

Iran Mortality and Measures of Risk: Rankings for Public policy

**M Aalabaf-Sabaghi*

E.C.O. College of Insurance, Allameh Tabatabai University, Tehran, Iran

(Received 12 Aug 2009; accepted 28 Feb 2010)

Abstract

Background: This paper offers mortality risk rankings for Iranian mortality data. It extends methods to include mixed cohorts, tests changes in mortality risks, compares measures of risk and discusses public policy implications.

Methods: The methodology used in risk measures takes current practice and extends it to include variations in population dynamics. The specification is presented and compared with existing literature.

Results: Our findings confirm literature results in the re-ordering that takes place when different risk measures are used. In addition, we find there is consistency in risk rankings between 1999 and 2000 records of Iranian mortality data. Thus, these risk measures are stable, robust across time and relay risk information consistently.

Conclusions: There are considerable implications in adopting particular risk measures for public policy. However, given properties of risk measures discussed here, it is clear that policy makers can select relevant risk measures depending on their priorities.

Keywords: *Mortality risk, Value of life, Life lost expectancy, Risk ranking, Iran*

Introduction

A major concern within health industries is some quantitative measure of mortality risk that may be faced by a member of population. Measures of mortality that only take the probability of death to represent risks faced by an individual do not take into account the timing of death and any discounting that may be present. Whereas, remaining life at risk, given life expectancies of individuals, are important in evaluating risks faced by the population as evidenced in the literature (1-7). Risk of death from different causes could be different due to the age of the individual exposed to such risks. Not all individuals, irrespective of their age, are subject to the same mortality risk from any cause. For example, death from a malignant neoplasm is far more likely to threaten the life of a 60 yr old than an infant is. While, congenital anomalies expose infants to higher risk that are almost nonexistent in older age groups.

The method for incorporating other information that affects measurement of risk as suggested in (5) takes into account factors other than just the probability of death. It includes life expectancies

at different ages to represent the remaining life at risk for an individual. As individuals may face risks from different ailments, then the incorporation of life expectancies brings in some measure of the magnitude of risk that is ex-ante based on a number of years the individual is expected to live. Life expectancies are given from life tables, which extrapolate remaining lives for individuals in all ages up to 100. In order to have some quantitative measure of lives lost, the expected years of life lost (EYLL) which is in a statistical sense an expected value of each life lost, provide a measure of human life lost because of each death following exposure to a risk. This factor is mainly the reason why a reordering of major causes of death ranks, takes place. The implication for health and safety regulation thus follows from this reordering of ranks of the major causes of death. As pointed out in (8-9) in most health services industries, a greater portion of health expenditure falls on therapy, for a few who experience an ailment. Thus, substantial financial resources are devoted to a few who are identified with having a condition. Whereas the re-

ordering of these major causes of death changes the way, health policy and regulation can be adopted. Thus, preventing or reducing the risk of these conditions for people who have not yet been diagnosed as having a particular condition. Of course, this is a major concern within the economics profession and the health industry to evaluate the costs and benefits of public resources and to suggest courses of action for policy making. Finally, as many health risks take effect in time and so there is a period during which the individual appears healthy while symptoms of a condition has not shown itself, a time lag between exposure and incidence of death is considered. We also provide a lag response rate estimated for all major conditions and the results confirm those found in (5). However, we are aware that such lag responses are ad-hoc. Some conditions take effect without any time lag, as in most accidents. Thus, it is meaningless to consider a measure of risk that lags the effect of some condition with immediate death implications.

This paper is presented in three sections. Section one presents the model adopted in here with extensions to include birth rates. Section two presents the empirical findings in four tables. Table 1 provides estimates for probability of death from major causes, life lost expectancies, expected years of life lost and the corresponding estimates that are discounted and then lagged. Table 2 ranks these major conditions based on probability of death, life lost expectancies and expected years of life lost and provides evidence for the reordering that takes place because of this method of measuring mortality risks. Tables 1 and 2 are estimates in eighteen groups of major conditions, thus aggregating the information that is provided in Tables 3 and 4. The aggregation will allow a comparison to be made in section three. Table 3 is similar to Table 2 except that the estimates are further sub-grouped in 150 headings. In Section three we calculate nonparametric tests for the existence of any shift in population distributions and find correlations in our mortality risk rankings for 1999 and 2000 data. Section four provides a comparison between

our findings and those of the literature and concludes the study with further research suggestions.

Model specification

We adopt the methodology in (5) and offer extensions. That is in calculating mortality risk measures, which in addition to the lifetime probability of death from any condition faced by an individual, takes into account the life expectancy of those individuals at every age (x). Individuals face different risks from a condition depending on their age. The magnitude of measures of lives lost is thus affected by both the probability of death from a condition at a particular age and the individual's life expectancy at that age. Therefore, the measures of mortality risk estimated in this way, changes the rank order of mortality risk in this model.

To be specific, a hypothetical cohort of N_0 people born at time $t=0$ are followed for T years. Survivors aged t, S_t at the end of every time period are given by

$$S_t = N_0 \prod_{t=0}^T (1 - \gamma_t) \quad [1]$$

Where γ_t is the probability of death in time period t and for N_0 people born at $t=0$, death at time t implies they died aged t . For a cohort this implies all individuals who die are t years old, i.e. $t=x$ where x represents age. However, $D_{jt} = \gamma_{jt} S_{t-1}$ where γ_{jt} the probability of death is aged t from condition j faced by the members of the cohort. Published statistics also provide information about the number of t -year olds who have died from condition j . Thus in order to calculate lost life expectancy for each individual, we calculate $D_{jt} l_t$ for each life lost. Then the average lost life expectancy LLE for all classified conditions are found from

$$LLE_j = \frac{\sum_{t=0}^T D_{jt} l_t}{\sum_{t=0}^T D_{jt}} \quad j = 1, \dots, J \quad [2]$$

Where l_t represents life expectancy at age t and obtained from life tables. The information about life expectancies in our model is obtained from

(11). While the estimates for expected years of life lost EYLL is obtained from

$$EYLL_j = p_j (LLE_j) \quad j = 1, \dots, J \quad [3]$$

Where p_j is the lifetime probability of death from an ailment. The estimated discounted and lagged values of [2] and [3] are obtained using standard calculus and are given by

$$disc LLE_j = \frac{(1+i)^{LLE_j} - 1}{i(1+i)^{LLE_j-1}} \quad [4]$$

$$disc EYLL_j = p_j (disc LLE_j) \quad [5]$$

Where i , is the rate of discount and set to 3%, as in (5) and the results are presented in Tables 1 and 3. However, it is worth noting that this 3% rate of discounting is the best estimate available, although it is rather ad-hoc. The evidence to support this rate of time preference is based on the goodness of fit presented in a number of regressions that examine factors affecting mortality risk perceptions. But the rate of time preference as may be indicated by inter-temporal decisions of individuals needs a more extensive discussion (3, 7, 8, 10). In discussions involving environmental issues, the role of discount rate is central to cost-benefit analysis, but finding the “right” discount rate has always been problematic (9). In order to calculate lagged values of LLE and EYLL by τ years, equations in [4] and [5] are multiplied by $(1+i)^\tau$. This will evaluate the corresponding deferred symptom factor that may be present in some health risks. While the medical indication to verify the length of time lag for each condition is not provided by published data, we have insufficient information to justify any length of time lag. Thus this ten-year lag is, once again, rather ad-hoc. At best, the statistical methodology of best fitting regressors to explain variations in dependent variable, namely risk perception, is not always “medically” accurate in reflecting the correct lag response between exposure and the incidence of death.

We also wish to make our theoretical model more accountable to the fact that population under

study includes birth as well as death rates. We assume birth, death rates are uniform and equal throughout the year, and there is no immigration or emigration such that the population remains stable. Hypothetical cohorts that construct theoretical models with changing populations, allowing variation in birth and death rates, are found in the demographic literature as in (12). The analysis in this paper tries to include birth rates using component method used in demographic studies. Thus if we reconsider our cohort of N_0 people and allow an inflow of newborns into this population, the above equations will change. Naturally, D_t and D_{jt} no longer represent the number of death, aged t , from all ailments and ailment j , correspondingly. However, D_t and D_{jt} represent the number who die in period t , where t is not necessarily equal to the age of the deceased. The information about the age of the dead is available in published statistics and we are able to estimate mortality measures taking age variations into account in the composition of our population due to an inflow of newborns. Suppose M_0 is the best estimate of population at time $t=0$. Let D_t be the outflow from our sample i.e. the dead and B_t represent the number of newborn i.e. the inflow. Survivors at the end of period t , can then be shown to equal

$$S_t = M_0 \prod_{t=0}^T (1 - \gamma_t + \beta_t) \quad [6]$$

Where β_t is the birth rate and γ_t is the death rate in period t and

$$\beta_t = \frac{B_t}{M_t} \quad , \quad \gamma_t = \frac{D_t}{M_t} \quad [7]$$

If however, we disallow the inflow of newborn in our population with $\beta_t = 0$ in [6] and assume a cohort in period t , we then obtain equation [2] as a special case. Taking note of the fact that information about population statistics includes newborns, thus there is an inflow in the population as well as an outflow. Therefore, mortality measures are better represented in this way. The

corresponding values of LLE in [2], EYLL in [3], the discounted and lagged values in [4] and [5] of our mortality measures follow from equation [6]. But, the probability of death from a condition j in year t is found by

$$p_{jt} = \frac{D_{jt}}{D_t} \quad [8]$$

In addition, the lifetime probability of death for a condition is given by

$$p_j = \sum_{t=1}^T p_{jt} \quad [9]$$

Where the probability of death for x year olds from condition j is

$$p_{jx} = \frac{D_{jx}}{D_{tx}} \quad [10]$$

Where, D_{jx} is the number of x year olds died from condition j and D_{tx} is the number of x year olds died in period t . Here p_{jx} is not equal to p_{jt} unless we have a cohort.

However, not all births or deaths take place or are supervised under ministry run health centers. The underreporting of deaths may be more than births as they may involve expenses for the bereaved and not reporting may entail continuation of certain state benefits. Failure to report a birth or death has also legal and financial implications where beneficiaries of any left state, require official certification. Overall these records are representative of the population and the best available.

Empirical findings

In our model, data were obtained from official statistics as published in the Iranian Ministry of Health Mortality Tables Annual Almanac (13-17). These tables provide information about recorded deaths for 150 causes. Age at death is recorded and the statistics provide fourteen different age groups in which records are available. The classification also aggregates these 150 ailments into seventeen broader categories. This broad grouping enables us to make comparisons with other findings.

We present the first set of our findings in Table 1 where seven measures are estimated in eighteen categories. The probability of death is found directly from data and represents the ratio of the number of deaths from a condition to total number in the sample. As such, it represents an ex-post estimate of a measure of risk that individuals may consider for any health condition. Therefore, the probabilities offer some magnitude of a health risk based on the existing recorded information and are a measure of risk after the event. The novelty of this model is in the comparison that is made between measures of risk that represent an ex-ante quantitative measure and those that are ex-post. LLE reflects a quantitative measure of lives lost, but subject to life expectancy of all individuals that are likely to be affected by a particular condition. It is therefore, conditional and weighted according to the number of years those individuals affected, might have expected to live. Thus, it offers an ex-ante quantitative measure of risk that is faced by a member of population. The EYLL is by definition the product of probability of death and LLE. It is therefore a weighted quantitative measure, which radically reorders mortality risk ranking. The rank orders are shown in Tables 2 and 3. As it is seen in Table 2 Circulatory diseases are the most risky and ranks 1. Whereas according to the number of years of life lost, it ranks 17. This condition is in contrast with prenatal disorders that result in the highest years of life lost, since those affected are infants and expected to live much longer in the absence of the health risk. The rank orders according to LLE are highest for prenatal disorders and nearly the last for Circulatory diseases. As pointed out in (8, 14) a critical decision has to be made regarding public finances directed to health services and health insurance. The ranking here clearly indicates that any decision about funding and costing of medical care that is based on priorities, is dramatically affected by mortality risk measures adopted.

Table 1: Mortality risks for major conditions

Condition	Prob	LLE	EYLL	Disc LLE	Disc EYLL	Lag LLE	Lag EYLL
Infectious and parasitic diseases	0.0156	35.81 (4.16)	0.56	22.42	0.35	16.68	0.26
Neoplasm (Cancer)	0.0905	17.89 (1.17)	1.62	14.1	1.28	10.49	0.95
Endocrine, nutritional and metabolic disease	0.0108	21.29 (1.7)	0.23	16.04	0.17	11.93	0.13
Blood disorders and blood forming organs	0.0048	38.41 (3.42)	0.18	23.3	0.11	17.34	0.08
Mental disorders	0.0056	40.37 (2.22)	0.22	23.92	0.13	17.8	0.1
Disorders of the nervous system	0.0057	33.09 (1.79)	0.19	21.42	0.12	15.94	0.09
Diseases of the circulatory system	0.3549	14.1 (1.27)	5.01	11.71	4.15	8.71	3.09
Diseases of the respiratory system	0.0351	23.98 (2.6)	0.84	17.43	0.61	12.97	0.45
Diseases of the digestive system	0.0237	20.02 (0.91)	0.47	15.34	0.36	11.41	0.27
Genitourinary disorders	0.0138	18.45 (1.0)	0.26	14.43	0.2	10.74	0.15
Complications of pregnancy, child birth and the puerperium	0.0007	38.62(4.91)	0.03	23.37	0.02	23.37*	0.02*
Skin and sub-tissue disorders	0.0005	31.61 (2.75)	0.01	20.84	0.01	15.51	0.01
Diseases of the musculoskeletal system	0.0011	27.77 (1.07)	0.03	19.23	0.02	14.31	0.02
Congenital anomalies	0.0289	62.71 (15.96)	1.81	28.95	0.84	21.55	0.62
Prenatal disorders	0.0482	65.07 (18.78)	3.13	29.32	1.41	21.81	1.05
Accidents and poisoning	0.1153	38.06 (2.35)	4.39	23.19	2.67	17.25	1.99
Ill defined conditions (old age)	0.1671	7.31 (1.86)	1.22	6.67	1.12	6.67*	1.12*
Unspecified	0.0779	33.5 (5.21)	2.61	21.58	1.68	21.58*	1.68*

Notes: Prob denotes probability of death, LLE denotes Lost Life Expectancy with corresponding standard errors in brackets, EYLL denotes Expected Years of Life Lost, Disc LLE and Disc EYLL incorporate a 3% annual discount rate. Lag LLE and lag EYLL take ten-year lags into account between exposure to an illness and the incidence of death. For entries that are not lagged, * indicates values of the corresponding Disc LLE and Disc EYLL have been carried over.

Table 2: Rank order of mortality risks for major conditions

Condition	Rank				
	Prob	LLE	EYLL	Lag LLE	Lag EYLL
Diseases of the circulatory system	1	17	14	1	17
Ill defined conditions (old age)	2	18	11	6*	18*
Accidents and poisoning	3	6	9	2	7
Neoplasm (Cancer)	4	16	15	5	16
Unspecified	5	8	3	3*	3*
Prenatal disorders	6	1	1	4	2
Diseases of the respiratory system	7	12	8	8	12
Congenital anomalies	8	2	2	7	4
Diseases of the digestive system	9	14	18	9	14
Infectious and parasitic diseases	10	7	5	10	8
Genitourinary disorders	11	15	17	11	15
Endocrine, nutritional and metabolic disease	12	13	13	12	13
Disorders of the nervous system	13	9	12	14	9
Mental disorders	14	3	10	13	5
Blood disorders and blood forming organs	15	5	6	15	6
Diseases of the musculoskeletal system	16	11	16	16	11
Complications of pregnancy, child birth and the puerperium	17	4	4	16*	1*
Skin and sub-tissue disorders	18	10	7	18	10

Notes: For entries marked with * values of the corresponding Disc LLE and Disc EYLL were not lagged.

The order in Table 3 to categorize ailments into diagnostically similar groups is made by the medical profession and does not reflect any risk attribute. The discounted values of LLE and EYLL are accordingly scaled down compared to the corresponding values of LLE and EYLL. Discounting LLE and EYLL are non-linear but monotonic. While at different ages, people have a different time horizon to discount their expected life, a higher LLE value will always lead to a higher discounted LLE without affecting the rank or-

ders between risk factors. The lagged values in Tables 1 and 3 further dampen down the effect of lives lost by a further lagged element. Hence values of lagged LLE and EYLL are smaller compared to the corresponding discounted and actual values of LLE and EYLL.

Some values in Table 3 and 4 are starred. This is in order to avoid lagging the effect of any health risk that takes effect without any time delay such as in most accidents.

Table 3: Mortality risks for 150 conditions

Condition	Prob	LLE	EYLL	Disc LLE	Disc EYLL	Lag LLE	Lag EYLL
1 Cholera	0.00012	36.03 (3.98)	0.0044	22.5	0.0028	16.74	0.0021
2 Typhoid fever	0.00022	21.33 (1.12)	0.0047	16.06	0.0036	11.95	0.0026
3 Paratyphoid fever & other salmonella infections	0.00015	43.1 (5.51)	0.0063	24.73	0.0036	18.4	0.0027
4 Bacillary dysentery and amoebiasis	0.00022	48.27 (5.93)	0.0107	26.09	0.0058	19.41	0.0043
5 Enteritis and other diarrhoeal diseases	0.00189	53.81 (9.7)	0.1018	27.34	0.0517	20.34	0.0385
6 Tuberculosis of respiratory system	0.00101	17.46 (1.31)	0.0176	13.84	0.014	10.3	0.0104
7 Tuberculosis of meninges and central nervous system	0.00027	19.67 (2.38)	0.0054	15.14	0.0041	11.26	0.0031
8 Tuberculosis of intestines peritoneum and mesenteric glands	0.00014	26.25 (1.38)	0.0036	18.53	0.0025	13.79	0.0019
9 Tuberculosis of bones and joints	0.00012	23.95 (1.84)	0.0028	17.42	0.0021	12.96	0.0015
10 Other tuberculosis including late effects	0.00037	20.67 (1.1)	0.0076	15.69	0.0058	11.68	0.0043
11 Plague	0	0	0	0	0	0	0
12 Anthrax	0.00001	27.13 (5.62)	0.0004	18.94	0.0003	14.09	0.0002
13 Brucellosis	0.00008	32.43 (2.36)	0.0024	21.17	0.0016	15.75	0.0012
14 Leprosy	0.0001	31.41 (6.25)	0.0031	20.76	0.0021	15.45	0.0015
15 Diphtheria	0.00013	61.3 (16.26)	0.0081	28.72	0.0038	21.37	0.0028
16 Whooping cough	0.0002	13.4 (1.7)	0.0027	11.23	0.0023	8.35	0.0017
17 Streptococcal sore throat and scarlet fever	0.00018	42.86 (2.88)	0.0077	24.66	0.0044	18.35	0.0033
18 Erysipelas	0.00001	11.71 (2.5)	0.0001	10.04	0.0001	7.47	0.0001
19 Meningococcal infection	0.00004	34.63 (3.64)	0.0015	22	0.0009	16.37	0.0007
20 Tetanus	0.00008	47.78 (8.12)	0.0041	25.97	0.0022	19.32	0.0016
21 Other bacterial diseases	0.00133	18.36 (1.19)	0.0243	14.38	0.0191	10.7	0.0142
22 Acute poliomyelitis	0.00008	41.83 (3.89)	0.0036	24.36	0.0021	18.13	0.0015
23 Late effect of acute poliomyelitis	0.00007	44.19 (4.13)	0.0029	25.03	0.0017	18.63	0.0012
24 Smallpox	0	0	0	0	0	0	0
25 Measles	0.00012	43.95 (3.73)	0.0054	24.97	0.0031	18.58	0.0023
26 Yellow fever	0	0	0	0	0	0	0
27 Viral encephalitis	0.00028	41.6 (4.76)	0.0118	24.29	0.0069	18.08	0.0051
28 Infectious hepatitis	0.00165	36.81 (3.69)	0.0606	22.77	0.0375	16.94	0.0279
29 Other viral diseases	0.00026	41.45 (4.57)	0.011	24.25	0.0064	18.04	0.0048
30 Typhus and other rickettsioses	0	0	0	0	0	0	0
31 Malaria	0.00008	26.86 (3.58)	0.0022	18.81	0.0015	14	0.0011
32 Trypanosomiasis	0	0	0	0	0	0	0
33 Relapsing fever	0	0	0	0	0	0	0
34 Congenital syphilis	0	48.65(14.04)	0.0002	26.18	0.0001	19.48	0.0001

Table 3: Continued...

35	Early syphilis, symptomatic	0	66.11(19.08)	0.0003	29.47	0.0001	21.93	0.0001
36	Syphilis of central nervous system	0.00007	18.21 (2.06)	0.0012	14.29	0.0009	10.63	0.0007
37	Other syphilis	0.00005	14.51 (2.68)	0.0008	11.97	0.0006	8.91	0.0005
38	Gonococcal infections	0.00004	18.33 (3.1)	0.0007	14.36	0.0005	10.69	0.0004
39	Schistosomiasis	0.00001	29.67 (5.8)	0.0004	20.05	0.0003	14.92	0.0002
40	Hydatidosis	0.0001	23.79 (2.53)	0.0024	17.34	0.0017	12.9	0.0013
41	Filarial infection	0.00002	27.71 (4.48)	0.0007	19.2	0.0005	14.28	0.0003
42	Ancylostomiasis	0.00015	53.51 (7.19)	0.0081	27.27	0.0041	20.29	0.0031
43	Other helminthiasis	0.00027	45.33 (5.25)	0.0122	25.34	0.0068	18.86	0.0051
44	All other infective and parasitic diseases	0.0056	38.04 (5.05)	0.2131	23.18	0.1298	17.25	0.0966
45	Malignant neoplasm of buccal cavity & pharynx	0.00057	16.25 (1.49)	0.0092	13.09	0.0074	9.74	0.0055
46	Malignant neoplasm of esophagus	0.00397	13.38 (1.47)	0.0531	11.21	0.0445	8.34	0.0331
47	Malignant neoplasm of stomach	0.017	13.86 (1.44)	0.2356	11.54	0.1962	8.59	0.146
48	Malignant neoplasm of intestine, except rectum	0.0033	17.18 (1.36)	0.0567	13.67	0.0451	10.17	0.0336
49	Malignant neoplasm of rectum & recto-sigmoid junction	0.00035	16.13 (1.66)	0.0056	13.02	0.0045	9.69	0.0034
50	Malignant neoplasm of larynx	0.00222	14.13(1.45)	0.0313	11.72	0.026	8.72	0.0193
51	Malignant neoplasm of trachea, bronchus & lung	0.00881	13.76 (1.43)	0.1212	11.47	0.1011	8.54	0.0752
52	Malignant neoplasm of bone	0.00148	26.02 (1.48)	0.0384	18.42	0.0272	13.71	0.0202
53	Malignant neoplasm of skin	0.00092	17.06 (1.26)	0.0157	13.6	0.0125	10.12	0.0093
54	Malignant neoplasm of breast	0.00286	21.45 (2.39)	0.0614	16.12	0.0462	11.99	0.0344
55	Malignant neoplasm of cervix uteri	0.0008	16.27 (1.84)	0.013	13.11	0.0105	9.75	0.0078
56	Other malignant neoplasm of uterus	0.00085	20.17 (2.04)	0.0172	15.42	0.0132	11.47	0.0098
57	Malignant neoplasm of prostate	0.00239	9.58 (1.6)	0.0229	8.47	0.0202	6.3	0.015
58	Malignant neoplasm of other and unspecified sites	0.02961	18.7 (1.15)	0.5537	14.58	0.4317	10.85	0.3212
59	Leukemia	0.00819	29.01 (1.22)	0.2376	19.77	0.1619	14.71	0.1205
60	Other neoplasm of lymphatic & haemotopoietic tissue	0.00256	22.45 (0.94)	0.0574	16.65	0.0426	12.39	0.0317
61	Benign neoplasm & neoplasm of unspecified nature	0.00458	19.14 (1.09)	0.0877	14.84	0.068	11.04	0.0506
62	Non-toxic goitre	0.00021	36.52 (3.47)	0.0078	22.67	0.0048	16.87	0.0036
63	Thyrotoxicosis with or without goitre	0.0001	24.47 (2.2)	0.0024	17.68	0.0018	13.15	0.0013
64	Diabetes mellitus	0.00685	14.72 (1.29)	0.1009	12.11	0.083	9.01	0.0618
65	Avitaminoses and other nutritional deficiency	0.00113	55.3 (11.78)	0.0624	27.64	0.0312	20.57	0.0232
66	Other endocrine and metabolic diseases	0.00249	22.53 (1.27)	0.0561	16.7	0.0416	12.42	0.0309
67	Anemia	0.00129	48.08 (4.11)	0.0619	26.04	0.0335	19.38	0.025
68	Other diseases of blood and blood-forming organs	0.00349	34.84 (3.31)	0.1215	22.07	0.077	16.42	0.0573
69	Psychoses	0.00116	28.8 (1.47)	0.0333	19.68	0.0227	14.64	0.0169
70	Neuroses, personality disorders & other non-psychotic mental disorders	0.00159	28.47 (0.98)	0.0451	19.54	0.031	14.54	0.023
71	Mental retardation	0.00282	51.8 (3.94)	0.1462	26.91	0.0759	20.02	0.0565
72	Meningitis	0.00103	43.63 (3.63)	0.0449	24.88	0.0256	18.51	0.019
73	Multiple sclerosis	0.00117	19.63 (1.24)	0.023	15.11	0.0177	11.25	0.0132
74	Epilepsy	0.00134	44.16 (2.97)	0.059	25.03	0.0334	18.62	0.0249
75	Inflammatory diseases of eye	0.00007	16.5 (1.91)	0.0012	13.25	0.0009	9.86	0.0007
76	Cataract	0.00005	13.99 (1.81)	0.0007	11.63	0.0006	8.65	0.0004
77	Glaucoma	0.00005	20.21(2.81)	0.001	15.44	0.0007	11.49	0.0005
78	Otitis media and mastoiditis	0.00013	18.21 (1.49)	0.0024	14.29	0.0019	10.63	0.0014
79	Other diseases of nervous system and sense organs	0.00185	30.32 (1.77)	0.0562	20.32	0.0377	15.12	0.028
80	Active rheumatic fever	0.00015	36.87 (2.74)	0.0054	22.79	0.0033	16.96	0.0025
81	Chronic rheumatic heart disease	0.00055	18.97 (1.22)	0.0105	14.73	0.0081	10.96	0.0061
82	Hypertensive disease	0.00696	11.25 (1.48)	0.0783	9.72	0.0676	7.23	0.0503
83	Ischaemic heart disease	0.09818	13.57 (1.35)	1.3322	11.34	1.1138	8.44	0.8287
84	Other forms of heart disease	0.16409	14.05 (1.28)	2.3061	11.67	1.9151	8.68	1.425
85	Cerebrovascular disease	0.06621	14.32 (1.22)	0.9479	11.85	0.7843	8.81	0.5836
86	Diseases of arteries arterioles & capillaries	0.00269	16.26 (1.12)	0.0437	13.1	0.0352	9.75	0.0262
87	Venous thrombosis and embolism	0.00589	15.39 (1.23)	0.0906	12.55	0.0739	9.34	0.055

Table 3: Continued...

88	Other diseases of circulatory system	0.01007	18.81 (0.93)	0.1894	14.65	0.1475	10.9	0.1097
89	Acute respiratory infection	0.00385	42.31 (7.47)	0.1631	24.5	0.0945	18.23	0.0703
90	Influenza	0.00022	38.82 (4.23)	0.0086	23.43	0.0052	17.44	0.0039
91	Viral pneumonia	0.00174	28.37 (3.67)	0.0494	19.49	0.0339	14.5	0.0252
92	Other pneumonia	0.00337	32.46 (4.6)	0.1094	21.18	0.0714	15.76	0.0531
93	Bronchitis, emphysema and asthma	0.00838	13.9 (1.29)	0.1166	11.57	0.097	8.61	0.0722
94	Hypertrophy of tonsils and adenoids	0.00023	31.29 (2.53)	0.0071	20.72	0.0047	15.42	0.0035
95	Emphysema and abscess of lung	0.00153	16.53 (1.16)	0.0253	13.27	0.0203	9.88	0.0151
96	Other diseases of respiratory system	0.01572	22.96 (2.35)	0.361	16.92	0.266	12.59	0.1979
97	Diseases of teeth and supporting structures	0.00003	37.33 (5.98)	0.0012	22.94	0.0008	17.07	0.0006
98	Peptic ulcer	0.00035	17.05 (1.16)	0.006	13.59	0.0048	10.11	0.0036
99	Gastritis and duodenitis	0.00068	16.77 (1.39)	0.0115	13.42	0.0092	9.98	0.0068
100	Appendicitis	0.00037	34.03 (1.92)	0.0125	21.78	0.008	16.2	0.006
101	Intestinal obstruction and hernia	0.00068	27.75 (3.86)	0.0189	19.22	0.0131	14.3	0.0097
102	Cirrhosis of liver	0.00537	20.08 (1.12)	0.1078	15.37	0.0825	11.44	0.0614
103	Cholelithiasis and cholecystitis	0.00062	16.55 (1.17)	0.0103	13.28	0.0083	9.88	0.0062
104	Other diseases of digestive system	0.01559	19.64 (0.89)	0.3061	15.12	0.2357	11.25	0.1754
105	Acute nephritis	0.00053	18.72 (1.15)	0.01	14.59	0.0078	10.86	0.0058
106	Other nephritis and nephrosis	0.00148	17.35 (1.11)	0.0256	13.77	0.0203	10.25	0.0151
107	Infections of kidney	0.00641	20.09 (0.94)	0.1287	15.38	0.0985	11.44	0.0733
108	Calculus of urinary system	0.00017	17.56 (1.78)	0.0029	13.9	0.0023	10.35	0.0017
109	Hyperplasia of prostate	0.00026	9.16 (1.66)	0.0024	8.14	0.0021	6.06	0.0016
110	Diseases of breast	0.00004	18.4 (2.55)	0.0008	14.4	0.0006	10.72	0.0005
111	Other diseases of genito-urinary system	0.00495	17.13 (1.09)	0.0848	13.64	0.0675	10.15	0.0502
112	Toxaemias of pregnancy and the puerperium	0.00003	38.91 (4.29)	0.0011	23.46	0.0007	17.46	0.0005
113	Haemorrhage of pregnancy and childbirth	0.00017	40.69 (5.77)	0.0069	24.02	0.0041	24.02*	0.0041*
114	Abortion induced for legal indications	0	6.84 (1.97)	0	6.28	0	6.28*	0*
115	Other and unspecified abortion	0.00014	42.98 (6.0)	0.0059	24.7	0.0034	24.7*	0.0034*
116	Sepsis of childbirth and the puerperium	0.00008	31.4 (3.14)	0.0024	20.76	0.0016	20.76*	0.0016*
117	Other complication of pregnancy, childbirth and the puerperium	0.00025	37.84 (5.32)	0.0095	23.11	0.0058	23.11*	0.0058*
118	Delivery without mention of complication	0.00002	35.9 (4.44)	0.0008	22.45	0.0005	22.45*	0.0005*
119	Infections of skin and subcutaneous tissue	0.0002	24.16 (2.5)	0.0048	17.52	0.0035	13.04	0.0026
120	Other diseases of skin and subcutaneous tissue	0.00025	37.4 (3.33)	0.0095	22.97	0.0059	17.09	0.0044
121	Arthritis & spondylitis	0.00012	14.85 (1.67)	0.0018	12.2	0.0014	9.08	0.0011
122	Non-articular rheumatism and rheumatism unspecified	0.00013	19.81 (1.49)	0.0025	15.21	0.0019	11.32	0.0014
123	Osteomyelitis and periostitis	0.00006	39.14 (3.14)	0.0024	23.54	0.0014	17.51	0.0011
124	Ankylosis and acquired musculoskeletal deformities	0.00003	33.88 (4.8)	0.0011	21.72	0.0007	16.16	0.0005
125	Other diseases of musculoskeletal system and connective tissue	0.00081	29.81 (1.17)	0.024	20.11	0.0162	14.96	0.0121
126	Spina bifida	0.00016	33.01 (6.22)	0.0051	21.39	0.0033	15.92	0.0025
127	Congenital anomalies of heart	0.0037	62.91 (14.55)	0.233	28.99	0.1074	21.57	0.0799
128	Other congenital anomalies of circulatory system	0.0011	59.81 (13.08)	0.0658	28.47	0.0313	21.19	0.0233
129	Cleft palate and cleft lip	0.00015	66.11 (19.08)	0.01	29.47	0.0044	21.93	0.0033
130	All other congenital anomalies	0.02377	62.99 (16.38)	1.4974	29	0.6893	21.58	0.5129
131	Birth injury and difficult labour	0.00263	65.88 (19.02)	0.1734	29.44	0.0775	29.44*	0.0775*
132	Conditions of placenta and cord	0.00127	62.98 (18.16)	0.0802	29	0.0369	29*	0.0369*
133	Haemolytic disease of newborn	0.00274	66.11 (19.08)	0.1809	29.47	0.0806	29.47*	0.0806*
134	Anoxic and hypoxic conditions not elsewhere classified	0.00206	64.62 (18.65)	0.1332	29.25	0.0603	21.76	0.0449
135	Other causes of prinalatal morbidity and mortality	0.03943	65.03 (18.77)	2.5641	29.31	1.1557	21.81	0.8599
136	Senility without mention of psychosis	0.16704	7.31 (1.86)	1.2213	6.67	1.1147	6.67*	1.1147*
137	Symptoms and other ill-defined conditions	0.04095	25.39 (1.43)	1.0399	18.12	0.7422	18.12*	0.7422*
138	Motor vehicle accidents	0.02723	37.12 (2.23)	1.0108	22.87	0.6228	22.87*	0.6228*

Table 3: Continued...

139	Other transport accidents	0.00999	37.04 (2.17)	0.3702	22.85	0.2283	22.85*	0.2283*
140	Accidental poisoning	0.00557	36.88 (2.15)	0.2053	22.79	0.1269	22.79*	0.1269*
141	Accidental falls	0.00309	34.8 (1.64)	0.1074	22.06	0.0681	22.06*	0.0681*
142	Accidents caused by fires	0.00925	42.24 (3.35)	0.3907	24.48	0.2264	24.48*	0.2264*
143	Accidental drowning and submersion	0.00655	48.45 (3.53)	0.3173	26.13	0.1712	26.13*	0.1712*
144	Accidents caused by firearm missiles	0.00271	41.89 (4.21)	0.1137	24.38	0.0661	24.38*	0.0661*
145	Accidents mainly of industrial type	0.00111	43.21 (3.05)	0.0479	24.76	0.0275	24.76*	0.0275*
146	All other accidents	0.02329	34.83 (1.91)	0.811	22.07	0.5139	22.07*	0.5139*
147	Suicide and self inflicted injury	0.00848	40.23 (4.26)	0.3413	23.88	0.2026	23.88*	0.2026*
148	Homicide and injury purposely inflicted by intervention	0.0049	38.18 (3.31)	0.187	23.23	0.1138	23.23*	0.1138*
149	Injury undetermined whether accidentally or purposely inflicted	0.01083	36.33 (2.12)	0.3936	22.6	0.2449	22.6*	0.2449*
150	Injury resulting from operations of war	0.00218	39.58 (3.42)	0.0861	23.68	0.0515	23.68*	0.0515*
151	Unspecified causes	0.0369	42.5 (9.67)	1.5683	24.56	0.9062	18.27	0.6743

Notes: For entries that are not lagged, * indicates values of the corresponding Disc LLE and Disc EYLL have been carried over.

In Table 3 there are also two categories that are not well defined 137 & 151: The “symptoms and other ill-defined conditions” plus “unspecified causes”. As data stand, the amount of unexplained death probability is 0.04095 plus 0.0369 i.e. 0.07785 or 7.8% of all deaths. In order to see how demographic composition of this group may affect EYLL, a look at the age at death is helpful. For “symptoms and other ill-defined conditions” the largest count is 3221 out of a total 8679, which are in the 65+ age group. Perhaps due to old age, the significance of cause of death has been overlooked. While for the “unspecified causes”, the largest count of 2968 out of a total 7820 is for aborted pregnancies. Again, perhaps due to a very early form of life, cause of death is overlooked. Raw data includes abortive deaths and stillbirths and it might be argued that these two categories should be excluded. However, taking an economic point of view, both of these categories impose a cost on people and health services and are therefore included in the calculations of EYLL.

We have also calculated EYLL for this 7.8% “unspecified” deaths based on age at death that is available for each record. Therefore, for the 215 death records for the age group 5-9 yr that were due to “symptoms and other ill-defined conditions” or just “unspecified” the calculated EYLL takes age composition into account.

The results in Table 4 giving rank orders for an extensive list of medical conditions highlight how this model changes the priority that is attached to any ailment may be contrary to the perceived image. But it is quite clear how reordering is affecting priorities. The ranking based on the probability of death is quite markedly different from the LLE measure. The EYLL also offer a somewhat in between measure of mortality risk than the probability of death or LLE. It is also worth noting that aggregation also affect the ranking as it is seen in Tables 2 and 4. In Table 2, it is shown that heart conditions are the riskiest, while in Table 4 the old age appears the most risky condition. This condition, i.e. senility (old age) is put in the “ill defined” category in Table 2, thus ranking second.

In addition to providing disaggregated information for the medical profession, Table 4 may also provide indications as to the level of insurance coverage that may be needed. This can be seen by noting risks involved. The higher is the ranking, the higher insurance premium. However, discussions regarding the consequences of insurance premiums and cost-effectiveness of various decisions based on this reordering are beyond this study (15).

Table 4: Rank orders of mortality risks for 150 conditions

Condition	Rank				
	Prob	LLE	EYLL	Lag LLE	Lag EYLL
Senility without mention of psychosis	1	144	6	142*	2*
Other forms of heart disease	2	132	2	132	1
Ischaemic heart disease	3	137	5	137	4
Cerebrovascular disease	4	130	9	130	8
Symptoms and other ill-defined conditions	5	82	7	48*	5*
Other causes of prenatal morbidity and mortality	6	5	1	23	3
Unspecified causes	7	30	3	45	6
Malignant neoplasm of other and unspecified sites	8	105	11	105	11
Motor vehicle accidents	9	48	8	14*	7*
All other congenital anomalies	10	7	4	25	10
All other accidents	11	58	10	19*	9*
Malignant neoplasm of stomach	12	135	20	135	19
Other diseases of respiratory system	13	87	15	87	16
Other diseases of digestive system	14	99	18	99	17
Injury undetermined whether accidentally or purposely inflicted	15	54	12	17*	12*
Other diseases of circulatory system	16	103	24	103	23
Other transport accidents	17	49	14	15*	13*
Accidents caused by fires	18	32	13	7*	14*
Malignant neoplasm of trachea, bronchus & lung	19	136	33	136	28
Suicide and self inflicted injury	20	38	16	10*	15*
Bronchitis, emphysema and asthma	21	134	34	134	30
Leukaemia	22	72	19	73	21
Hypertensive disease	23	141	46	141	42
Diabetes mellitus	24	128	40	128	34
Accidental drowning and submersion	25	17	17	4*	18*
Infections of kidney	26	95	31	95	29
Venous thrombosis and embolism	27	126	41	126	38
All other infective and parasitic diseases	28	44	22	54	24
Accidental poisoning	29	50	23	16*	20*
Cirrhosis of liver	30	96	37	95	35
Other diseases of genito-urinary system	31	115	44	115	43
Homicide and injury purposely inflicted by intervention	32	43	25	12*	22*
Benign neoplasm & neoplasms of unspecified nature	33	101	42	101	41
Malignant neoplasm of oesophagus	34	139	57	139	49
Acute respiratory infection	35	31	28	46	31
Congenital anomalies of heart	36	9	21	26	26
Other diseases of blood and blood-forming organs	37	57	32	61	36
Other pneumonia	38	64	36	66	39
Malignant neoplasm of intestine, except rectum	39	114	54	114	48
Accidental falls	40	59	38	20*	32*
Malignant neoplasm of breast	41	90	50	90	47
Mental retardation	42	15	29	33	37
Haemolytic disease of newborn	43	1	26	1*	25*
Accidents caused by firearm missiles	44	33	35	8*	33*
Diseases of arteries arterioles & capillaries	45	123	62	122	55
Birth injury and difficult labour	46	4	27	2*	27*
Other neoplasm of lymphatic & haematopoietic tissue	47	89	53	89	50
Other endocrine and metabolic diseases	48	88	56	88	51
Malignant neoplasm of prostate	49	142	71	143	68

Table 4: Continued...

Malignant neoplasm of larynx	50	131	65	131	63
Injury resulting from operations of war	51	39	43	11*	40*
Anoxic and hypoxic conditions not elsewhere classified	52	6	30	24	44
Enteritis and other diarrhoeal diseases	53	13	39	31	45
Other diseases of nervous system and sense organs	54	69	55	70	52
Viral pneumonia	55	75	58	76	56
Infectious hepatitis	56	52	51	58	53
Neuroses, personality disorders & other non-psychotic mental disorders	57	74	60	75	61
Empyema and abscess of lung	58	120	67	119	66
Malignant neoplasm of bone	59	81	63	82	62
Other nephritis and nephrosis	59	113	66	113	66
Epilepsy	61	23	52	40	58
Other bacterial diseases	62	107	68	107	69
Anaemias	63	19	49	36	57
Conditions of placenta and cord	64	8	45	3*	46*
Multiple sclerosis	65	100	70	99	70
Psychoses	66	73	64	74	65
Avitaminoses and other nutritional deficiency	67	12	48	30	60
Accidents mainly of industrial type	68	26	59	5*	54*
Other congenital anomalies of circulatory system	69	11	47	28	59
Meningitis	70	25	61	42	64
Tuberculosis of respiratory system	71	112	73	112	72
Malignant neoplasm of skin	72	116	75	116	75
Other malignant neoplasm of uterus	73	94	74	94	73
Other diseases of musculoskeletal system and connective tissue	74	70	69	71	71
Malignant neoplasm of cervix uteri	75	122	76	122	76
Gastritis and duodenitis	76	118	80	118	77
Intestinal obstruction and hernia	76	76	72	77	74
Cholelithiasis and cholecystitis	78	119	84	119	78
Malignant neoplasm of buccal cavity & pharynx	79	124	89	124	83
Chronic rheumatic heart disease	80	102	83	102	79
Acute nephritis	81	104	85	104	81
Other tuberculosis including late effects	82	92	95	92	88
Appendicitis	82	61	77	63	80
Malignant neoplasm of rectum & rectosigmoid junction	84	125	101	125	95
Peptic ulcer	84	117	99	117	92
Viral encephalitis	86	35	79	49	84
Tuberculosis of meninges and central nervous system	87	98	102	98	99
Other helminthiasis	87	21	78	38	84
Other viral diseases	89	36	81	50	86
Hyperplasia of prostate	89	143	118	145	112
Other complication of pregnancy, childbirth and the puerperium	91	45	87	13*	81*
Other diseases of skin and subcutaneous tissue	91	46	87	55	87
Hypertrophy of tonsils and adenoids	93	68	96	69	94
Typhoid fever	94	91	107	91	103
Bacillary dysentery and amoebiasis	94	18	82	35	88
Influenza	94	42	90	53	91
Non-toxic goitre	97	53	93	59	92
Whooping cough	98	138	116	138	110
Infections of skin and subcutaneous tissue	98	84	106	84	103
Streptococcal sore throat and scarlet fever	100	29	94	44	97
Calculus of urinary system	101	111	113	111	110
Haemorrhage of pregnancy and childbirth	101	37	97	9*	90*
Spina bifida	103	63	105	65	105
Paratyphoid fever & other salmonella infections	104	27	98	43	102

Table 4: Continued...

Ancylostomiasis	104	14	91	32	99
Active rheumatic fever	104	51	102	57	105
Cleft palate and cleft lip	104	1	85	21	97
Tuberculosis of intestines peritoneum and mesenteric glands	108	80	110	81	109
Other and unspecified abortion	108	28	100	6*	95*
Diphtheria	110	10	91	27	101
Otitis media and mastoiditis	110	109	118	109	118
Non-articular rheumatism and rheumatism unspecified	110	97	117	97	118
Cholera	113	55	108	60	108
Tuberculosis of bones and joints	113	85	115	85	115
Measles	113	24	102	41	107
Arthritis & spondylitis	113	127	126	127	124
Leprosy	117	66	112	68	115
Hydatidosis	117	86	118	86	120
Thyrotoxicosis with or without goitre	117	83	118	83	120
Brucellosis	120	65	118	67	122
Tetanus	120	20	109	37	112
Acute poliomyelitis	120	34	110	47	115
Malaria	120	79	125	80	124
Sepsis of childbirth and the puerperium	120	67	118	29*	112*
Late effect of acute poliomyelitis	125	22	113	39	122
Syphilis of cenral nervous system	125	109	128	109	127
Inflammatory diseases of eye	125	121	128	121	127
Osteomyelitis and periostitis	128	40	118	51	124
Other syphilis	129	129	134	129	131
Cataract	129	133	137	133	137
Glaucoma	129	93	133	93	131
Meningococcal infection	132	60	127	62	127
Gonococcal infections	132	108	137	108	137
Diseases of breast	132	106	134	106	131
Diseases of teeth and supporting structures	135	47	128	56	130
Toxaemias of pregnancy and the puerperium	135	41	131	52	131
Ankylosis and acquired musculoskeletal deformities	135	62	131	64	131
Filarial infection	138	77	137	78	139
Delivery without mention of complication	138	56	134	18*	131*
Anthrax	140	78	140	79	140
Erysipelas	140	140	144	140	142
Schistosomiasis	140	71	140	72	140
Plague	143	146	145	146	145
Smallpox	143	146	145	146	145
Yellow fever	143	146	145	146	145
Typhus and other rickettsioses	143	146	145	146	145
Trypanosomiasis	143	146	145	146	145
Relapsing fever	143	146	145	146	145
Congenital syphilis	143	16	143	34	142
Early syphilis, symptomatic	143	1	142	21	142
Abortion induced for legal indications	143	145	145	144*	145*

Notes: For entries marked with * values of the corresponding Disc LLE and Disc EYLL were not lagged.

Estimations were carried out for year 2000 as data became available but the presentation of these results involves considerable length of tables that are avoided to save space (as in 18). However,

we state that our findings for the year 2000 also confirm a reordering of mortality risks as presented in Section 2. However, we compare mortality risk ranks for the 2 yr and present them in Section 3.

3. Tests

Here we present the results of nonparametric tests with the intention of examining if there has been any tendency for the data to shift between these two years. This is done using the Mann-Whitney U test, which detects shifts in the distribution of our mortality risk ranking. The results presented in section 2 enable us to examine ranks using nonparametric methods. We have ranks of various mortality risk measures and we wish to know if mortality risk ranking is significantly different between these two years. Differences between these two mortality data could be in the form of a shift among various causes of death between the two years. Ranks of some causes may have changed and therefore we would like to know if there are any significant changes in mortality risk ranking. Since we are dealing with ranks, nonparametric tests are used.

Procedures to carry out these tests are found in many statistical texts as in (16-19).

The Mann-Whitney U test for a change in the location of population distribution is calculated and the results are shown in Table 5. We have also calculated the Spearman rank correlation coefficient to test the strength of association between the two mortality risk rankings. For the Spearman rank correlation coefficient the null hypothesis H_0 is that the observed ranks of mortality risks in 1999 and 2000 are positively correlated against the alternative H_1 that they are independent, hence there has been no significant change in ranks. For Mann-Whitney U test, the null hypothesis H_0 is that there has been no change in mortality risk ranking from 1999 to 2000 against the alternative H_1 that there has been a shift in the distribution of mortality risk rankings.

Table 5: Nonparametric tests of mortality risk ranking

Test	Probability of death	LLE	EYLL
Coefficient of correlation r	0.9727	0.6923	0.9734
Spearman rank correlation coefficient r_s	0.9722	0.6861	0.9728
z-score	11.87	8.38	11.88
Mann-Whitney U	-0.058	-0.351	-0.074

The test statistic to take account of large samples is $z = r_s \sqrt{J-1}$ where r_s represent the Spearman rank correlation coefficient. However, the smaller value of 0.6861 for the Spearman rank correlation coefficient for LLE compared with the corresponding values of probability and EYLL indicates that there seems to be some variation in the age composition of death frequencies with probabilities of deaths remaining unchanged. This may be clearer by considering equation [2]. The interpretation is in the number of death frequencies for infants and childhood diseases that affect LLE. The LLE seem to show some variation from year to year. But, this variation does not seem to be carried through to the EYLL. The reason, we think would have to be in the properties of non-parametric statistics. EYLL is found through a non-linear operation ($p_j(LLE_j)$),

whereas ranking is a linear comparison that does not take into account the size of the difference between any two adjacent numbers. Only their relative size is important. Ranking LLE, EYLL and probability does not take into account what these numbers are explaining or are about. The fact that probabilities vary from 0 to 1 (in Table 4 from 0 to 0.16704) and that LLE vary from 0 to 66.77 i.e. the concentration or dispersion of these numbers, has nothing to do with their rank. Consequently, their product could provide a different ranking not necessarily showing any systematic dominance of either probability or LLE. As an example from Table 4, "Other causes of prenatal morbidity and mortality" probability ranks 6 and LLE ranks 5, but EYLL ranks first. Taking another example at the bottom of the Table 4, we see that conditions "Anthrax" and "Schis-

tosomiasis” rank 140 in probability, but the LLE’s are 78 and 71 while the corresponding EYLL have remained unchanged at 140. While for “Erysipelas” that has probability rank of 140 and LLE rank of 140, the corresponding EYLL rank is 144. The EYLL measure of risk averages somewhat non-linearly the information content of LLE and probability of death. The weights that are given to each element in this product are unity, i.e. giving equal weight to each, but distributions are different. p_j varies from 0 to 0.16704 (theoretically 0 to 1) and LLE is distributed from 0 to 66.77 (hypothetically up to 100 yr). Thus EYLL is a measure of risk that tells us, in a non-linear way, how much risk there is in every condition in terms of so many probable life years. In order to test for correlation in the ranks of mortality risks we use a large sample approximation (20). Our data includes 151 pairs of observations, thus z scores are calculated which are approximately distributed as standard normal. If both r and r_s in Table 5 were to be considered, they show very significant positive correlation between mortality risk ranks. The values are statistically significant at 0.001 level. The z scores which are approximately $N(0,1)$, are significant. The probability of a $z=4$ is 0.99997 see (21). Thus, we could not reject the null hypothesis of positive correlation between 1999 and 2000 mortality risk rankings and the two sets of risk rankings are highly correlated. With the Mann-Whitney U test in Table 5 we do not reject the null hypothesis and thus conclude that there were no shifts within the distribution of our mortality risk rankings. The results are statistically significant at 0.05 level. The test results in this section indicate that mortality risk measures offered in section 2 are stable across the two. Thus, these risk measures are robust across time and relay risk information consistently.

Conclusion

This study emphasizes the significance of considering measures of mortality risk that take into account life expectancies at different ages as well

as discounted and lagged symptom effects. Our results confirm findings in (5, 18) that a major reordering of mortality risk ranks takes place once we allow for the risk weighting measures. The most significant risks facing the population in both studies are heart conditions. Cancer also appears ranking high in (5) as in here. Nevertheless, aggregation and classification of health conditions make comparison difficult between this study and others. The results of nonparametric tests in Section 3, confirms that the risk rankings have remained the same for the two years. However, it has not been possible to see how public regulations could change mortality risk rankings in Iran. It has not been possible to find the corresponding regulations and the relevant data. Such impacts and their research are thought to occupy future research and we hope that this study may provide some encouragement in that respect.

Table 6: Aggregation of causes

Group	Condition	Condition(s) in Table 3
1	Infectious and parasitic diseases	1-44
2	Neoplasm (Cancer)	45-61
3	Endocrine, nutritional and metabolic disease	62-66
4	Blood disorders and blood forming organs	67-68
5	Mental disorders	69-71
6	Disorders of the nervous system	72-79
7	Diseases of the circulatory system	80-88
8	Diseases of the respiratory system	89-96
9	Diseases of the digestive system	97-104
10	Genitourinary disorders	105-111
11	Complications of pregnancy, child birth and the puerperium	112-118
12	Skin and sub-tissue disorders	119-120
13	Diseases of the musculoskeletal system	121-125
14	Congenital anomalies	126-130
15	Prenatal disorders	131-135
16	Accidents and poisoning	138-150
17	Senility without mention of psychosis (old age)	136
18	Unspecified	137,151

Acknowledgements

I would like to thank the editors and two anonymous referees for their helpful comments and suggestions. However any remaining errors remain with me. The authors declare that they have no conflicts of interest.

References

1. Aalabaf-Sabaghi M (2008). Mortality and Approximate Hazard Plots. 12th International Congress of Insurance: Mathematics and Economics, Dalian, China.
2. Aalabaf-Sabaghi M (2009). Risk Perceptions and Rationality in Measures of Risk. *Journal of Computational and Applied Mathematics*, 233: 46-50.
3. Viscusi WK (1993). The Value of Risks of Life and Health. *Journal of Economic Literature*, 31(4): 1912-46.
4. Viscusi WK (1995). Discounting Health Effects for Medical Decisions. In: F.A. Sloan. Ed, Valuing Health Care. Cambridge University Press, pp. 125-48.
5. Viscusi WK, Hakes JK, Carlin A (1997). Measures of Mortality Risks. *Journal of Risk and Uncertainty*, 14: 213-33.
6. Viscusi WK, Moore MJ (1989). Rates of Time Preference and Valuations of the Duration of Life. *Journal of Public Economics*, 8(3): 393-417.
7. Moore MJ, Viscusi WK (1988). The Quality-Adjusted Value of Life. *Economic Inquiry*, 26(3): 369-88.
8. Pratt JW, Zeckhauser J (1996). Willingness to Pay and the Distribution of Risk and Wealth. *Journal of Political Economy*, 104 (4): 747-63.
9. Jenni KE, Lowenstein G (1997). Explaining the "Identifiable Victim Effect". *Journal of Risk and Uncertainty*, 14: 235-257.
10. Weitzman M (2001). Gamma Discounting. *American Economic Review*, 91(1): 260-71.
11. Zanjani H, Noorallahi T (1999). The Iranian Life Table for 1996. The Higher Institute for Social Security Research, Tehran, Iran.
12. Brown RL (1997). Introduction to the Mathematics of Demography. 3rd ed. Actex Publications.
13. Mortality Table Annual Almanac (1999). Iranian Ministry of Health, Tehran, Iran, publication No. 341, www.amar.hbi.or.ir.
13. Diamond P (1992). Organizing the Health Insurance Market. *Econometrica*, 60(6): 1233-54.
14. Sloan FA (1995). Valuing health Care. Cambridge University Press.
16. Spatz C and Johnston JO (1989). Basic Statistics. 4th ed. Brooke/Cole Publishing Company.
17. Mortality Table Annual Almanac (2000). Iranian Ministry of Health, Tehran, Iran, publication No. 345. www.amar.hbi.or.ir.
15. Aalabaf-Sabaghi M (2002). Mortality Risk in Iran. 6th International Congress of Insurance: Mathematics and Economics, ISEG, Lisbon, Portugal, and at the annual meeting of the American Risk and Insurance Association (ARIA), Montreal, Canada.
16. Daniel WW (1990). Applied Nonparametric Statistics. 2nd ed. PWS-Kent Publishing Company.
17. Eeckhoudt LT, Hammitt JK (2001). Background Risks and the Value of a Statistical Life. *Journal of Risk and Uncertainty*, 23(3): 261-79.
18. Lundley DV, Miller JCP (1952). Cambridge Elementary Statistical Tables. Cambridge University Press.