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Life expectancy at birth in Aran-Bidgol region, Iran, 2012: A study based on corrected Health Houses data

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Received: 22/Dec/2015 Accepted: 18/Jan/2016

ABSTRACT

Background and aims: Life expectancy is one of the most important indicators of health and well-being of a society. Since it is claimed that in Aran-Bidgol region, center of Iran, life expectancy is higher than the average of the country, this study was designed.

Methods: During a cross-sectional study, population and mortality data of Kashan University of Medical Sciences (KAUMS) in 2011 were used for calculating life expectancy. Brass Growth-Balance method was used to adjustmortality data with over 5 years old and to correct under reporting of deaths. Completeness and coverage of death registration data and the correction factor were calculated. Finally, anadjustedlife table for males and females was calculated separately. Microsoft Excel 2007 was used for calculations.

Results: Population of Aran-Bidgol was 93571 in 2012 based on KAUMS data. Among the total population, 47331 (50.6%) were males. Number of registered deaths was 479 [280 male (58.4%)]. Completeness of the death registration data was found to be %74.9 for males and %70.1 for females. Correction factor (K) for adjustment of reported death was calculated to be 1.33 and 1.42 for males and females respectively. Adjusted life expectancy at birth for males and females was 71.3 and 76.5 years respectively.

Conclusion: Although adjusted life expectancy for females in our study was to some extent more than the average life expectancy of Iranian women, but this indicator was slightly lower in men. Generally, it seems that there is no considerable difference between life expectancy of Aran-Bidgol population and national average life expectancy.

Keywords: Life expectancy, Longevity, Life table, Iran.

Original article

INTRODUCTION

Life expectancy at birth is the average number of years that a newborn is expected to live if current mortality rates continue to apply. Life expectancy at birth reflects the overall mortality level of a population. It summarizes the mortality pattern that

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prevails across all age groups.[1,2] Life expectancy shows the level of population health overall, with the effect of death on it.[3]On the other hand, the life expectancy shows the final consequences of the risk factors leading to death, health programs, healthy and unhealthy behaviors of the general population and also factors affecting them quantitatively.[4] It is not dependent on the age structure of a population. Therefore, it is widely used and interpreted by the public and policymakers.[5] Life expectancy along with GPD per capita and the literacy rate are considered as indicators of development and the World Bank has been calculating Human Development Index on the basis of these three markers.[4]

Life expectancy can be estimated directly or indirectly. In the presence of enough information (population and mortality data) life tables can be constructed and it could be calculated directly. In the absence of direct access to population and mortality data, it can be calculated indirectly using statistical models. The most appropriate method of collecting data of death, which is consistent with its dynamic nature, is the registration method.[6]Currently, there are two sources for death registration in Iran, National Organization for Civil Registration that is legally responsible for death registration and health record system which is run by the Ministry of Health and Medical Education. A study in Iran showed that like the other developing countries, data on mortality is not complete.[7]

The completeness of the data on mortality by sex and age must be evaluated by the researchers before using it in health metrics.[5]To adjust the data for under reported deaths different methods have been introduced. Most of them need data from two consecutive censuses.[8]Nevertheless, if the mortality data are available just for one year, they could be adjusted by several demographic techniques for underreporting of death.[5,8] In fact, high quality data on different mortality rates will be obtained if the registry covers at least 70% of the death cases.[8]

It is claimed that Aran-Bidgol city alongside Kashan and Semnan in Iran have the oldest population among Iranian cities with higher life expectancy than the average of Iranian people.[9] This study was designed to estimate life expectancy at birth in Aran-Bidgol region in 2012 using the data registry of Kashan University of Medical Sciences (KAUMS) after correcting death rates for under reported deaths.

METHODS

After approving the study by the IRB of KAUMS and during a cross sectional study an abridged life table for Aran-Bidgolcounty was constructed in the year 2012 using vital horoscope data of Health Houses covered by KAUMS via the direct method. Brass Growth-Balance method was used to adjust over 5 years old mortality data assuming the stability of the population. This method estimates the completeness of adult death registration based on the "balancing" equation:

$$\frac{N(x)}{N(x+)} = r + \frac{D(x+)}{N(x+)}$$

Where *N(X)* is population at each exact age,*N(X+)* is population at each X and above, *D(X)* registered death at age X, *D(X+)* registered death at age X and over and *r* is population growth rate.

Estimation of the completeness of adult death registration based on Brass Growth-Balance method has been explained elsewhere comprehensively.[8] Briefly, partial birth rate (*N(X)/N(X+)*) against partial death rate ((*Dx+)/(NX+*)) was calculated and plotted, using orthogonal regression to fit the best line to the data and estimate the completeness of the death registration. Then,

data points [X_i , Y_i, were grouped, where X_i=D(i+)/N(i+) and Y_i= N(i)/N(i+)] into 2 subsets. Subset 1 groups together points for age 5, 10, 15, 20, 25, 30. Subset 2 groups together points for ages 35, 40, 60. X_1,Y_1 and X_2,Y_2 were calculated as the average (mean) of points in subset 1 and subset 2 respectively. Finally, the correction factor, the *K*, was calculated using the following formula:[8]

$$K = \frac{Y2 - Y1}{X2 - X1}$$

At the end, the final estimate of the completeness of death registration (C) was calculated using the following formula:[8]

$$C = \frac{1}{K}$$

Mortality rates were adjusted for the incompleteness by multiplying correction factor to the reported deaths.[8]Microsoft Excel 2007 software was used for all calculations.

RESULTS

Population of Aran-Bidgol was 93571 in 2012 based on KAUMS vital registry report. Number of registered deaths based on the same registry was 479 [male 280 (58.4%)] during the same year.

Table 1: Correction of under numeration of deaths in the male population older than 5 years in Aran-Bidgol County

	Registered	**Reported**	**Exact**	**Population at**	**Population aged**	**Reported Deaths**	**Partial Death**	**Partial Birth**
Age	Deaths	Population	Age	Exact age x	X and over	Over age x	Rate	Rate
x	$_5D_x$	$_5N_x$	x	N(x)	N(x+)	D(x+)	D(x+)/N(x+)	N(x)/N(x+)
0-4	17	4182						
5-9	2	3455	5	764	43149	263	0.0061	0.0177
10-14	2	3378	10	683	39694	261	0.0066	0.0172
15-19	8	3588	15	697	36316	259	0.0071	0.0192
20-24	3	4643	20	823	32728	251	0.0077	0.0251
25-29	11	5351	25	999	28085	248	0.0088	0.0356
30-34	7	4482	30	983	22734	237	0.0104	0.0433
35-39	9	4025	35	851	18252	230	0.0126	0.0466
40-44	7	3601	40	763	14227	221	0.0155	0.0536
45-49	11	2618	45	622	10626	214	0.0201	0.0585
50-54	9	2117	50	474	8008	203	0.0253	0.0591
55-59	9	1690	55	381	5891	194	0.0329	0.0646
60-64	12	945	60	264	4201	185	0.0440	0.0627
65-69	18	759	65	170	3256	173	0.0531	0.0523
70-74	19	803	70	156	2497	155	0.0621	0.0626
75+	136	1694						

Table 2: Correction of under numeration of deaths in the female population older than 5 years in Aran-Bidgol County, Iran, 2012

	Registered	**Reported**	**Exact**	**Population at**	**Population aged**	**Reported Deaths**	**Partial Death**	**Partial Birth**
Age	Deaths	Population	Age	exact age x	x and over	over age x	Rate	Rate
x	$_5D_x$	$_5N_x$	x	N(x)	N(x+)	D(x+)	D(x+)/N(x+)	N(x)/N(x+)
0-4	11	3992						
5-9	1	3157	5	715	42248	188	0.0044	0.0169
10-14	0	3331	10	649	39091	187	0.0048	0.0166
15-19	2	3606	15	694	35760	187	0.0052	0.0194
20-24	2	5220	20	883	32154	185	0.0058	0.0274
25-29	1	5257	25	1048	26934	183	0.0068	0.0389
30-34	1	4238	30	950	21677	182	0.0084	0.0438
35-39	3	3616	35	785	17439	181	0.0104	0.0450
40-44	3	3365	40	698	13823	178	0.0129	0.0505
45-49	8	2538	45	590	10458	175	0.0167	0.0564
50-54	2	2043	50	458	7920	167	0.0211	0.0578
55-59	8	1577	55	362	5877	165	0.0281	0.0616
60-64	12	954	60	253	4300	157	0.0365	0.0589
65-69	5	836	65	179	3346	145	0.0433	0.0535
70-74	13	835	70	167	2510	140	0.0558	0.0666

Table 3: Mean partial death and birth, and death registration coverage in Aran-Bidgol County regarding gender, 2012

Title	**Male**	**Female**
Partial death rate 5-34 yr (X1)	0.0078	0.0059
Partial death rate 40-69 yr (X2)	0.0319	0.0264
Partial birth rate 5-34 yr (Y1)	0.0263	0.0272
Partial birth rate 40-69 yr (Y2)	0.0585	0.0565
Correction factor (K)	1.33	1.42
Completeness of the death data	74.8	70.1

Among the total population, 47331 (%50.6) were males. Regarding the adjustment of death rate, the mean of partial death rate for six year age groups of 5-34 yr (X_1) for male and female population were 0.0078 and 0.0059, respectively. Mean of partial birth for these 6 groups (Y_1) were 0.263 and 0.0272 for males and females respectively. The mean of partial death rate for six age groups of 40-69 (X_2) for males

and females were 0.0319 and 0.0264 respectively. These amounts for the mean of partial birth (Y_2) for these age groups were 0.0585 and 0.0565 for males and females respectively. Correction factor (K) for adjustment of under reported deaths was calculated 1.33 and 1.42 for males and females respectively. Completeness of the death registration data was found as %74.9 for males and %70.1 for females (Table 1,2,3).

Adjusted life expectancy at birth for males was 71.3 years and for females was 76.5 years (Table 4,5).

Table 4: Male life table for Aran-Bidgol population, Iran, 2012

Age	Years in interval	Linearity adjustment	Reported population	Deaths rate	Mortality	Probability of dying	Individuals surviving	Deaths in interval x	Years lived in interval x	Cumulative years lived	Expectancy of life at age x
x	n	a	nPx	nDx	nMx	nqx	lx	ndx	nLx	Tx	ex
0	1	0.1	889	15	0.0169	0.0166	100000	1662	98504	7130303	71.3
1-4	4	0.4	3293	2	0.0006	0.0024	98338	239	392779	7031799	71.5
5-9	5	0.5	3455	3	0.0008	0.0039	98099	378	489551	6639020	67.7
10-14	5	0.5	3378	3	0.0008	0.0039	97721	386	487641	6149469	62.9
15-19	5	0.5	3588	11	0.0030	0.0148	97335	1439	483080	5661828	58.2
20-24	5	0.5	4643	4	0.0009	0.0043	95897	413	478451	5178748	54.0
25-29	5	0.5	5351	15	0.0027	0.0136	95484	1302	474165	4700297	49.2
30-34	5	0.5	4482	9	0.0021	0.0104	94182	977	468467	4226132	44.9
35-39	5	0.5	4025	12	0.0030	0.0148	93205	1381	462570	3757665	40.3
40-44	5	0.5	3601	9	0.0026	0.0129	91823	1184	456156	3295095	35.9
45-49	5	0.5	2618	15	0.0056	0.0277	90639	2508	446925	2838939	31.3
50-54	5	0.5	2117	12	0.0057	0.0280	88131	2467	434488	2392014	27.1
55-59	5	0.5	1690	12	0.0071	0.0349	85664	2993	420837	1957526	22.9
60-64	5	0.5	945	16	0.0170	0.0814	82671	6725	396540	1536689	18.6
65-69	5	0.5	759	24	0.0317	0.1468	75945	11145	351865	1140149	15.0
70-74	5	0.5	803	25	0.0316	0.1464	64800	9489	300279	788284	12.2
75-79	5	0.5	776	48	0.0619	0.2679	55311	14815	239517	488006	8.8
80-84	5	0.5	512	46	0.0898	0.3668	40496	14855	165341	248489	6.1
+85	5	0.5	406	88	0.2167	0.7029	25641	18022	83148	83148	3.2

Table 5: Female life table for Aran-Bidgol population, Iran, 2012

Age	Years in Interval	Linearity Adjustment	Reported Population	Deaths Rate	Mortality	Probability of Dying	Individuals Surviving	Deaths in Interval x	Years Lived in Interval x	Cumulative Years Lived	Expectancy of Life at Age x
x	n	a	nPx	nDx	nMx	nqx	lx	ndx	nLx	Tx	ex
0	1	0.1	898	8	0.0089	0.0088	100000	884	99205	7654422	76.5
1-4	4	0.4	3094	3	0.0010	0.0039	99116	384	395544	7555217	76.2
5-9	5	0.5	3157	1	0.0004	0.0022	98733	219	493116	7159673	72.5
10-14	5	0.5	3331	0	0.0000	0.0000	98514	0	492569	6666557	67.7
15-19	5	0.5	3606	3	0.0008	0.0039	98514	382	491614	6173988	62.7
20-24	5	0.5	5220	3	0.0005	0.0027	98132	263	490001	5682374	57.9
25-29	5	0.5	5257	1	0.0003	0.0013	97869	130	489017	5192373	53.1
30-34	5	0.5	4238	1	0.0003	0.0017	97738	161	488288	4703356	48.1
35-39	5	0.5	3616	4	0.0012	0.0058	97577	566	486470	4215068	43.2
40-44	5	0.5	3365	4	0.0012	0.0062	97011	604	483546	3728598	38.4
45-49	5	0.5	2538	11	0.0044	0.0218	96407	2106	476771	3245053	33.7
50-54	5	0.5	2043	3	0.0014	0.0068	94301	645	469894	2768282	29.4
55-59	5	0.5	1577	11	0.0071	0.0349	93656	3271	460105	2298388	24.5
60-64	5	0.5	954	17	0.0176	0.0844	90386	7630	432853	1838283	20.3
65-69	5	0.5	836	7	0.0084	0.0410	82756	3397	405286	1405429	17.0
70-74	5	0.5	835	18	0.0218	0.1034	79359	8209	376271	1000143	12.6
75-79	5	0.5	726	48	0.0661	0.2837	71150	20184	305287	623872	8.8
80-84	5	0.5	549	46	0.0838	0.3464	50965	17654	210692	318584	6.3
+85	5	0.5	400	87	0.2175	0.7045	33312	23467	107892	107892	3.2

DISCUSSION

The present study showed that life expectancy at birth in 2012 was 71.3 and 76.5 years for males and females respectively. The difference in life expectancy at birth for men and women was 5.2 years. Based on the results of the 2011 National Population and Housing Census, performed by theStatistical Center of Iran, life expectancy at birth has been 72.1 and 74.6 yr for Iranian males and females respectively.[10] Meanwhile, life expectancy at birth was reported 72 yr for males and 76 yr for females by World Health Organization (WHO) in 2012.[11] These statistics to some extent differ from the results of the present study. In the current study, life expectancy at birth for men was lower than WHO and Statistical Center of Iran's reports, while, it was calculated in females a higher life expectancy than the mentioned two sources. A possible explanation for this might be that different methods were used for calculating

life expectancy in our study and their calculation. In the present study, the direct method was used to calculate life expectancy. In addition, under numeration of registered death was corrected using Brass Growth-Balance method. However, WHO estimates life expectancy indirectly using statistical models like the modified Logit system.[12] Statistical Center of Iran also estimates life expectancy by using indirect methods.[4]YazdaniCharati et al. considered changes in life expectancy of people in Sari during 2005-2010. Based on their report, the life expectancy of males and females in 2010, the nearest years to our study, were 75 and 78.01 respectively.[13]Although they have used the data of health centers, the same source was used, but they did not evaluate completeness of death registration and correct under numeration of deaths. Hosseini et al. also calculated life expectancy at birth for men and women in the Bushehr province in 2011 74.91 and 75.91 respectively.[14] In addition; Ahmadi A and Shojae M during an epidemiologic study estimated the life expectancy changes during 2005-2009 in CharmahalandBakhtiary province in Iran. They found that during the mentioned period, the trend in life expectancy has been increased slightly either in men or in women. In 2009, the closest year to our study, the life expectancy for men and women has been 72.14 and 75.38 respectively.[15]With a little difference, their results are almost consistent with our findings.

Compared to our study, they calculated life expectancy to be higher for men and lower for women in the year close to our study.[14,15] The possible explanation for these differences in results may be the different methods of life expectancy calculation. Like previous studies, they also had not corrected under reported deaths. Mokhayeri et al. calculated Life expectancy at birth in Tehran in 2010 for men and women 74.6 and 78.4 years respectively.[16] This difference with our results can be justified due to the use of different source of data for providing life table by them and also other socioeconomic differences between the capital and a city with small population in the margin of the desert in central Iran.

In the all mentioned studies, little difference (less than 3 yr) was found between life expectancy of men and women. However, in the current study this difference was more than 5 yr. Khoshhali M and Mahjoub H reported the life expectancy of men and women in Hamadan province to be 68.47 and 74.04 for males and females, respectively with the difference of 5.57 yr, close to our results.[17] The mean gap between male and female life expectancy is about 6 yr for developed countries, while, this value is less than 2 yr for under-developed ones.[18] For example, in the U.S. male life expectancy was 73.4 years for males and 80.1 years for females, a gap of 6.7 years, whereas in France it was 7.8 years and in the U.K., 5.3 years. This difference is 0.6 and 0.1 yr for India and Bangladesh, respectively.[19]This gap between male and female life expectancy may be explained by a number of different factors.The variety in the worldwide longevity of females indicates that the difference in mortality between the sexes depends on biological, genetic and social factors.[19] Access to safe drinking water, reducing mortality, access to health facilities, as well as micronutrients,

enhance literacy rate and increased proportion of women in society especially decision-making and executive positions tend to increase the life expectancy of women in developed communities.[18] Mortality rateUnder-five years is very important among community development indicators because it represents important factors such as quality of life, income, culture and education of the women. Decrease in mortality rate under-five years is another effective factor that has been enhancing the life expectancy of women.According to the World Bank, in Iran, this indicator has reached from 77 to 16 over a 30 years period, 1985-2015.[20]

In conclusion, the current study showed more adjusted life expectancy at birth for women compared to Statistical Center of Iran and WHO reports. However, this amount was slightly lower for men compared to the numbers reported in mentioned resources. Therefore, it seems that there is no considerable difference between life expectancy of Aran-Bidgol population and the national average life expectancy.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ACKNOWLEDGEMENT

This study is a part of the PhD dissertation, supported by Deputy of Research Kashan University of Medical Sciences (Grant no: 92173). The authors also express their gratitude to the staff of Deputy of health of the university for their assistance in data gathering.

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How to cite the article: Mahdian M, Sehat M, Fazel MR, Rahimi H, Mohammad Zadeh M. Life expectancy at birth in Aran-Bidgol region, Iran, 2012: A study based on corrected Health Houses data. Int J Epidemiol Res. 2016; 3(3): 259-267.