

# The Kuwaiti Cause of Death and Expectation of Life

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## 1. Introduction

The complete expectation of life at birth is often used as a convenient summary measure of the mortality of a population [3].

Formula were recently derived which allow the analysis of the contributions of various causes of death at different ages to the change in expectation of life at birth of a population over a given time period. These formulae can also be used to analyse the sex differentials in life expectancy between populations [4].

In this paper, the changes in expectation of life over the 1970's decade of Kuwait is analysed, and the contributions of the various age groups and causes of death to the sex differential in expectation of life at birth are obtained.

## 2. Availability of data

Kuwait has a good deal of demographic data collected through population censuses and vital registration system. Since 1957, seven regular censuses have been taken, the last one was conducted in April 1985. A system of vital registration which provides a fairly adequate amount of information on the dynamics of population was started only in 1964 through the introduction of legislation for the compulsory [7]. Since then, serious efforts have had been made

for the improvement of the registration system. IN 1969, a new law was enacted for overcoming the shortcoming of the first legislation. Thus, from 1970 onwards, the vital registration system in kuwait could be considered as more complete and reliable.

### 3. Methodology

An improvement of  $\phi$  in the force of mortality in the small age-range  $(x, x + \Delta x)$  causes the expectation of life at birth in the population under consideration to increase by an amount. Assuming that there are no changes

$$p_{x0} e_{x0}^0 \phi \Delta x \quad (1)$$

in mortality at other ages. This formula is well-known and leads to the following approximate formula for the gain in expectation of life at birth in a population between time 1 and time 2.

$$e_{00}^{02} - e_{00}^{01} = \int_0^{\infty} (u_x^1 - u_x^2) p_{x0}^1 e_x^{01} dx \quad (2)$$

In this, and other formulae in this paper, a superscript 1 will indicate that the function concerned is evaluated at time 1 (1970), and a superscript 2 will indicate that the function is evaluated at time 2 (1980);  $u$  represents the force of mortality at age  $x$ ,  $p$  the probability of survival  $x$  years from age 0, and  $e$  the complete expectation of life at age  $x$ .

Formula (2) is reasonably accurate, provided the improvements in mortality are modest. It always underestimates the gain in expectation of life when mortality improvements are positive. The reason the formula is only approximate and under estimate the actual gain in expectation of life when sitive improvements in mortality take place at all or most ages is that it

ignores interaction effects between mortality improvements at the different ages.

An exact formula explaining the gain in expectation of life of a population in terms of mortality improvements at the individual ages was recently derived [8]. In its simplest form, the formula may be written

$$e_o^{02} - e_o^{01} = \int_0^{\infty} (u_x^{12} - u_x^{11}) w_x dx \quad (3)$$

with

$$w_x = \frac{1}{2} ({}_x p_o^{201} e_o^{102} + {}_x p_o^{102} e_x^{201}) \quad (4)$$

A variant of (3) allows the separation of the main effects of mortality improvements at the various ages (formula (2)) and the interaction effects of various orders. If we define

$$M_x = \int_0^x u_t dt = \ln {}_x p_o \quad (5)$$

the differential in expectation of life at birth may be written [8]:

$$e_o^{02} - e_o^{01} = \int_0^{\infty} (u_x^{12} - u_x^{11}) \exp(M_x^{12} - M_x^{11}) {}_x p_o^{01} e_x^{201} dx \quad (6)$$

When the exponential term in (6) is expanded in terms of the powers of  $M_x^{12} - M_x^{11}$ , the main-effects term (2) and various interaction terms are obtained. The  $j$ -order interaction term, for example takes the form

$$\frac{1}{j!} \int_0^{\infty} (M_x^{12} - M_x^{11})^j (u_x^{12} - u_x^{11}) {}_x p_o^{01} e_x^{201} dx \quad (7)$$

For numerical work, the integral in (3) may be approximated by

$$\begin{aligned}
 {}^{02}e_o - {}^{01}e_o &= \left( \frac{{}^1m_o - {}^2m_o}{1} \right) w_o + 4 \left( \frac{{}^1m_1 - {}^2m_1}{4} \right) w_1 \\
 &+ 5 \left( \frac{{}^1m_5 - {}^2m_5}{5} \right) w_{7.5} + \dots
 \end{aligned} \tag{8}$$

where  ${}_n m_x$  is the central mortality rate at age  $x$ .

#### 4. Cause of Death

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According to the usual model of mortality by cause, the force of mortality at age  $x$  is the sum of the forces of mortality for the various causes [9]. In other words,

$$\mu_x = \sum_i \mu_{ix} \tag{9}$$

where  $\mu$  is the force of mortality by cause  $i$ . Substituted in (3), formula (9) allows the partition of  $e - e$  in (8) by cause, as well as age.

The central mortality rate for cause  $i$ ,  ${}_n m^{(i)}$  will usually provide an accurate estimate of

$$\frac{1}{n} \int_0^n \mu_{ix+t}^{(i)} dt \tag{10}$$

provided  $n$  is not too great. Furthermore, central mortality rates by age and cause are readily available for Kuwait [2], [5], [6].

The following formula can therefore be used to analyse change in expectation of life at birth according to mortality trends by age and cause.

$$\begin{aligned}
 e_o^{02} - e_o^{01} &= \sum_i (m_{i1}^{(i)1} - m_{i1}^{(i)2}) w_o + 4 \sum_i (m_{i41}^{(i)1} - m_{i41}^{(i)2}) w_o + \\
 &+ 5 \sum_i (m_{i55}^{(i)1} - m_{i55}^{(i)2}) w_{7.5} + 5 \sum_i (m_{i510}^{(i)1} - m_{i510}^{(i)2}) w_{12.5} + \dots \quad (11)
 \end{aligned}$$

In applying this formula, it is important to ensure that the values on the left-hand side and right-hand side are calculated on a consistent basis. In the same time, approximations (10) and (11) are very accurate and can be used to detect and correct errors in life expectation calculations [9], they also permit comparisons of mortality and expectation of life between different populations.

#### 4. Concluding Remarks

Change in expectation of life of a population over time can be analysed by using equation (11) to determine the contributions of the various ages and causes of death to the change in life expectancy. The technique was applied by pollard [9], to males and females over the 1970's in Australia, Belgium, England and Wales, Hungary, Japan and Netherlands.

In this paper, the author has applied the same technique on the available kuwaiti data. According to this data, life expectancy for kuwaiti males improved 4.64 years between 1970 and 1980 [1], see Table (I.1) (Appendix I). Table (II.1) (Appendix II) indicates that all causes except motor vehicle traffic accidents, bronchitis and asthma contributed to this improvement. The major contributor were infectious and parasitic diseases (24.32%).

All causes except neoplasma of breast, motor vehicle traffic accidents, bronchitides, emphysema and asthma made positive contributions to the improvement of 4.88 years in the kuwaiti female expectation of life between 1970 and 1980 [1], see Table (1.2) (Appendix I). And according to Table (II.2) (Appendix II), the largest contributors were also infectious and parasitic disease (25%).

The most important diseases in order of magnitude which made after the large contribution of the first cause were circulatory disease (13.15%), ischaemic heart disease (12.72%), respiratory disease (10.78%) and digestive system disease (10.34%) for males.

In the case of females were respiratory disease (14.14%), circulatory disease (13.37%), ischaemic heart disease (12.70%) and cerebrovascular disease (8.61%).

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A P P E N D I X ( I )



Table (I.1)

Gain expectation of life of kuwaiti males 1970-1980 : main effect and interactions contribution to

<u>Source</u>	<u>e. gain</u>	<u>% of gain</u>
Main effects	4.182	90.13
First-order interaction	.343	7.40
Second-order interaction	.109	2.30
Higher-order interaction	.006	.17
<u>Total</u>	<u>4.640</u>	<u>100.00</u>

\* Source: [1]

Table (I.2)

Gain in expectation of life of kuwaiti females 1970-1980 : main effect and interaction contribution to

<u>Source</u>	<u>e. gain</u>	<u>% of gain</u>
Main effects	4.542	93.04
First-order interaction	.268	5.51
Second-order interaction	.063	1.29
Higher-order interaction	.008	.64
<u>Total</u>	<u>4.881</u>	<u>100.00</u>

\* Source: [1]

A P P E N D I X ( I I )

Table (II.1)

Contribution of the various causes of death to  
the change in expectation of life between 1970 and 1980  
(Kuwaiti-males)

Cause of Death	Males 1970/1980							All ages	%Contrib. to change in e.	
	Age group									
	1-4	5-14	15-29	30-49	50-69	70+				
1. Infective,paras.C.28	22	9	4	14	18	20	115	24.78		
2. Malig.t Neoplasms.	0	0	0	2	4	7	13	26	5.60	
3. Neop.of Stomach	0	0	0	1	-2	3	5	7	1.51	
4. Neop.of Trachea										
Bronchus&Lung	0	0	0	1	6	4	8	19	4.10	
5. Neop.of Fem.Br.st.	0	0	0	0	0	0	0	0	0.00	
6. Dis.Circulatory.s.	0	0	0	-2	18	19	26	61	13.25	
7. Isch.Heart Dis.	0	0	0	3	13	27	16	59	12.72	
8. Cerebrovas.r Dis	0	0	0	0	5	18	14	37	7.97	
9. Respiratory Dis	.14	8	4	0	14	13	-3	50	10.88	
10. Bronch,emphys										
asthma	-.2	1	1	-2	0	4	9	-7	-18	-3.88
11. Digestive Sys.m	.8	0	0	4	9	14	13	48	10.45	
12. Cirroh.s of liver.	0	0	0	12	18	-1	9	38	8.19	
13. Injury & pois.	9	0	13	10	0	8	-2	12	41	8.84
14. Motor veh.accid.t.	0	1	-3	-7	-6	-7	1	-21	-4.53	
15. Suicide &self Inf.	0	0	0	2	1	-1	0	2	0.01	
Total All Causes	.48	45	21	18	102	103	127	464	100.00	

# The figure shown are hundredths of a year of life.

\* Sources: [2], [5], [7].

Table (II.2)

Contribution of the various causes of death to  
the change in expectation of life between 1970 and 1980

(Kuwaiti-females)

Cause of Death	Age group							All ages	% contr. to change in e
	0	1-4	5-14	15-29	30-49	50-69	70+		
1. Infective, para.c.	23	24	12	3	13	14	24	113.	23.1
2. Malignant Neoplasms	0	0	0	3	4	8	18	33.	6.7
3. Neoplasms of Stomach	0	0	0	3	4	12	6	25.	5.1
4. Neoplasms of Trachea Bronchus & Lung	0	0	0	0	1	-2	3	2.	0.0
5. Neoplasms of Female Breast	0	0	0	0	-1	-2	0	-3.	-0.0
6. Diseases of Circulatory System	0	0	0	4	17	23	23	67.	13.7
7. Ischaemic Heart Disease	0	0	0	2	11	24	25	62.	12.7
8. Cerebrovascular Disease	0	0	0	0	3	13	26	42.	8.6
9. Respiratory Diseases	13	11	2	3	21	14	5	69.	14.1
10. Bronchitis, emphysema, asthma	-1	0	-1	0	-3	-8	-6	-19.	-3.8
11. Digestive System	4	0	1	1	8	13	12	39.	7.9
12. Cirrhosis of liver	0	0	0	11	13	3	-4	23.	4.7
13. Injury & Poisoning	0	11	12	0	8	2	1	34.	6.9
14. Motor vehicle accidents	0	1	-1	-2	-3	1	1	-3.	-0.0
15. Suicide & self injury	0	0	0	2	1	0	0	4.	0.01
Total All Causes	39	47	25	30	97	116	134	488.	100.00

" The figures Shown are hundredths of a year of life.

\* Sources: [2], [5], [7].