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Estimation life expectancy in Gaza Strip using Brass growth balance method

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ABSTRACT

Life expectancy is an important demographic indicator that is used for comparison between different population groups. A life table is designed mainly to measure a life expectation. Incompleteness of death registration is causing a problem to estimate the life expectancy.

In this paper, we estimated the life expectancy for Gaza strip using population and mortality data from the Ministry of Health. Estimation of the corrected life expectancy in Gaza strip was conducted by correcting the incompleteness of death registration by Brass growth balance method. By using Brass growth balance method the uncertainty interval was much smaller than that computed without correcting underreporting. The estimate of life expectancy at birth for the total population of Gaza strip in 2006 is about 1.41 year higher than the estimation when correcting underreporting with Brass growth balance method. It is about 2.2 year higher for males and only 0.35 year for females. It is found that this difference is statistically significant for males and both sexes only.

Keywords:
Life expectancy - abridged life table - Brass growth balance method – crude mortality rate - incompleteness of death registration.

تقدير متوسط العمر المتوقع في قطاع غزة باستخدام طريقة ميزان نمو براس

الدكتور عبدالله محمد الهبيل
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المستخلص

يعتبر مقياس متوسط العمر المتوقع مؤشر ديموغرافي مهم يستخدم للمقارنة بين المجموعات السكانية المختلفة، وقد صممت جداول الحياة بالاساس لتقدير متوسط العمر المتوقع، في حين أن عدم اكتمال تسجيل الوفيات يتسبب في عدم دقة تقدير هذا المقياس.

تم تقدير في هذه الورقة البحثية متوسط العمر المتوقع في قطاع غزة للعام ٢٠٠٦ باستخدام بيانات السكان والوفيات من وزارة الصحة في فلسطين، ثم بعد ذلك تم تصحيح عدم

تأريخ استلام البحث ٢٠١١/٦/٢ تأريخ قبول النشر ٢٠١١/١٠/٤

اكتمال تسجيل الوفيات باستخدام طريقة براس لتوازن النمو، ومن ثم قدرنا متوسط العمر المتوقع المعدل، حيث وجدنا أن فترات الثقة لمتوسط العمر المتوقع أصغر بشكل ملحوظ بعد التعديل عنها قبل التعديل، وكذلك اتضح لنا أن تقدير متوسط العمر المتوقع لسكان قطاع غزة في العام ٢٠٠٦ يزيد ١.٤١ سنة قبل التعديل عنه بعد التعديل، حيث أنه يزيد ٢.٢ سنة في حالة الذكور و ٠.٣٥ سنة في حالة الإناث. واتضح من خلال الاختبار الإحصائي أن هذا الاختلاف بين التقديرين هو اختلافا معنويا في حالة الذكور وكلا الجنسين فقط.

الكلمات المفتاحية:

متوسط العمر المتوقع - طريقة ميزان نمو براس - جداول الحياة.

Estimation life expectancy in Gaza Strip using Brass growth balance method

1. Introduction

Life expectancy is an important demographic indicator that is used for comparison between different population groups. It is defined as the average of years a cohort of people might expect to live according to the current age-specific mortality rates. By using World Health Organization (WHO) definition (2003), “life expectancy is average number of years that a newborn is expected to live if current mortality rates continue to apply". Life expectancy is one of three indicators adopted by United Nations Development Programme (UNDP) 1990 to determine the status of human development in the particular country.

Countries are often interested in calculating life expectancy, as to the significance of this demographic indicator in the formulation of health policy in the country, the life tables is one of the most important tool of calculating the life expectancy. Many researchers have focused on life expectancy; Pourmalek and others (2009) estimated the life expectancy for 2003 for 23 provinces in Iran, using population and mortality data from the Ministry of Health and Medical Education. The underreporting of deaths above 4 years was corrected using the Brass Growth Balance method; they estimated life expectancy at birth to be 71.56 years for the total population. Their estimates were higher than the model-based estimates of the Statistical Centre of Iran, United Nations agencies and the World Bank. Abdalla and Shaheen (2007) proposed a study paper on completeness of adult death registration in Sudan in 2002. They used Brass Growth Balance method. Partial birth and death rates were calculated from registered deaths in 2002 and total mid-year population projections. Linear regression of partial birth rates and partial death rates was used to calculate the completeness of death registration. The analysis showed that only 4.4% of deaths were registered and registration completeness was more for male deaths (6.5%) than for female deaths (2.8%). Beaie (2008) done a working paper about mortality in Guyana, it was produced by Bureau of Statistics, he calculates the age specific death rates, and construct a life table for Guyana. He concludes that a new born baby boy and girl in Guyana are expected to life up to 63.36 and

68.96 respectively. Habib Ullah and Zafar (2003) did a study about estimation of infant and child mortality. Abridged life table for both sexes, separate for males and females have been constructed to study the mortality pattern at different ages, they found that the level of infant and child mortality are still very high in Pakistan, life expectancy at birth still low compared to many developing countries. Milanović and others (2006) examined the differences in life expectancy and mortality between the populations on Croatian islands and the mainland and among the islands themselves, they used life table and standardized mortality rates to analyze data on population size and mortality collected in Croatia in 2001. The analysis shows that life expectancy at birth of the population on Croatian islands was 76.4 year, which was significantly higher than life expectancy at birth of general Croatian population which was 73.8 year, or mainland Croatian population which was 73.7 year. Traditionally, demographic estimation has been based on data collected by censuses and by a vital registration system. A continuous registration system usually has the task of recording vital events (deaths), Assuming that, both the registration of vital events and the census counts were perfect, demographic parameters specially life expectancy could be estimated directly from the data reported. Some of the possible deficiencies of a vital registration system, where it exists at all, may be outlined. The main deficiency is its failure to record all data of deaths. Incompleteness of death registration is causing a problem of estimating the life expectancy, therefore we will find away to estimate the life expectancy for people in Gaza strip using Ministry of Health (MOH) death registration by using abridged life table after making correction for the incompleteness of deaths by brass growth balance method. Therefore, the research problem is:

By using real data, how can we apply a statistical method for estimating the corrected life expectancy?

The paper is organized as follows: Section 2 recalls definitions, Section 3 data analysis. Section 4 concludes.

2. Definitions

Here, we will give an overview of some definitions are related to life expectancy.

Life expectancy

Life expectancy is defined as the average of years a cohort of people might expect to live according to the current age-specific mortality rates. Life expectancy is using for comparison between countries, and socio-economic levels. It represents the average life span of a newborn and is an indicator of the overall health of a country (UNDP, 1990). Life expectancy reflects the overall mortality level. Life expectancy is declining due the events that occur on the country like famine, war, disease and poor health (Habib, 2007). Life expectancy is the main outcome measure of life table analysis.

Life table

Life tables models are widely using in demographic studies, mainly in the measurement of mortality. Where is the main entry to life tables are the variable of deaths and the variable of age. Life table is illustrating several statistical issues. It is principally designed particularly to measure the level of mortality of the population involved and life expectation (Siegel and Swanson, 2004). It is a fictitious pattern reflecting the mortality experience of a real population during the interval of age. It is an effective means of summarizing mortality and survival experience of a population and is a sound of basis for making statistical inference about the specific population under the study (UN, 1980). It is based on probabilities of dying, the probability that an individual alive at age x dies before reaching his or her next birthday (age x + 1). Keyfitz and Caswell (2004) state that the probability of surviving from birth to age x is designated as l(x) for a continuous function of x and as l_x for discrete x, it most commonly starting with fixing number 10,000 or 100,000 which is called a radix. There are two kinds of life tables exist, called cohort and current life tables: The cohort life table which describes the actual survival experience of a group or cohort of individuals born at about the same time. It is generated from cumulative data of survival times from the birth of the first member of a population until the death of the last member. And the current life table which is derived from current mortality data of specific population, it is an excellent description of mortality in a year (complete life table) or a short period (abridged life table). An abridged life table is based on a sequence of age intervals of any chosen length, 5 or 10 years of age for most of the age range. Demographers usually prepare the simpler abridged life table rather than the more elaborate complete life table.

Incompleteness of death registration

In many development countries mortality measures and the analysis of the death statistics depend on the availability of appropriate population data from a census, or population estimates. The registration of deaths may be incomplete because of failure to cover the entire geographic area of the country or all groups in the population and failure to register all of the vital events in the established registration area. Demographers suggested methods to solve this problem. One of these methods is Brass growth balance method.

Brass growth balance method

The simplest way of calculating mortality rates is by using the data on deaths and age from vital registration system, but the reported death is usually underestimate of the real death rate. With underreporting of death we fall in a problem with a bias estimate of life of expectancy because the survival function l_x will fall slowly as age increase (UN, 1983).

Brass (1975) proposed the Growth Balance method, this method is based on the stable population equations.

$$\frac{N(x)}{N(x+)} = r + \frac{D^{*}(x+)}{N(x+)} \qquad (2.1)$$

Where N(x) is the number of persons of exact age x; N(x+) is the total number of persons aged x and over, $D^{*}(x+)$ is the total number of deaths at age x and over, and r is the growth rate. N(x)/N(x+) can be interpreted as a "birth rate" for the population aged x and over, and $D^{*}(x+)/N(x+)$ is the "death rate" corresponding to the same population, r(x+) denotes to the growth rate for population aged x and over.

Brass estimates the completeness of death recording and provides an actual adjustment factor for the deaths relating between the N(x)/N(x+) and $D^{*}(x+)/N(x+)$ (Hill, 2001).

If deaths are reported with completeness C(x) of registration at age x and over, assumed constant by age at least over age 5, so $D^{*}(x+) = D(x+)/C(x)$, here D(x+) is the reported deaths at ages x and over. If we replace constant c with C(x), let K = 1/c, then, K here refers to correction coefficient for deaths registered, so the equation (2.1) will be

$$\frac{N(x)}{N(x+)} = r + K\frac{D(x+)}{N(x+)} \qquad (2.2)$$

Where N(x) is the population at an age x during the course of year under consideration, when the total of population is the classified by n years of ages, so N(x) can be estimated as

$$N(x) = \frac{{}_nN_{x-n} + {}_nN_x}{2*n}$$

N(x+) is the total number of persons aged x and over, and D(x+) is the total number of deaths after an exact age, so if the data is classified by n years of age groups, then

$$N(x+) = \sum_{j=x}^{A-5} {}_nN_j + N(A+)$$

$$D(x+) = \sum_{j=x}^{A-5} {}_nD_j + D(A+)$$

Where N (A+) is the number of persons in the last open ended age group, and D (A+) is the deaths in the open ended age interval A and over. From equation (2.2) the relationship between the entry rate or birth rate and reported death rate is linearity. To display the relation graphically by plotting D(x+)/N(x+) and N(x)/N(x+), there are many methods to fit a line defined by points [N(x)/N(x+), D(x+)/N(x+)] such as least square method (LS) (UN, 1983).

3. Data analysis

We will start with the data requirements to generate the life table, and its functions and then estimates the completeness of death registration using the Brass growth balance method.

The main data sources in the generation of the life tables are the deaths and the population data.

To construct an abridged life table, the data used was estimated population data in 2006 based on 1997 census conducted by Palestinian Central Bureau of Statistics (PCBS), and registered deaths available in the Ministry of Health (MOH) through the vital registration system by age and sex. The source of these data is from the electronic version of the Statistical Health Reports (Annul Report 2006) [http://www.pcbs.gov.ps]. The data are derived from sets of tables: population by age and sex, and deaths by sex and age. The live population data are available by 5-year age group with the exception of age 80 and above. The death data were divided into five-year age categories running from 0-4, 5-9, and so on, up to the age category of 80 and more. Stats direct statistical Software was used to perform and generate life tables functions.

Table 1
Distribution of population and Deaths by gender and age group in Gaza strip (2006)

	Male		Female		Total		Age Specific Death Rates		
	Population	Death	Population	Death	Population	Death	Male	Female	Total
0-4	140,325	633	134,616	457	274941	1090	4.51	3.40	3.96
5-9	118,578	50	113,866	35	232444	85	0.42	0.31	0.37
10-14	100,173	56	97,422	38	197595	94	0.56	0.39	0.48
15-19	82,510	196	80,047	41	162557	237	2.38	0.51	1.46
20-24	64,243	215	61,212	26	125455	241	3.35	0.43	1.92
25-29	51,040	128	49,623	23	100663	151	2.51	0.46	1.50
30-34	40,706	88	40,074	30	80780	118	2.16	0.75	1.46
35-39	32,720	62	31,546	28	64266	90	1.90	0.89	1.40
40-44	29,816	68	26,863	36	56679	104	2.28	1.34	1.84
45-49	21,851	80	20,030	43	41881	123	3.66	2.15	2.94
50-54	15,501	82	15,061	59	30562	141	5.29	3.92	4.61
55-59	11,536	124	12,302	111	23838	235	10.75	9.02	9.86
60-64	7,068	122	8,876	134	15944	256	17.26	15.10	16.06
65-69	5,237	147	7,619	206	12856	353	28.07	27.04	27.46
70-74	4,792	220	6,209	193	11001	413	45.91	31.08	37.54
75-79	2,845	224	4,171	244	7016	468	78.74	58.50	66.71
80+	2,287	150	3,049	436	5336	586	65.59	143.00	109.82
Unknown		14		7		21			
Total	731,228	2659	712,586	2147	1,443,814	4806	3.64	3.01	3.33

Number of deaths is based on information from all death certificates which was reported in Gaza Governorates. Table (1) shows the distribution of the deaths by gender and age group (each group contains of five-year age groups except 80+, start from 0-4 group and end with up to 80), 4806 persons died in Gaza strip (2659 males, 2147 females), out of them 21 people died and misreporting their age (14 male, 7 female).

The population of the 5 provinces of Gaza strip in 2006 was 1,443,814 persons, the crude mortality rate was 3.33 per 1000, Mortality rates for children under 5 years 4.51 and 3.40 per 1000 for male and female respectively, the death rate of a particular age group is referred as an age specific death rate. It is derived by dividing the total deaths in each age group by the corresponding total population in the same age group.

Abridged life tables for both sexes, separate for males and females have been constructed to study the mortality pattern at different ages according to registered death and adjusted death. The key step of life table construction is the derivation of $_nq_x$, the probability of dying, which shows the proportion of a cohort alive at the beginning of an indicated age interval, who will die before reaching the end of that age interval.

Table 2
Abridged Life Table Based on Registered Deaths and Population Distribution for Gaza Strip, males: 2006

Interval	Death Rate	Probability of dying	Standard error of ($_nq_x$)	Alive at start	Dying in interval	Fraction	Years in interval	Years beyond	Life expectancy	Variance of life expectancy	95 % Confidence Interval	
	$_nm_x$	$_nq_x$	SEq	l_x	d_x	$_nf_x$	$_nL_x$	T_x	e_x	Var(e_x)	LCI (e_x)	UCI (e_x)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
0 to 4	0.0045	0.0223	0.00088	100000	2230.326	0.5	494434.2	7371100	73.71	0.1187	73.04	74.39
5 to 9	0.0004	0.0021	0.00030	97769.67	205.9124	0.5	488331.6	6876766	70.34	0.1199	69.66	71.01
10 to 14	0.0006	0.0028	0.00037	97563.76	272.3262	0.5	487138	6388433	65.48	0.1200	64.80	66.16
15 to 19	0.0024	0.0118	0.00084	97291.44	1148.742	0.5	483585.3	5901295	60.66	0.1201	59.98	61.34
20 to 24	0.0025	0.0124	0.00112	96142.69	1195.44	0.5	477724.9	5417709	56.35	0.1201	55.67	57.03
25 to 29	0.0025	0.0125	0.00118	94947.25	1178.159	0.5	471790.9	4939984	52.26	0.1202	51.58	52.94
30 to 34	0.0022	0.0108	0.00114	93769.09	1003.822	0.5	464335.9	4471194	47.89	0.1206	47.21	48.57
35 to 39	0.0019	0.0094	0.00119	92765.27	870.9729	0.5	459648.9	4006853	43.38	0.1205	42.70	44.06
40 to 44	0.0023	0.0115	0.00132	91894.3	1057.42	0.5	456828	3547209	38.77	0.1206	38.09	39.45
45 to 49	0.0037	0.0181	0.00201	90836.88	1640.867	0.5	450082.2	3090381	34.19	0.1205	33.51	34.87
50 to 54	0.0053	0.0261	0.00284	88516.01	2318.313	0.5	435282.5	2644143	29.77	0.1206	29.09	30.45
55 to 59	0.0107	0.0523	0.00157	86197.5	4527.156	0.5	421169.7	2205865	25.50	0.1205	24.82	26.18
60 to 64	0.0175	0.0827	0.00318	81670.36	6081.761	0.5	393891.4	1784695	21.77	0.1204	21.09	22.45
65 to 69	0.0281	0.1311	0.01010	75188.6	9860.531	0.5	351291.6	1391798	18.51	0.1161	17.84	19.18
70 to 74	0.0459	0.2059	0.01237	65328.02	13452.05	0.5	293010	1040506	15.93	0.1081	15.28	16.57
75 to 79	0.0787	0.3289	0.01500	51875.95	17063.16	0.5	216721.2	747496	14.41	0.1021	13.78	15.04
80 up	0.0656	1.0000	*	34812.51	34812.51	*	530774.8	530774.8	15.25	*	*	*

Table 3
Abridged Life Table Based on Registered Deaths and Population Distribution for Gaza Strip, females: 2006

Interval	Death Rate	Probability of dying	Standard error of (nqx)	Alive at start	Dying in interval	Fraction	Years in interval	Years beyond	Life expectancy	Variance of life expectancy	95 % Confidence Interval	
	nmx	nqx	SEq	lx	dx	nfx	nLx	Tx	ex	Var(ex)	LCI (ex)	UCI (ex)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
0 to 4	0.0034	0.016831	6.09E-07	100000	1683.136	0.5	495792.2	7530540	75.3054	0.056501	74.83951	75.77128
5 to 9	0.0003	0.001536	6.75E-08	98316.86	150.9866	0.5	491206.9	7034748	71.55179	0.054995	71.09216	72.01142
10 to 14	0.0004	0.001948	9.57E-08	98165.88	191.2645	0.5	490351.2	6543541	66.658	0.054841	66.19901	67.11698
15 to 19	0.0005	0.002558	1.59E-07	97974.61	250.5917	0.5	489246.6	6053189	61.78324	0.054647	61.32509	62.2414
20 to 24	0.0004	0.002122	1.73E-07	97724.02	207.3229	0.5	488101.8	5563943	56.93526	0.054358	56.4783	57.39222
25 to 29	0.0005	0.002315	2.32E-07	97516.7	225.7308	0.5	487019.2	5075841	52.05099	0.054073	51.59523	52.50675
30 to 34	0.0007	0.003736	4.64E-07	97290.97	363.4831	0.5	485546.1	4588822	47.16596	0.053718	46.71157	47.62035
35 to 39	0.0009	0.004428	6.97E-07	96927.48	429.2082	0.5	483564.4	4103276	42.33346	0.053213	41.88134	42.78558
40 to 44	0.0013	0.006678	1.23E-06	96498.27	644.4436	0.5	480880.3	3619711	37.51063	0.052561	37.06129	37.95998
45 to 49	0.0021	0.010677	2.62E-06	95853.83	1023.393	0.5	476710.7	3138831	32.74602	0.051721	32.30028	33.19176
50 to 54	0.0039	0.019397	6.25E-06	94830.44	1839.43	0.5	469553.6	2662120	28.07243	0.050559	27.63268	28.51217
55 to 59	0.0090	0.044119	1.68E-05	92991.01	4102.707	0.5	454698.3	2192567	23.57827	0.047928	23.14919	24.00735
60 to 64	0.0151	0.072739	3.66E-05	88888.3	6465.656	0.5	478277.4	1737869	19.55115	0.043553	19.14221	19.96009
65 to 69	0.0270	0.126629	6.8E-05	82472.64	10437.09	0.5	386620.5	1309591	15.88874	0.036257	15.51566	16.26181
70 to 74	0.0311	0.144213	9.22E-05	71985.55	10381.24	0.5	333974.6	923570.8	12.82995	0.026555	12.51056	13.14934
75 to 79	0.0585	0.255177	0.000199	61604.31	15719.99	0.5	268721.6	589596.1	9.570696	0.017913	9.308377	9.833015
80 up	0.1430	1	*	45884.32	45884.32	*	320874.5	320874.5	6.993119	*	*	*

Table 4
Abridged Life Table Based on Registered Deaths and Population Distribution for Gaza Strip, both sexes: 2006

Interval	Death Rate	Probability of dying	Standard error of (nqx)	Alive at start	Dying in interval	Fraction	Years in interval	Years beyond	Life expectancy	Variance of life expectancy	95 % Confidence Interval	
	nmx	nqx	SEq	lx	dx	nfx	nLx	Tx	ex	Var(ex)	LCI (ex)	UCI (ex)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
0 to 4	3.96	0.0196	0.00059	100000.00	1962.79	0.5	495093.03	7391252.22	73.91	0.0370	73.54	74.29
5 to 9	0.37	0.0018	0.00020	98037.21	179.09	0.5	489738.35	6896159.19	70.34	0.0366	69.97	70.72
10 to 14	0.48	0.0024	0.00024	97858.12	232.49	0.5	488709.30	6406420.86	65.47	0.0365	65.09	65.84
15 to 19	1.46	0.0073	0.00047	97625.63	709.08	0.5	486355.46	5917711.47	60.62	0.0365	60.24	60.99
20 to 24	1.92	0.0096	0.00061	96916.55	926.44	0.5	482266.66	5431356.01	56.04	0.0363	55.67	56.41
25 to 29	1.50	0.0075	0.00061	95990.11	717.26	0.5	478157.41	4949089.34	51.56	0.0358	51.19	51.93
30 to 34	1.46	0.0073	0.00067	95272.85	693.32	0.5	474630.96	4470931.93	46.93	0.0355	46.56	47.30
35 to 39	1.40	0.0070	0.00075	94579.53	659.95	0.5	471247.78	3996300.97	42.25	0.0351	41.89	42.62
40 to 44	1.84	0.0091	0.00089	93919.58	857.73	0.5	467453.59	3525053.19	37.53	0.0347	37.17	37.90
45 to 49	2.94	0.0146	0.00130	93061.85	1356.60	0.5	461917.76	3057599.60	32.86	0.0343	32.49	33.22
50 to 54	4.61	0.0228	0.00190	91705.25	2091.32	0.5	453297.95	2595681.84	28.30	0.0337	27.94	28.66
55 to 59	9.86	0.0481	0.00306	89613.93	4310.92	0.5	437292.34	2142383.90	23.91	0.0327	23.55	24.26
60 to 64	16.06	0.0772	0.00463	85303.01	6583.93	0.5	410055.22	1705091.56	19.99	0.0308	19.64	20.33
65 to 69	27.46	0.1285	0.00638	78719.08	10113.13	0.5	368312.59	1295036.35	16.45	0.0271	16.13	16.77
70 to 74	37.54	0.1716	0.00769	68605.96	11773.07	0.5	313397.09	926723.74	13.51	0.0220	13.22	13.80
75 to 79	66.71	0.2859	0.01117	56832.88	16245.90	0.5	243549.65	613126.66	10.79	0.0168	10.53	11.04
80 up	109.82	1	*	40586.98	40586.98	*	369577.00	369577.00	9.11	*	*	*

Calculating $_nq_x$

The symbol $_nq_x$ represents the conditional probability that a member of the life table cohort who is alive at age x dies before age x+n. In symbols,

P (death before age x + n | alive at age x) = $_nq_x = {}_nd_x / l_x$

$_nd_x$ is the number out of the artificial cohort die within the indicated age interval (x to x + n)

l_x is the number out of the artificial cohort alive at age x

The relationship between $_nq_x$ and $_nm_x$ can be determined by the following equation
(WHO, 1980)

$$_nq_x = \frac{_nm_x}{\frac{1}{n} + 0.5 \ * \ _nm_x} \qquad (3.1)$$

$$_nm_x = \frac{_nd_x}{_nL_x} = \frac{_nD_x}{_nP_x} = {}_nM_x$$

Where n is the length of the interval, $_nm_x$ is the age-specific death rate in the life table population, $_nM_x$ is the death rate in the interval, $_nL_x$ The total number of years lived during the indicated age interval, $_nD_x$ is the observed number of deaths in age interval (x to x+ n), $_nP_x$ is the For example, according to registered death $_nq_4$ is the proportion of male dying between exact age 0 and 4, by using equation (3.1), an estimate of child mortality for males is

$$_nq_4 = \frac{0.0045}{\frac{1}{5} + 0.5 * 0.0045} = 0.0223$$

This means that, out of every 10,000 males born, 223 will die before reaching their 4^{th} birthday. And so on the $_nq_{29}$ the probability of male dying between exact age 25 and 29 is

$$_nq_{29} = \frac{0.0025}{\frac{1}{5} + 0.5 \ * \ 0.0025} = 0.01246$$

Similarly, an estimate of child mortality for female is

$$_nq_4 = \frac{0.0034}{\frac{1}{5} + 0.5 \ * \ 0.0034} = 0.0168$$

This means that, out of every 10,000 females born, 168 will die before reaching the 4th birthday, (see columns 3 in tables (3.2) to (3.4)).

The graphical features of these probabilities are illustrated in figure (3.1), and are seem to depict a concave pattern.

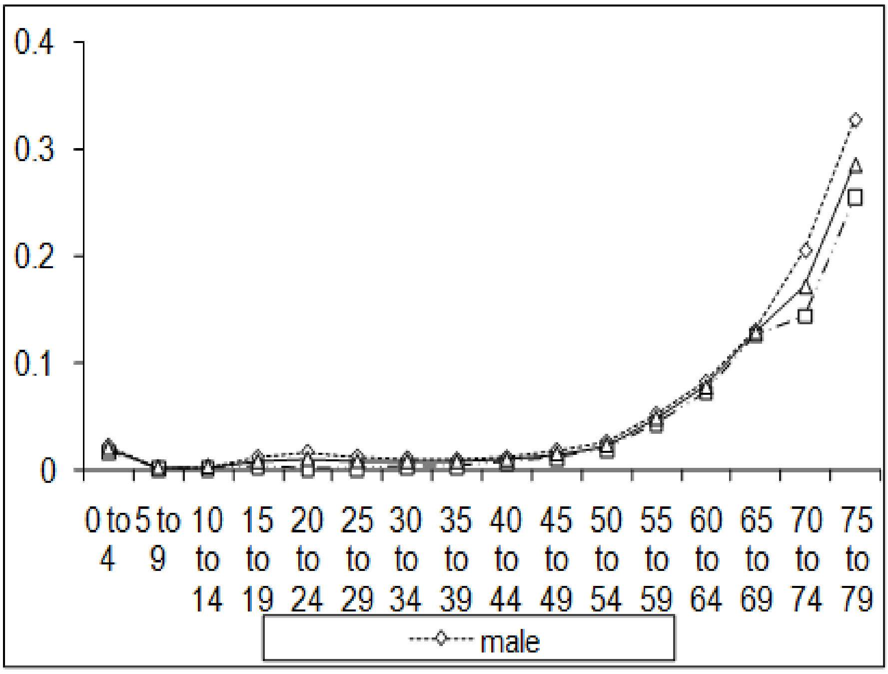

Figure 1
Plot of probabilities of death, Gaza Strip, 2006

probabilities of dying can be applied to census or survey population age distributions to derive an estimated mortality. For instance, in table (1), the male population in age group, 20-24 years is 64,243 persons, but the corresponding probability of dying shown in table (2) is 0.01659. Applying this rate to the population means that, out of those who are alive and passing through 20-24 years, about 1066 will die before reaching their 25^{th} birthday, while 63,177 will survive to celebrate the 25^{th} birthday.

Calculating the variance of $_nq_x$

To calculate a variance of the probability of dying we will use the equation which obtained according to Chiang's method (1968)·

$$Var({}_nq_x) = \frac{{}_nq_x^2 * (1 - {}_nq_x)}{{}_nD_x} = Var({}_np_x) \qquad (3.2)$$

By using equation (3.2), the variance of the probability of male dying between exact age 0 and 4 is

$$Var({}_nq_4) = \frac{{}_5q_4^2 * (1 - {}_5q_4)}{{}_5D_4} = \frac{0.0223^2 * (1 - 0.0223)}{633} = 7.683E - 007$$

And so on the variance of the probability of male dying between exact age 15 and 19 is

$$Var({}_nq_{19}) = \frac{{}_5q_{19}^2 * (1 - {}_5q_{19})}{{}_5D_{19}} = \frac{0.0118^2 * (1 - 0.0118)}{196} = 7.0202E\text{-}007$$

Similarly, the variance of the probability of female dying between exact age 0 and 4 is

$$Var({}_nq_4) = \frac{{}_5q_4^2 * (1 - {}_5q_4)}{{}_5D_4} = \frac{0.0168^2 * (1 - 0.0168)}{457} = 6.0937E - 007$$

And at the same age interval for both sexes the variance of the probability of dying is

$$Var({}_nq_4) = \frac{{}_5q_4^2 * (1 - {}_5q_4)}{{}_5D_4} = \frac{0.0196^2 * (1 - 0.0196)}{1090} = 3.4553E - 007$$

Estimation of life expectancy e_x

The expectation of life at age x, (e_x-value) summarizes life table survival in terms of mean additional years of remaining lifetime from age x. This mean value is calculated just like any mean value. It is

$$e_x = \frac{\text{total person-years lived beyond age x}}{\text{number of persons of age x}} = \frac{T_x}{l_x} \qquad (3.3)$$

Where T_x is a total time lived beyond age x by all individuals who are age at x. The value T_x is the sum of the total person-years-at-risk lived in each age interval starting at age x.

In symbols,

$$T_x = L_x + L_{x+1} + L_{x+2} + \ldots.. L_w \qquad (3.4)$$

w denote to the lower boundary of the upper age group.

$$L_x = 5 * (l_x + {}_nd_x) + 0.5 * 5 *_n d_x \qquad (3.5)$$

The accumulated time lived, T_x, is primarily a computational step in the life table construction.

To calculate a life expectancy we need at first find to T_x and L_x, by using equation (3.4) and equation (3.5) we will get values of T_x and L_x in the abridged life tables (see columns 8,9 in tables (3.2) to (3.4)).

So the estimation of life expectancy for males at birth is

$$e_0 = \frac{T_0}{l_0} = \frac{7371190}{100000} = 73.71$$

The estimation of life expectancy for females at birth is

$$e_0 = \frac{T_0}{l_0} = \frac{7530540}{100000} = 75.31$$

And the estimation of life expectancy for both sexes is

$$e_0 = \frac{T_0}{l_0} = \frac{7391252}{100000} = 73.91$$

The value of life expectancy is rounded to one or two decimals according to the size of the population and the accuracy of the original data.

Calculating the variance of e_x

According to Chiang's (1984) the variance of life expectancy is

$$Var(e_x) = \frac{\sum_{a=x}^{w-n} l_a^2 \left[e_{a+n} + 2.5\right]^2}{l_x^2} Var({}_n p_a) \qquad (3.6)$$

where w denotes the final age interval.

By using equation (3.6) the variance of the life expectancy at 65 for males is

$$Var(e_{65}) = \frac{\sum_{a=65}^{75} l_a^2 \left[e_{a+5} + 2.5\right]^2}{(75188.604)^2} Var({}_5 p_a) = 1*(2.5+15.93)^2*(0.000102) +$$

$$(\frac{65328.02}{75188.604})^2*(2.5+14.41)^2*(0.000153) + (\frac{51875.978}{75188.604})^2*(2.5+15.25)^2*(0.000324) = 1.11615$$

And similarly, we can calculate the variance of e_x at any interval of age. (See columns 11 in tables (2) to (4)).

Estimation of uncertainty limits

One important use of the standard error of a life expectancy is to determine boundaries of the uncertainty intervals (UI), UI provides explicit characterizations of the precision around estimates derived from limited information sources. By using Chiang's variance estimate the 95% UI can be calculated by using the equation:

$$e_x \pm Z_{\frac{\alpha}{2}} * SE_e \qquad (3.7)$$

Where as Z is normal deviate, and α is the probability of normal deviate being greater than |Z|. It is customary to select α = 0.05, hence Z = 1.96.

So 95% UI for life expectancy at birth for both sexes to first class is

$$73.91 \pm 1.96 \ * \sqrt{\text{Var}(e_x)} = 73.91 \pm (1.96 \ * \sqrt{0.0370}) = (73.54,\ 74.29)$$

Table (3.5) shows an estimate of child mortality for Gaza strip is 20 deaths for every 1000 children under 5 years. The estimate of child mortality for male and female were 22.3 per 1000 and 16.8 per 1000 respectively. Life expectancy was 73.9 years, while it was 73.7 for males and 75.3 for females.

Table 5
Estimate of child mortality per 1000 and life expectancy at birth for Gaza strip, 2006

	Total	Male	Female
Child mortality (0-4) years	19.6	22.3	16.8
Life expectancy	73.9	73.7	75.3
95 % C.I	73.54 - 74.29	73.04 – 74.39	74.84 - 75.77

Correction for the under-reporting of deaths

The simplest way of calculating mortality rates is by using the information on deaths by age produced by a vital registration system, However registration of deaths in many developing countries is often incomplete, and even when reporting is adequate, information regarding age is immediately inaccurate and the death rate implied by the reported deaths is usually an underestimate of the true death rate. If deaths are underreported, the survival function, lx, will fall too slowly as age increases and estimates of life expectancy will be biased upward. Some methods of adjustment are required to transform the reported death rate into a better estimate of true mortality conditions. One of these methods is Brass growth balance method.

Calculating partial birth rate

The calculation of the partial birth rate, N(x)/N(x+), where N(x) is the population at an age x during the course of year under consideration, when the total of population is the classified by 5 years of ages, and N(x+) is the total number of persons aged x and over so

$$N(x) = \frac{{}_5N_{x-5} + {}_5N_x}{10} \qquad (3.8)$$

And

$$N(x+) = \sum_{j=x}^{75} {}_5N_j + N(80+) \qquad (3.9)$$

Where as 5Nx is a population at exact age.

By using equations (3.8) and (3.9), N(20) and N(20+) for males can be calculated as the following:

$$N(20) = \frac{{}_5N_{15} + {}_5N_{20}}{10} = \frac{82510 + 64243}{10} = 14675$$

$$N(20+) = \sum_{j=20}^{75} {}_5N_j + N(80+)$$

$$= 64243 + 51040 + 40706 + ... + 2287 = 289642$$

N(40) for female will be

$$N(40) = \frac{{}_5N_{35} + {}_5N_{40}}{10} = \frac{31546 + 26863}{10} = 5841$$

$$N(40+) = \sum_{j=40}^{75} {}_5N_j + N(80+)$$

$$= 26863 + 20030 + 15061 + ... + 3049 = 104180$$

And similarly by using the same equation, we can obtain all values for males, females, and both sexes of age x up to 80.

By using the values obtained the partial birth rates N(x) / N(x+) will be calculated. (See columns 4, 5, 8 in tables 3.6 to 3.8).

Calculating partial death rate

Partial death rate calculated as the ratio of deaths ages x and over to the population of the same ages. To calculate, D(x+) / N(x+), we need to calculate D(x+) is a total number of deaths after an exact age.

$$D(x+) = \sum_{j=x}^{75} {}_5D_j + D(80+) \qquad (3.10)$$

So D(20+) for male can be calculated by applying equation (3.10)

$$D(20+) = \sum_{j=20}^{75} {}_5D_j + D(80+) = 215 + 128 + ... + 224 + 150 = 1710$$

D (40+) for female will be

$$D(40+) = \sum_{j=20}^{75} {}_5D_j + D(80+) = 36 + 43 + 59 + ... + 244 + 436 = 1462$$

And similarly by using the same equation, we can obtain all values for males, females, and both sexes of age x up to 80.

By using the values obtained the partial death rates D(x+) / N(x+) will be calculated. (See columns 5, 6, 7 in tables (6) to (8)).

Table 6
Correction for the under-reporting of deaths of above 4 years age group, males in Gaza strip (2006)

Exact age (years)	Population	Registered death	Population at exact age x	Population at exact age x and above	Death at exact age x and above	Partial death rates	Partial birth rate	Adjusted deaths
x	$_5N_x$	$_5D_x$	N(x)	N(x+)	D(x+)	D(x+)/N(x+)	N(x)/N(x+)	Adj. $_5$Dx
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
0	140,325	633						
5	118,578	50	25890.3	590903	2012	0.0034	0.0438	55.5
10	100,173	56	21875.1	472325	1962	0.0042	0.0463	63
15	82,510	196	18268.3	372152	1906	0.0051	0.0491	221
20	64,243	215	14675.3	289642	1710	0.0059	0.0507	242
25	51,040	128	11528.3	225399	1495	0.0066	0.0511	144
30	40,706	88	9174.6	174359	1367	0.0078	0.0526	99
35	32,720	62	7342.6	133653	1279	0.0096	0.0549	70
40	29,816	68	6253.6	100933	1217	0.0121	0.0620	77
45	21,851	80	5166.7	71117	1149	0.0162	0.0727	90
50	15,501	82	3735.2	49266	1069	0.0217	0.0758	92
55	11,536	124	2703.7	33765	987	0.0292	0.0801	140
60	7,068	122	1860.4	22229	863	0.0388	0.0837	137
65	5,237	147	1230.5	15161	741	0.0489	0.0812	166
70	4,792	220	1002.9	9924	594	0.0599	0.1011	248
75	2,845	224	763.7	5132	374	0.0729	0.1488	252
80	2,287	150	513.2	2287	150	0.0656	0.2244	169

Table 7
Correction for the under-reporting of deaths of above 4 years age group, females in Gaza strip (2006)

Exact age (years)	Population	Registered death	Population at exact age x	Population at exact age x and above	Death at exact age x and above	Partial death rates	Partial birth rate	Adjusted deaths
x	$_5N_x$	$_5D_x$	N(x)	N(x+)	D(x+)	D(x+)/N(x+)	N(x)/N(x+)	Adj. $_5$Dx
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
0	134,616	457						
5	113,866	35	24848.2	577970	1683	0.0029	0.0430	36
10	97,422	38	21128.8	464104	1648	0.0036	0.0455	39
15	80,047	41	17746.9	366682	1610	0.0044	0.0484	42
20	61,212	26	14125.9	286635	1569	0.0055	0.0493	27
25	49,623	23	11033.5	225423	1543	0.0068	0.0492	24
30	40,074	30	8969.7	175800	1520	0.0086	0.0510	31
35	31,546	28	7162	135726	1490	0.0110	0.0528	29
40	26,363	36	5840.9	104180	1462	0.0140	0.0561	37
45	20,030	43	4689.3	77317	1426	0.0184	0.0607	44
50	15,061	59	3509.1	57287	1383	0.0241	0.0613	61
55	12,302	111	2736.3	42226	1324	0.0314	0.0648	115
60	8,876	134	2117.8	29924	1213	0.0405	0.0708	138
65	7,619	206	1649.5	21048	1079	0.0513	0.0784	213
70	6,209	193	1382.8	13429	873	0.0650	0.1030	199
75	4,171	244	1038	7220	680	0.0942	0.1438	252
80	3,049	436	722	3049	436	0.1430	0.2368	450

Table 8
Correction for the under-reporting of deaths of above 4 years age group, both sexes in Gaza strip (2006)

Exact age (years)	Population	Registered death	Population at exact age x	Population at exact age x and above	Death at exact age x and above	Partial death rates	Partial birth rate	Adjusted deaths
x	$_5N_x$	$_5D_x$	N(x)	N(x+)	D(x+)	D(x+)/N(x+)	N(x)/N(x+)	Adj. $_5Dx$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
0	274941	1090						
5	232444	85	50739	1168873	3695	0.0032	0.0434	94
10	197595	94	43004	936429	3610	0.0039	0.0459	104
15	162557	237	36015	738834	3516	0.0048	0.0487	263
20	125455	241	28801	576277	3279	0.0057	0.0500	268
25	100663	151	22612	450822	3038	0.0067	0.0502	168
30	80780	118	18144	350159	2887	0.0082	0.0518	131
35	64266	90	14505	269379	2769	0.0103	0.0538	100
40	56679	104	12095	205113	2679	0.0131	0.0590	115
45	41881	123	9856	148434	2575	0.0173	0.0664	137
50	30562	141	7244	106553	2452	0.0230	0.0680	157
55	23838	235	5440	75991	2311	0.0304	0.0716	261
60	15944	256	3978	52153	2076	0.0398	0.0763	284
65	12856	353	2880	36209	1820	0.0503	0.0795	392
70	11001	413	2386	23353	1467	0.0628	0.1022	458
75	7016	468	1502	12352	1054	0.0853	0.1459	519
80	5336	586	1235	5336	586	0.1098	0.2315	650

Adjustment of death rate

This technique estimates the completeness of reporting of deaths over age 5 years in relation to information on population (Brass, 1975). It compares the distribution of deaths in relation to the distribution of population, both by age.

Fitting a line by using least square (LS) method provides a best fit if the data only affected by random error. But real populations often diverge from the ideal conditions for applying this technique. Populations usually are not precisely stable, there is often age misreporting of the population and of deaths, and there is often differential completeness in the registration of population and of deaths by age, therefore demographers suggested another technique, separating the points into two groups, computing the average birth rate and death rate in each, and then fitting a straight line to the pairs of a points. The slope of the adjusted line would thus represent an average adjustment factor for registered deaths.

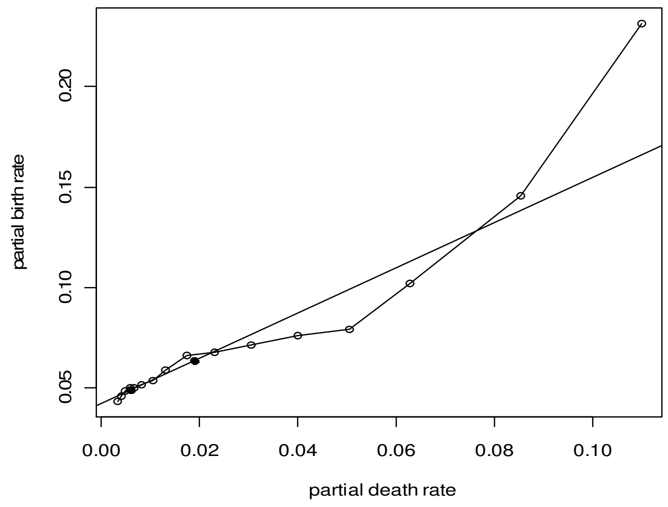

Figure 2
Plot of partial birth rates against partial death rates, both sexes

Adjustment of both sexes death rate

For total population, examination of the points shown in figure (2) suggests that there is diverge from linearity, therefore the points are divided into two equally sized groups, one comprising points for ages ranging from 10 to 34, the other from 35 to 59. The average partial death rate for the 5 age groups between 10 and 34 years (X1) is 0.00586 and the average partial birth rate for the 5 age groups between 10 and 34 years (Y1) is 0.0493. The average partial death rate for the 5 age groups between 35 and 59 years (X2) is 0.0188 and average partial birth rate for these groups (Y2) is 0.0638, therefore the slope of the fitted line is calculated according to the equation:

$$K = \frac{(Y_2 - Y_1)}{(X_2 - X_1)} = \frac{(0.0638 - 0.0493)}{(0.0188 - 0.00586)} = 1.11$$

This adjusted number of deaths should be used to calculate the age-specific mortality rates. by multiplying the number of deaths by the estimated adjustment factor for deaths. See column 9 in table (8)

The value of C implies that the completeness of death registration is

$$C = \frac{1}{K} = \%90$$

Adjustment of males' death rate

For males, examination of the points shown in figure (3) suggests that there is diverge from linearity, therefore the points are divided into two equally sized groups, one comprising points for ages ranging from 15 to 39, the other from 45 to 69. The average partial death rate for the 5 age groups between 15 and 39 years (X1) is 0.00701 and the average partial birth rate for the 5 age groups between 15 and 39 years (Y1) is 0.0517. The average partial death rate for the 5 age groups between 45 and 69 years (X2) is 0.0310 and average partial birth rate for these groups (Y2) is 0.0787, therefore the slope of the fitted line is calculated according to the equation

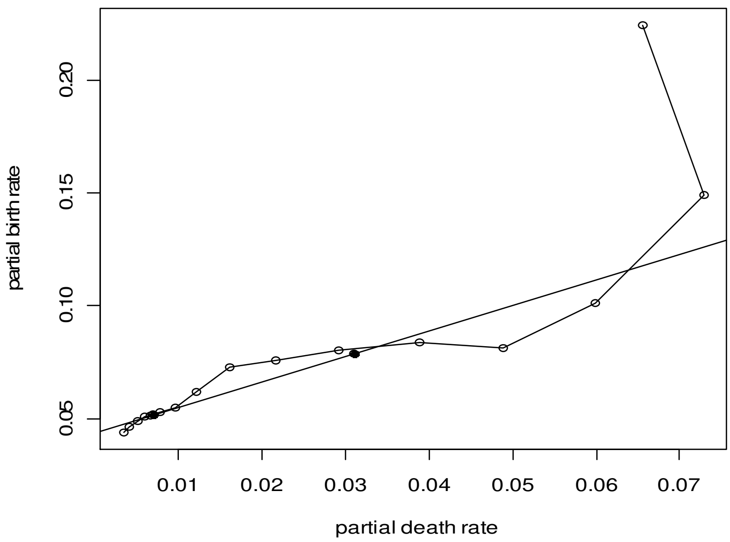

Figure 3
Plot of partial birth rates against partial death rates, males

$$K = \frac{(Y_2 - Y_1)}{(X_2 - X_1)} = \frac{(0.0787 - 0.0517)}{(0.0310 - 0.00701)} = 1.127$$

This adjusted number of deaths should be used to calculate the age-specific mortality rates, by multiplying the number of deaths by the estimated adjustment factor for deaths. See column 9 in table (6)

The value of C implies that the completeness of death registration is

$$C = \frac{1}{K} = \%88.7$$

Adjustment of females' death rate

For females, examination of the points shown in figure (4) suggests that there is diverge from linearity, therefore the points are divided into two equally sized groups, one comprising points for ages ranging from 5 to 44, the other from 45 to 80 and up. The average partial death rate for the 8 age groups between 5 and 44 years (X1) is 0.00710 and the average partial birth rate for the 8 age groups between 5 and 44 years (Y1) is 0.0494. The average partial death rate for the 8 age groups between 45 and 80+ years (X2) is 0.0585 and average partial birth rate for these groups (Y2) is 0.1024, therefore the slope of the fitted line is calculated according to the equation

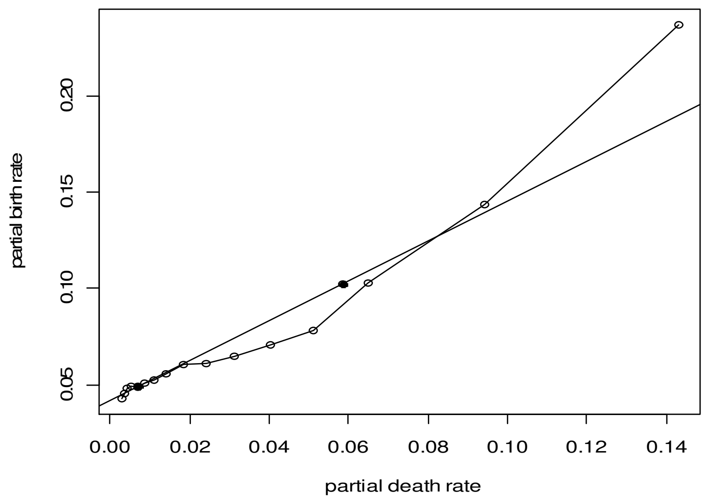

Figure 4
Plot of partial birth rates against partial death rates, females

$$K = \frac{(Y_2 - Y_1)}{(X_2 - X_1)} = \frac{(0.1024 - 0.0494)}{(0.0585 - 0.00710)} = 1.032$$

This adjusted number of deaths should be used to calculate the age-specific mortality rates, by multiplying the number of deaths by the estimated adjustment factor for deaths. See column 9 in table (7). The value of C implies that the completeness of death registration is

$$C = \frac{1}{K} = \%96.9$$

Estimation of life expectancy by corrected deaths

Applying abridged life table technique on the corrected deaths by using brass growth balance method, Tables 3.10, 3.11 and 3.12 show abridged life table based on corrected deaths and population distribution for Gaza Strip, for males, females and both sexes respectively.

Table (9) shows the point estimates and 95% uncertainty intervals (UI) of life expectancy at birth for the Gaza Strip in 2006 by sex. Life expectancy at birth was 72.5 years for the total population (95% UI: 72.14 to 72.87), 71.55 years for males (95% UI: 70.93 – 72.17), and 74.95 years for females (95% UI: 74.49 – 75.42).

Table 9
Estimate life expectancy at birth for Gaza strip 2006

SEX	Life expectancy	95 % C.I
Male	71.55	70.93 – 72.17
Female	74.95	74.49 -75.42
Overall	72.50	72.14 - 72.87

The statistical test for differences

Statistical test for differences in life expectancy at age x between two populations i and j is

$$z = \frac{e_{xi} - e_{xj}}{\left[\sqrt{(Var(e_{xi}) + Var(e_{xj}))}\right]} \qquad (3.11)$$

The hypotheses are:
H0: There is no difference, H1: There is a significant difference

We can obtain the statistical for the difference between two methods in estimate a life expectancy at birth by using equation (3.11).

The statistical test for the difference between two methods (before and after the correction of deaths registration) in life expectancy at birth for males is:
H0: There is no difference, H1: There is a significant difference

$$z = \frac{73.71 - 71.55}{\sqrt{[0.1187 + 0.10094]}} = 4.61$$

The value of the test statistic exceeds the critical value of 1.96, so we can conclude that this difference is statistically significant between the two methods.

The statistical test for the difference between two methods in life expectancy at birth for females is:

H0: There is no difference, H1: There is a significant difference

$$z = \frac{75.31 - 74.95}{\sqrt{[0.0565 + 0.05561]}} = 1.08$$

The value of the test statistic does not exceed the critical value of 1.96, and then we can't conclude that the difference is statistically significant between the two methods.

The statistical test for the difference between two methods in life expectancy at birth for both sexes is:

H0: There is no difference, H1: There is a significant difference

$$z = \frac{73.91 - 72.50}{\sqrt{[0.0370 + 0.0343]}} = 5.28$$

The value of the test statistic exceeds the critical value of 1.96, so we can conclude that there is a statistical significant difference between the two methods in life expectancy at birth for both sexes.

This was an evident and consistent finding of our study.

Table 10
Abridged Life Table Based on Corrected Deaths and Population Distribution for Gaza Strip, male: 2006

Interval	Death Rate	Probability of dying	Standard error of ($_nq_x$)	Alive at start	Dying in interval	Fraction	Years in interval	Years beyond	Life expectancy	Variance of life expectancy	95 % Confidence Interval	
	$_nm_x$	$_nq_x$	SE_q	l_x	d_x	$_nf_x$	$_nL_x$	T_x	e_x	$Var(e_x)$	LCI (e_x)	UCI (e_x)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
0 to 4	0.004511	0.0223	0.000377	100000	2230.326	0.5	494424.15	7155035.54	71.55	0.10084	70.93	72.17
5 to 9	0.000472	0.0024	0.000315	97769.67	230.5927	0.5	488271.89	6660609.35	68.13	0.10129	67.50	68.75
10 to 14	0.000629	0.0031	0.000395	97539.08	306.236	0.5	486929.82	6172337.47	63.28	0.10164	62.66	63.91
15 to 19	0.002678	0.0133	0.000889	97232.85	1293.511	0.5	482930.45	5685407.65	58.47	0.10169	57.85	59.10
20 to 24	0.003767	0.0187	0.001188	95939.33	1790.134	0.5	475221.33	5202477.20	54.23	0.10154	53.60	54.85
25 to 29	0.002821	0.0140	0.001159	94149.2	1318.821	0.5	467448.93	4727255.87	50.21	0.10168	49.59	50.84
30 to 34	0.002432	0.0121	0.001207	92830.38	1122.03	0.5	461346.82	4259806.92	45.89	0.10135	45.26	46.51
35 to 39	0.002139	0.0106	0.001265	91708.35	975.769	0.5	456102.32	3798460.10	41.42	0.09997	40.80	42.04
40 to 44	0.002553	0.0128	0.001453	90732.58	1161.072	0.5	450751.72	3342357.78	36.84	0.10061	36.22	37.46
45 to 49	0.004119	0.0204	0.002127	89565.51	1825.776	0.5	443278.10	2891605.06	32.28	0.10063	31.66	32.91
50 to 54	0.005935	0.0292	0.003004	87742.73	2565.74	0.5	432299.31	2448326.96	27.90	0.10051	27.28	28.52
55 to 59	0.012136	0.0589	0.004329	85176.99	5016.313	0.5	413344.15	2016027.65	23.67	0.10010	23.05	24.29
60 to 64	0.019383	0.0924	0.007524	80160.68	7409.765	0.5	382278.98	1602683.47	19.99	0.09970	19.37	20.61
65 to 69	0.031695	0.1469	0.010528	72751.01	10688.52	0.5	337045.77	1220404.48	16.78	0.09551	16.17	17.38
70 to 74	0.051753	0.2291	0.012774	62067.39	14220.91	0.5	271784.69	883358.71	14.23	0.05559	13.65	14.82
75 to 79	0.088576	0.3626	0.013236	47846.48	17348.65	0.5	195960.73	608574.03	12.72	0.05548	12.15	13.29
80 up	0.073896	1.0000	*	30497.83	30497.83	*	412713.24	412713.24	13.53	*	*	*

Table 11
Abridged Life Table Based on Corrected Deaths and Population Distribution for Gaza Strip, female: 2006

Interval	Death Rate	Probability of dying	Standard error of (nqx)	Alive at start	Dying in interval	Fraction	Years in interval	Years beyond	Life expectancy	Variance of life expectancy	95 % Confidence Interval	
	nmx	nqx	SEq	lx	dx	nfx	nLx	Tx	ex	Var(ex)	LCI (ex)	UCI (ex)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
0 to 4	0.00340	0.0168	0.00075	100000.00	1683.14	0.5	495792.16	7459388.41	74.95	0.056805	74.49	75.42
5 to 9	0.00032	0.0016	0.00026	98316.86	155.30	0.5	491196.08	6995596.25	71.19	0.054101	70.74	71.65
10 to 14	0.00040	0.0020	0.00032	98161.57	196.28	0.5	490317.15	6508100.17	66.30	0.053944	65.85	66.76
15 to 19	0.00053	0.0026	0.00040	97965.28	256.67	0.5	489184.74	6018083.04	61.43	0.05374	60.98	61.89
20 to 24	0.00044	0.0022	0.00042	97708.61	215.25	0.5	488004.92	5528898.31	56.59	0.053451	56.13	57.04
25 to 29	0.00048	0.0024	0.00049	97493.36	235.48	0.5	486878.10	5040893.38	51.70	0.053158	51.25	52.16
30 to 34	0.00077	0.0039	0.00069	97257.88	375.45	0.5	485350.77	4554015.28	46.82	0.052823	46.37	47.27
35 to 39	0.00092	0.0046	0.00085	96882.43	444.30	0.5	483301.40	4068664.51	42.00	0.052277	41.55	42.44
40 to 44	0.00138	0.0069	0.00112	96438.13	661.87	0.5	480535.99	3585363.10	37.18	0.051613	36.73	37.62
45 to 49	0.00220	0.0109	0.00164	95776.26	1046.22	0.5	476265.77	3104827.12	32.42	0.050766	31.98	32.86
50 to 54	0.00405	0.0200	0.00231	94730.05	1899.15	0.5	468902.37	2628561.34	27.75	0.049385	27.31	28.18
55 to 59	0.00935	0.0457	0.00416	92830.90	4239.88	0.5	453554.84	2159658.97	23.26	0.046963	22.84	23.69
60 to 64	0.01555	0.0748	0.00613	88591.04	6629.20	0.5	426382.19	1706104.13	19.26	0.042067	18.85	19.66
65 to 69	0.02796	0.1307	0.00835	81961.84	10708.38	0.5	383038.25	1279721.93	15.61	0.035342	15.25	15.98
70 to 74	0.03206	0.1484	0.00971	71253.46	10571.41	0.5	329838.77	896683.68	12.58	0.025788	12.27	12.90
75 to 79	0.06042	0.2624	0.01420	60682.05	15925.72	0.5	263595.95	566844.91	9.34	0.017344	9.08	9.60
80 up	0.14759	1.0000	*	44756.33	44756.33	*	303248.98	303248.98	6.78	*	*	*

Table 12
Abridged Life Table Based on Corrected Deaths and Population Distribution for Gaza Strip, both sexes: 2006

Interval	Death Rate	Probability of dying	Standard error of (nqx)	Alive at start	Dying in interval	Fraction	Years in interval	Years beyond	Life expectancy	Variance of life expectancy	95 % Confidence Interval	
	nmx	nqx	SEq	lx	dx	nfx	nLx	Tx	ex	Var(ex)	LCI (ex)	UCI (ex)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
0 to 4	0.00398	0.0196	0.0006	100000.00	1962.79	0.5	495095.03	7230424.26	72.50	0.034234	72.14	72.87
5 to 9	0.00040	0.0020	0.0002	98037.21	198.03	0.5	489690.98	6735331.59	68.71	0.033802	68.35	69.07
10 to 14	0.00053	0.0026	0.0003	97839.18	257.14	0.5	488553.03	6245640.56	64.04	0.033716	63.68	64.40
15 to 19	0.00162	0.0081	0.0005	97582.04	786.21	0.5	485944.68	5757087.51	59.20	0.03367	58.84	59.56
20 to 24	0.00214	0.0106	0.0006	96795.83	1028.40	0.5	481408.18	5271142.83	54.66	0.033407	54.30	55.02
25 to 29	0.00167	0.0083	0.0006	95767.44	795.83	0.5	476847.63	4809734.65	50.22	0.032915	49.87	50.58
30 to 34	0.00162	0.0081	0.0007	94971.61	766.96	0.5	472940.64	4332887.03	45.62	0.032539	45.27	45.98
35 to 39	0.00156	0.0078	0.0008	94204.65	730.09	0.5	469198.02	3859946.38	40.97	0.032123	40.62	41.33
40 to 44	0.00203	0.0101	0.0009	93474.56	943.50	0.5	465014.05	3390748.37	36.27	0.031716	35.93	36.62
45 to 49	0.00327	0.0162	0.0014	92531.06	1501.15	0.5	458902.43	2925734.32	31.62	0.031324	31.27	31.97
50 to 54	0.00514	0.0254	0.0020	91029.91	2308.50	0.5	449378.30	2466831.89	27.10	0.030655	26.76	27.44
55 to 59	0.01095	0.0533	0.0032	88721.41	4727.61	0.5	431788.04	2017453.58	22.74	0.029994	22.40	23.08
60 to 64	0.01781	0.0853	0.0048	83993.80	7161.72	0.5	402061.73	1585665.55	18.88	0.027767	18.55	19.20
65 to 69	0.03049	0.1417	0.0066	76832.09	10883.99	0.5	356950.47	1183600.81	15.41	0.024215	15.10	15.71
70 to 74	0.04165	0.1885	0.0079	65948.10	12433.82	0.5	298655.95	826650.35	12.53	0.019383	12.26	12.81
75 to 79	0.07397	0.3121	0.0114	53514.28	16704.10	0.5	225811.15	527994.40	9.87	0.01481	9.63	10.10
80 up	0.12181	1.0000		36810.18	36810.18	*	302183.23	302183.23	8.21	*	*	*

4. Conclusion

In this paper, we estimated the life expectancy of the population of Gaza strip according to registered deaths in MOH. In life tables analysis based on registered deaths the estimation of life expectancy for males at birth is 73.71 years with uncertainty limits (73.04 – 74.39), the estimation of life expectancy for females at birth is 75.31 with uncertainty limits (74.84 - 75.77), the estimation of life expectancy for both sexes at birth is 73.91 with uncertainty limits (73.54 - 74.29). The completeness of death registration for males is (88.7%), the completeness of death registration for females is (96.9%), and the completeness of death registration for both sexes is (90%). The underreporting of deaths above four years was corrected using the Brass growth balance method. According to corrected number of deaths, the life expectancy at birth for males is 71.55 years with (UI 95% :70.93–72.17), the life expectancy at birth for females is 74.95 years with uncertainty limits (UI 95% 74.49 – 75.42), and the life expectancy at birth for the total population is 72.50 years with (UI 95%:72.14-72.87). By using Brass growth balance method the uncertainty interval was much smaller than that computed without correcting underreporting. The estimate of life expectancy at birth for the total population of Gaza strip in 2006 is about 1.41 (73.91 minus 72.5) year higher than the estimation when correcting underreporting with Brass growth balance method. It is about 2.2 year higher for males and only 0.35 year for females. It is found that this difference is statistically significant for males and both sexes only.

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