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Short Communication

Years of Potential Life Lost as the Indicator of Premature Mortality in Occupational Medicine

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Abstract

Measurement of premature mortality is necessary to plan medical programs and to conduct effective medical activities. The purpose of this study was to compare the years of potential life lost (YPLL) with other mortality indices and to understand the usefulness and limitations of quantitative measurement for premature mortality. Data concerning death during employment were surveyed from 1979 to 1984. One thousand seven hundred twenty-five deaths were observed in 1,504,462 person-years in the study population. Proportionate mortality ratios indicated medical problems concerning malignant neoplasms and heart disease, but they could not identify the problems of suicide and traffic accidents occurring in the relatively younger group. YPLL by a constant end point at 60 years of age could rank these causes next below the major leading causes of death. Thus, YPLL might be a useful indicator of the problems concerning premature mortality in occupational medicine.

Key words: Years of Potential Life Lost (YPLL), Premature mortality, Occupational medicine, Healthy worker effect, Age-adjusted mortality rate

Introduction

A reduction in premature mortality is a central goal of occupational health practice [1]. Therefore, it is necessary to quantify premature mortality in the occupational field to establish medical policy and evaluate medical actions taken in occupational medicine.

Some statistics such as age-adjusted mortality rates have been widely used as health indicators [2]. However, these indicators may fail to adequately reflect premature mortality in younger groups, because these are dominated by the underlying disease process of the elderly [3].

Years of potential life lost (YPLL)[4] or working years lost [5] are both recognized as approaches to quantitatively measuring premature mortality.

The purpose of this study is to compare YPLL with other ordinary mortality indices and to evaluate the usefulness and the limitations of YPLL as an occupational medical indicator.

Subjects and Method

This survey was conducted in a securities-related company from 1979 to 1984. The death cases were collected for persons under employment and data regarding age and the cause of death were gathered on the basis of death certificates. The number of male death cases was 1,725 during the observation period. The cause of death was re-coded in accordance with the International Classification of Disease modified 9th version. Sixty-nine cases were excluded from the following analysis because cause of death could not be confirmed.

The number of person-years and the death cases by age are shown in Table 1. The distribution of age ranged from 18 to 60 years among the observed subjects.

The causes of death were classified into the following 9 groups: malignant neoplasms (ICD 9; 140-208), heart disease (ICD 9; 393-398, 401-405, 410-429), cerebrovascular disease

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Table 1 Number of subjects and death cases by age during the observation period.

Age	Person-years	Death cases
18-19	36,997	8 (1)
20-24	190,880	57 (3)
25-29	293,348	103 (7)
30-34	310,562	143 (11)
35-39	218,579	152 (6)
40-44	128,350	125 (7)
45-49	97,532	197 (8)
50-54	148,696	513 (17)
55-59	79,518	427 (9)
Total	1,504,462	1,725 (69)

Parentheses indicate the cases whose cause of death was not certified.

(ICD 9; 430-438), pneumonia and bronchitis (ICD 9; 466, 480-486, 490, 491, 493), digestive tract and liver disease (ICD 9; 531-533, 555, 556, 558, 562), kidney disease (ICD 9; 580-589), suicide (ICD 9; E950-E959), unintentional injuries (ICD 9; E810-E819) and traffic accidents (ICD 9; E820-E825).

The following statistics were calculated:

Age-adjusted mortality rate was based on direct standardization[2]. The reference population was based on the Japanese population in 1981 estimated by the Statistics Bureau, Management and Coordination Agency[6]. The rate was expressed per 100,000 subjects.

The standardized mortality ratio (SMR) and 95% confidence interval were calculated based on indirect adjustment of age[2]. The reference age-specific mortality rate was based on the Vital Statistics in 1981 from the Statistics and Information Department, Ministry of Health and Welfare, Japan[7]. The confidence interval of the SMR was based on Ederer's method[8]. The proportionate mortality ratio (PMR) was a ratio of cause-specific SMR to the all causes SMR. SMR is considered to provide information on a study group's overall dying, but PMR is considered to be a tool for estimating cause-specific risks[9].

Two common weighting systems for YPLL are the remaining life expectancy (RLE)[10] and the constant end point (CEP)[4] methods. In the YPLL based on the CEP method, YPLL was tabulated by subtracting the age of death from the defined end point life. In this study, two endpoints, 60 and 65 years of age, were used. The life expectancy at a specified age was based on Vital Statistics in 1981 from the Statistics and Information Department, Ministry of Health and Welfare, Japan[7]. The YPLL was expressed as the summation of years of each cause.

Results

The differently weighted YPLLs and age-adjusted mortality rates are shown in Table 2. This table consists of the following statistics; observed death cases, SMR and 95% confidence interval, PMR, direct age-adjusted rate, YPLL weighted by RLE, and YPLL weighted by CEP at 60 y.o. and 65 y.o.

According to the age-specific mortality rates, the leading cause of death was malignant neoplasms. Heart disease, cerebrovascular disease, and digestive tract and liver disease followed malignant neoplasms.

All SMRs were less than 1.0 and significantly lower than for the reference population. PMRs for malignant neoplasms and heart disease were over 1.0, but PMRs for other causes were under 1.0. The YPLL weighted by CEP at 60 y.o. and 65 y.o. and YPLL by weighted RLE were 22,528 and 30,808 and 50,280.53, respectively.

Table 3 shows the mean age at death and three YPLLs. Mean ages at death for suicide, unintentional injuries, and traffic accidents were significantly younger than those of other causes of death. Mean YPLLs for suicide, unintentional injuries, and traffic accidents were significantly higher than those of other causes of death as determined by the analysis of variance.

Figure 1 indicates the proportional distribution of the causes of death. This figure presents mortality rates. Using the age-adjusted mortality rates, malignant neoplasms represented 43.7% of the total mortality rate, followed by heart disease (16.9%), cerebrovascular disease (12.6%), digestive tract and liver disease (8.0%), suicide (6.9%) and traffic accidents (5.4%).

Using the YPLL by CEP at 60 y.o., the first and second leading causes were similar to those in the age-adjusted mortality rates. In contrast, they were followed by suicide (12.4%), traffic accidents (11.8%), and cerebrovascular disease (10.3%).

Figure 2 indicates the proportional distribution of the caus-

Table 2 Age-adjusted mortality rates and YPLL by cause of death.

Cause	No. of death	SMR[1] (95% C.I.)	PMR[2]	Age-adjusted rate	YPLL[3]		
					RLE[4]	CEP[5]	
						60 y.o.	65 y.o.
Malignant neoplasms	707	0.75 (0.68-0.83)	1.51	55.27	19,887.28	7,891	11,426
Heart disease	277	0.61 (0.52-0.71)	1.22	21.31	8,244.36	3,580	4,965
Cerebrovascular disease	205	0.48 (0.41-0.57)	0.97	15.90	5,787.39	2,316	3,341
Pneumonia and bronchitis	23	0.32 (0.19-0.52)	0.64	1.79	615.32	220	335
Digestive tract and liver disease	126	0.46 (0.37-0.58)	0.93	10.22	3,451.38	1,304	1,934
Kidney disease	17	0.41 (0.22-0.74)	0.82	1.22	470.48	181	266
Suicide	127	0.32 (0.26-0.39)	0.64	8.73	4,825.33	2,796	3,431
Unintentional injuries	70	0.33 (0.25-0.44)	0.66	5.12	2,700.83	1,584	1,934
Traffic accidents	104	0.42 (0.33-0.53)	0.84	6.83	4,298.16	2,656	3,176
Total	1,656	0.54 (0.51-0.58)	1.00	126.39	50,280.53	22,528	30,808

1: standardized mortality ratio
2: proportionate mortality ratio
3: years of potential life lost
4: remaining life expectancy method
5: constant end point method

Table 3 Mean age at death and YPLL by cause of death.

Cause	Age at death	YPLL[1]		
		RLE[2]	CEP[3]	
			60 y.o.	65 y.o.
Malignant neoplasms	48.8 ± 8.4	28.1 ± 7.6	11.2 ± 8.4	16.2 ± 8.4
Heart disease	47.1 ± 10.3	29.8 ± 9.4	12.9 ± 10.3	17.9 ± 10.3
Cerebrovascular disease	48.7 ± 8.0	28.2 ± 7.1	11.3 ± 8.0	16.3 ± 8.0
Pneumonia and bronchitis	50.4 ± 8.3	26.8 ± 7.4	9.6 ± 8.3	14.6 ± 8.3
Digestive tract and liver disease	49.7 ± 7.8	27.4 ± 7.0	10.4 ± 7.8	15.4 ± 7.8
Kidney disease	49.4 ± 9.0	27.7 ± 8.2	10.7 ± 9.0	15.7 ± 9.0
Suicide	38.0 ± 10.5[b]	38.0 ± 9.7[‡]	22.0 ± 10.5[¶]	27.0 ± 10.5[#]
Unintentional injuries	37.4 ± 10.9[b]	38.6 ± 10.1[‡]	22.6 ± 10.9[¶]	27.6 ± 10.9[#]
Traffic accidents	34.5 ± 11.2[b]	41.3 ± 10.4[‡]	25.5 ± 11.2[¶]	30.5 ± 11.2[#]
Total	46.5 ± 10.3	30.4 ± 9.3	13.6 ± 10.3	18.6 ± 10.3

Figures indicate mean ±S.D. (years).
1: years of potential life lost
2: remaining life expectancy method
3: constant end point method
[b]: Mean ages at death for suicide, unintentional injuries, and traffic accidents were significantly younger than those for other causes of death based on analysis of variance.
[‡¶#]: Mean YPLLs for suicide, unintentional injuries, and traffic accidents were significantly higher than those for other causes of death based on analysis of variance.

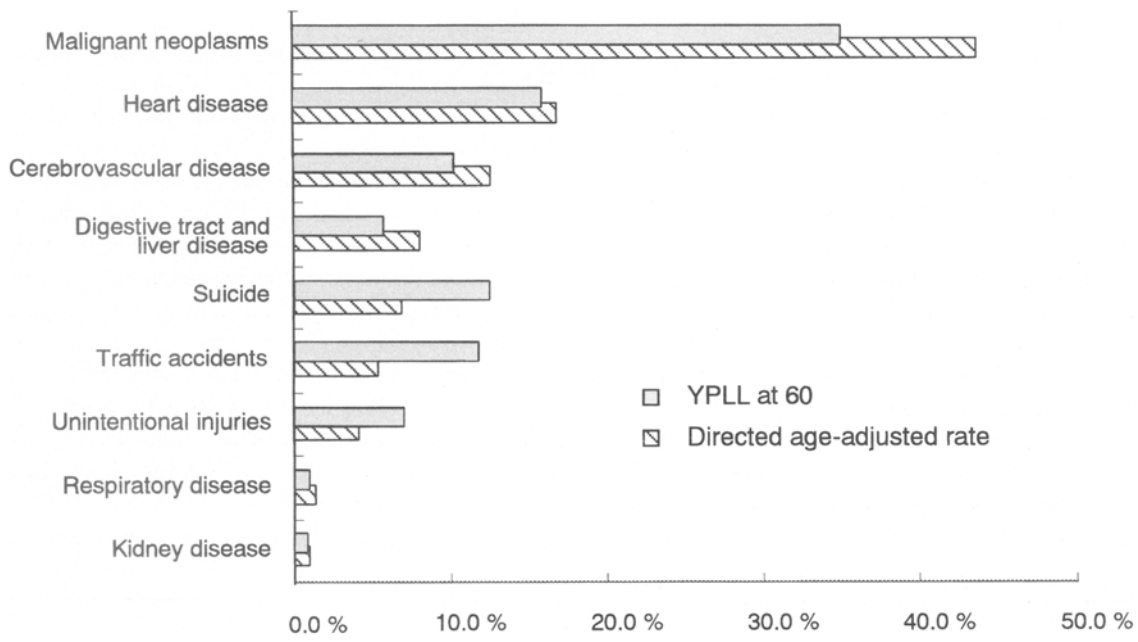

Figure 1 Proportions of causes of death by direct age-adjusted rate and YPLL at 60.

es of death for three different YPLLs. In comparison with these YPLLs, YPLLs weighted by CEP had similar orders of causes of death. But the order of YPLL weighted by RLE was different from those of YPLLs weighted by CEP. Using the YPLL weighted by RLE, the first and second leading causes were similar to those of YPLLs weighted by CEP; however, the third leading cause was cerebrovascular disease (11.5%). The YPLL weighted by RLE was similar to that of the age-adjusted mortality rates.

Discussion

Reduction of premature mortality during employment has been one of the central goals of occupational medicine [1]. For effective medical activities, the status of premature mortality should be evaluated quantitatively. Direct and indirect age-adjusted mortality rates have been used as mortality indices to elucidate the medical problems in occupational medicine [2].

However, Gaffey [11] pointed out that SMR did not explicitly take into account the age at which the observed death occurred, only how many deaths there were. Yerushalmy [12] pointed out that age-adjusted mortality rates put relatively heavy emphasis and penalties on minor proportionate changes at older ages.

The limitations associated with age-adjusted mortality data have led to the development of alternative methods to summarize mortality experience of younger persons [3]. YPLL has been available as an indicator of premature mortality. Romeder et al.[13] reported that the concept of potential years of life lost originated with the primary object of comparing the relative importance of

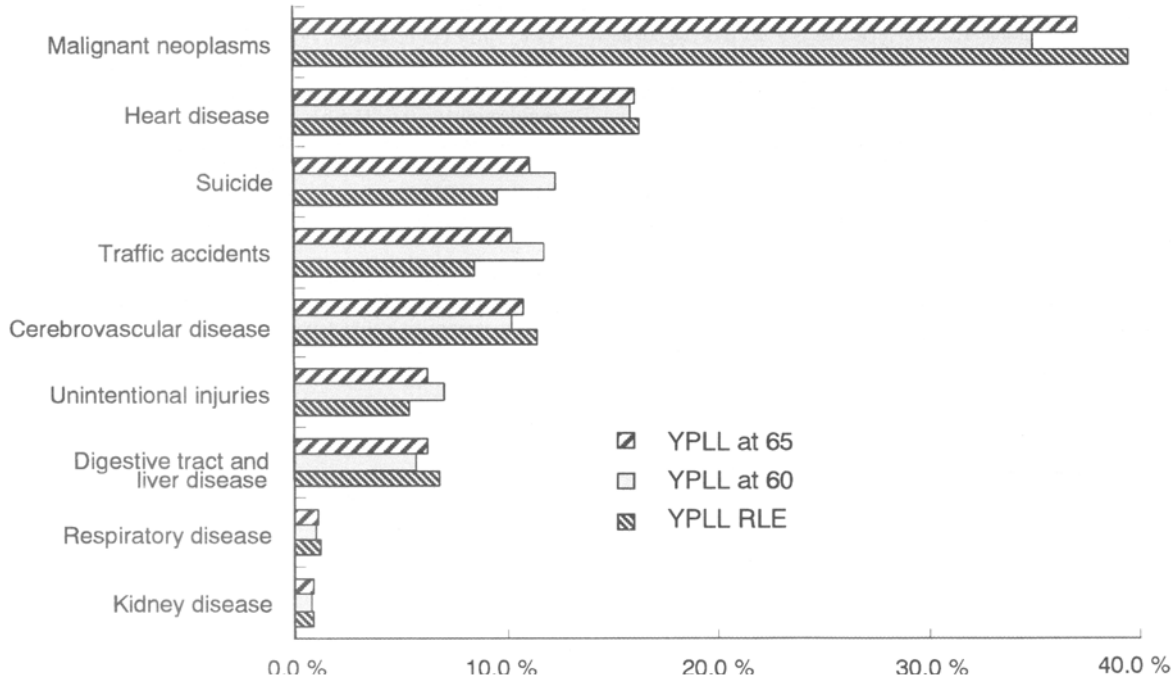

Figure 2 Proportions of causes of death by three different YPLLs.

different causes of death for a particular population.

The purpose of this study was to compare the YPLL with ordinary mortality indices [2] and to identify the limitations of using YPLL as a risk indicator of premature mortality.

The healthy worker effect [14] was observed in the subjects of this study because all cause-specific SMRs were significantly lower than 1.0. The cause-specific PMR revealed that malignant neoplasms and heart disease were regarded as the major medical problems among Japanese employees [15, 16]. On the basis of PMR, medical problems concerning malignant neoplasms and heart disease were observed. But medical problems concerning traffic accidents and suicide in the younger group were not detectable, as cause-specific PMRs concerning these causes were less than 1.0. In contrast, on the basis of YPLL weighted by CEP at 60 y.o., suicide and traffic accidents ranked next below the leading causes of death. YPLL weighted by CEP at 60 y.o. made it possible to elucidate medical problems of younger groups.

It was necessary to illustrate the sensitivity of the method to choose the cutoff age for calculation of YPLL. The proportion of causes mainly occurring in the younger group was higher in the YPLL weighted by CEP at 60 y.o. than in the YPLL by CEP at 65 y.o. and the YPLL weighted by RLE. Therefore, YPLL weighted by CEP at 60 y.o. might be desirable as an indicator for measuring premature mortality in the occupational field. Seventy years of age was recommended as the cutoff age for Canadian males [13], as the age of the subjects in the study ranged from 1 to 70. Because the age of subjects in occupational medicine usually restricted to from 18 to 60 years old, a cutoff age of 70 was considered to be rather old to represent premature mortality.

YPLL is designed to give a broad view of the relative importance of major causes of premature mortality. This index is useful for health planners who intend to define properties and programs for prevention of premature mortality [13]. However, there are few statistical methods to compare the YPLLs of different populations with different distributions. The age-adjusted rate of YPLL based on direct standardization [13] is one of the methods used to compare two or more different populations. Wise et al.[3] reported that little was gained from the standardization of YPLL for monitoring year-to-year trends in a relatively stable population.

For health planning concerning early preventive medical activity from premature mortality, other dimensions such as morbidity and disability should be taken into account. Some diseases such as diabetes mellitus, which plays an important role in the incidence of chronic diseases, may fail to be recognized as a cause of death.

In summary, YPLL is a simple statistical method that can be used to identify the relative importance of premature mortality in occupational medicine.

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