.3	5.0985

75-79	5	0.0047	1575	97	0.3079	27203.04	8377	58706.74	63253.21	2.3252
80-84	5	0.0029	951	109	0.5731	11613.49	6655	4535.986	4546.468	0.3915
≥85	5	0.0024	811	150	0.9248	873.52	808	10.48222	10.48222	0.0120

x: age groups;

n(x): number of years related to interval x;

a(x): Proportion alive at the beginning of age interval x;

p(x): Number alive at the beginning of the age interval x;

d(x): number of deaths at age interval x;

m(x): probability of dying during interval  $x = n(x)[d(x)p(x)]$ ;

l(x): number of defaults surviving at the beginning of interval x;

D(x): number of deaths in default population =  $m(x)l(x)$ ;

L(x): person-year lived in the interval  $x = n(x)[L(x+1) + a(x)D(x)]$ ;

T(x): Total persons- year cumulated from bottom;

E(x): Life expectancy =  $T(x)/L(x)$ .

Table 4. Life table for women in Zahedan (2014)

Age	n(x)	a(x)	p(x)	d(x)	m(x)	l(x)	D(x)	L(x)	T(x)	e(x)
<1	1	0.0300	8979	192	0.0214	100000	2138	99017.52	6751707	67.5171
1-4	4	0.0275	34000	84	0.0099	99011.76	978	405946.8	6652689	67.1909
5-9	5	0.1043	37944	19	0.0025	98763.87	247	543852.6	6246743	63.2493
10-14	5	0.1164	33544	20	0.0030	98469.44	294	547842.9	5702890	57.9153
15-19	5	0.1029	33936	25	0.0037	98106.74	361	538713.9	5155047	52.5453
20-24	5	0.1041	40599	38	0.0047	97647.6	457	535866.5	4616333	47.2754
25-29	5	0.1245	35888	47	0.0065	97008.19	635	541081.2	4080467	42.0631
30-34	5	0.1101	27335	49	0.0090	96138.72	862	529407.2	3539385	36.8154
35-39	5	0.0838	18836	33	0.0088	95296.56	835	511336.4	3009978	31.5854
40-44	5	0.0578	15959	34	0.0107	94281.44	1004	490995.4	2498642	26.5020
45-49	5	0.0489	12002	39	0.0162	92749.62	1507	468477	2007646	21.6459
50-54	5	0.0368	9560	74	0.0387	89159.94	3451	432876.2	1539169	17.2630
55-59	5	0.0293	5624	74	0.0658	83294.15	5480	377986.2	1106293	13.2818
60-64	5	0.0172	3985	97	0.1217	73156.72	8904	303437	728307	9.9554
65-69	5	0.0122	2558	96	0.1876	59429.11	11152	226379.1	424870	7.1492
70-74	5	0.0078	2117	106	0.2504	44550.78	11153	160406.6	198490.9	4.4554
75-79	5	0.0065	1877	108	0.2877	31733.83	9130	35995.81	38084.32	1.2001
80-84	5	0.0058	776	121	0.7796	6992.89	5452	2083.999	2088.513	0.2987
≥85	5	0.0024	539	102	0.9462	376.24	356	4.514891	4.514891	0.0120

x: age groups;

n(x): number of years related to interval x;

a(x): Proportion alive at the beginning of age interval x;

p(x): Number alive at the beginning of the age interval x;

d(x): number of deaths at age interval x;

m(x): probability of dying during interval  $x = n(x)[d(x)p(x)]$ ;

$I(x)$ : number of defaults surviving at the beginning of interval  $x$ ;

$D(x)$ : number of deaths in default population =  $m(x)I(x)$ ;

$L(x)$ : person-year lived in the interval  $x = n(x)[L(x+1) + a(x)D(x)]$ ;

$T(x)$ : Total persons- year cumulated from bottom;

$E(x)$ : Life expectancy =  $T(x)/L(x)$ ;

$e(x)$ : Life expectancy;

After applying undercount deaths and based on life table calculations, we determined life expectancy 64.39 years and 67.51 years respectively for men and women in Zahedan city in 2014.

#### 4. Discussion

Having ignored the undercount cases of death, it was recognized in our study that total life expectancy for men and women in Zahedan is 68.3 years which is approximately the same as the published results of Iran ministry of health study for Sistan and Baloochestan province in 2011 (68.42 years) (Neisi, 2010). But applying mortality undercount by William Brass method, the life expectancy of men and women in Zahedan at birth is 64.3 and 67.5 years which is lower than the reported one by the ministry of health in 2011 and is closer to the reality.

Based on Iran's ministry of health report, Kurdistan, Kerman and Ilam provinces have the least life expectancy 69, 35, 69.4 and 69.39 respectively after Sistan and Balouchestan province. Tehran, Yazd, Isfahan and Ghazvin have had the highest life expectancy in the country with 71.39, 71.42, 71.59 and 72.3 years respectively (Neisi, 2010).

Life expectancy is one of the most important development indexes based on WHO third millennium goals.

It is known that the socio-economic variables such as per capita income, education and government expenditure on health are strong determinants of life expectancy in developing countries (Sede & Ohemeng, 2015)

Sistan-Bluchestan province was ranked in the last position of development indicators in Iran in comparison with other provinces. (Abdollahzade & Sharifzadeh, 2012). Also, it is one of the most deprived provinces in Iran based on Health indicators (Zarrabi & Shaykh Baygloo, 2011).

Then low life expectancy in the center of Sistan and Balouchestan province obviously indicates an undesired developmental condition and deprived health services.

The gap in gender life expectancy is observed all over the world, as almost in all countries of the world women live longer (Barford, Dorling, Davey Smith, & Shaw, 2006), but the degree differs among countries or regions. This gap has been engendered by health behaviors, socio-economic status, culture related dietary habits, fertility preferences, environmental or genetic and physiologic factors (Lindahl-Jacobsen et al., 2013), with the interaction of the effect of several bio-psycho-social risk factors on the survival. Also based on our result women life expectancy was 3 years more than men in our study.

According to Iran ministry of health report in 2011, the average of life expectancy for men and women were respectively 72.1 and 74.6 years (Neisi, 2010). Then in comparison with the country's average, we found a gap in life expectancy as 7.8 and 7.1 years respectively for Zahedani men and women. These differences can be related to the different pattern of mortality, as we found in this study significant differences regarding the main causes of death in Zahedan with the most common causes of death in Iran and in the world.

The top five causes of death in our study were respectively: 1). Injury, poisoning and other certain consequences of external causes (64.14% related to traffic accidents), 2). Certain conditions originating in the prenatal period, 3). Strokes, 4). Ischemic heart diseases, 5). Cancers. The top five causes of death based on the report of Iran ministry of health in 2010 included 1). Ischemic heart diseases, 2). stroke, 3). Injury and poisoning, 4). Hypertension-related diseases, 5). Cancers (Khosravi et al., 2011). The first rank of injuries and the second rank of prenatal diseases are completely different from country patterns.

Also the top ten main causes of death in the world based on 2014 WHO report are, ischemic heart disease, stroke, lung obstruction diseases, lower respiratory system infection, lung and respiratory tract cancer, HIV/AIDS, diarrhea-related diseases, diabetes mellitus, road accidents and hypertension. This ranking is different for countries based on their income. While the main causes of death in low-income countries are, lower respiratory system infection, HIV/AIDS, diarrhea-related diseases, stroke, ischemic heart disease, malaria, premature birth disorders, tuberculosis, asphyxia during birth trauma and protein-energy malnutrition.

In middle-income countries, they include ischemic heart disease, stroke, lower respiratory system infection, lung

obstruction diseases, diarrhea- related diseases, premature birth disorders, HIV/AIDS, diabetes, tuberculosis, and cirrhosis.

While for countries with upper middle income, stroke, ischemic heart disease, lung obstruction diseases, lung and respiratory tract cancer, diabetes mellitus, lower respiratory system infection, road accidents, hypertension -related heart diseases, liver and stomach cancer are the main cause of death.

Finally in high-income countries, the main causes of death are, ischemic heart disease, stroke, respiratory tract and lung cancer, Alzheimer disease, dementia, lung obstruction diseases, lower respiratory system infection, colon cancer, rectum cancer, diabetes mellitus, hypertension-related heart diseases and breast cancer (WHO, 2015b).

In regard to ranks of strokes, Ischemic heart disease, road accidents and cancers in our study; our results is similar to countries with middle and higher income bracket. But the second rank of prenatal disease in our population indicates the less developed condition and undesirable health care services especially for pregnant women and newborns that can be more similar to low-income countries.

Based on our results, accidents and injuries had the first rank of mortality in Zahedan and 67.22% of all mortalities due to injuries had been caused by traffic accidents.

TaravatManesh et al studied the epidemiology of fatal traffic injuries in Sistan and Balouchestan province in 2011 and described that this province in comparison with other provinces of Iran had the most unsafe roads and is one of the provinces with high traffic injuries. They reported that among all traffic fatal injuries, 78.8% had occurred in males and 21.3% in women. The mean age of these deaths was  $30.19 \pm 16.9$  (Taravatmanesh, Hashemi-Nazari, Ghadirzadeh, & Taravatmanesh, 2015). This fact can be one of justifying factors of low life expectancy in Zahedan and also lower life expectancy in men than women.

As well prenatal period diseases as the second rank of mortality are obviously another reason for low life expectancy in this city.

Naghavi et al investigated Iran health transition based on global burden of diseases in 2010 and found that major causes of disability-adjusted life year (DALYs), such as injuries, interpersonal violence, and suicide, showed increasing trends, while rates of communicable diseases, neonatal disorders, and nutritional deficiencies have declined significantly (Naghavi et al., 2014), and as we found in our study, the injuries are the first cause of death in Zahedan population.

Tarkiainen et al. studied trends in life expectancy by income from 1988 to 2007 in the Finnish general population and reported that the gap in life expectancy between the highest and the lowest income population widened during the study period by 5.1 years among men and 2.9 years among women. The increasing gap in life expectancy was mainly due to increases of mortality in the lowest income population and most importantly because of the increasing mortality in alcohol-related diseases. Their result determined an essential need to eliminate the specific health problems of the poorest (Tarkiainen, Martikainen, Laaksonen, & Valkonen, 2012).

In developed countries like the U.S.A, the decrease in deaths from heart disease, cancer, and HIV were confirmed to increase life expectancy for both sexes, among all racial or ethnic groups and for both US born and the foreign born (Li, Maduro, & Begier, 2015).

In the United States of America, life expectancy for the black population was 3.8 years lower than the white population. This difference was related to higher mortality rates for the black population due to heart disease, cancer, homicide, diabetes and prenatal conditions (Kochanek, Arias, & Anderson, 2013).

Mackenbach et al investigated the causes of the sudden improvement in life expectancy in Central and Eastern Europe in the 1990s. They concluded that the increase in life expectancy in Central and Eastern Europe had started at different times, but the main cause of this aforementioned improvement relates to the prevention or treatment of ischemic heart disease in all six countries and also changes in alcohol consumption and road traffic safety in some countries (Mackenbach, Karanikolos, Lopez Bernal, & McKee, 2015).

We also reported in our results, a lower life expectancy in comparison with other parts of Iran and the global pattern due to the different ranking cause of death in Zahedan.

## 5. Conclusion

With reference to the ranks of strokes, Ischemic heart disease, road accidents and cancers in our study; our results are similar to countries with middle and higher income. Conclusively it is also important to state it that the second rank of prenatal disease in our population is similar to those of the low-income countries. The relatively low life expectancy in Zahedan indicates a less developed condition and purposeful intervention a holistic approach to

improving the development condition and prevention of the main causes of death in Zahedan are necessary to improve life expectancy in this region.

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### Competing Interests Statement

The authors declare that there is no conflict of interests regarding the publication of this paper.

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