

Person-Years of Life Lost Due to Cancer in the United States, 1970 and 1984

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Abstract: The number of deaths due to cancer in the United States reached an all-time high of 453,450 deaths in 1984 and, due to the dynamics of population growth, will continue to increase if the risk of dying from cancer does not change.

Between 1970 and 1984, the total Person-Years of Life Lost (PYLL), the sum of the difference between the actual age at death and the expected remaining lifetime for each person who died of cancer, increased for most cancer sites as well as for all sites combined. In 1984, 6,881,281 person-years of life were lost due to cancer deaths, up from 5,303,668 in 1970. The exceptions are those cancers for which there has been major progress in either prevention or treatment; e.g., stomach and cervix uteri (prevention) and

testicular, Hodgkin's disease, leukemia, and childhood cancers (treatment).

The Average Years of Life Lost (AYLL) per person dying from cancer in 1984 was generally less than in 1970. Overall, each person who died from cancer in 1984 died 15.2 years earlier than his/her life expectancy. The greatest loss was for those who died of childhood cancers (66.9 years earlier), followed by testicular cancer (35.8 years earlier). The least loss relative to the expectation of life was for those who died of prostate cancer. The 25,400 men who died from prostate cancer in 1984 died an average of nine years earlier than otherwise expected. (*Am J Public Health* 1989; 79:1490-1493.)

Introduction

Deaths due to cancer accounted for 453,450 deaths in 1984¹ in the United States, second only to heart disease. Many of these deaths may be postponed or avoided entirely through the use of appropriate interventions such as primary prevention, screening/early detection, and increased application of state-of-the-art treatment.² A death which occurs before the end of average life expectancy is, by definition, a premature death. The age-adjusted and age-specific cancer mortality rates do not fully address the issue of premature mortality and therefore other measures are needed.³

Person-Years of Life Lost (PYLL) considers a cancer death to be premature in that the death occurred earlier than it would have occurred in the absence of that cancer.

Average Years of Life Lost (AYLL) is the average of the differences between the actual ages at death and the expected remaining years of life for each person who died of cancer.

In our computation of PYLL and AYLL we have used age-based and sex-specific estimates of the length of life remaining rather than fix an upper bound on length of life at age 65 such as has been used by others.

Taken together, the PYLL and the AYLL reflect the cost of dying from cancer in terms of lost years of life expectancy. They may also be used to assist in the evaluation of cancer control progress and to provide guidance for resource allocation in cancer prevention and control. We examined PYLL and AYLL for cancer in 1970 and 1984.

Methods

The numbers of cancer deaths for both 1970 and 1984 and information on the underlying cause of death as well as demographic information such as age, sex, race, and other items for each death occurring annually in the United States were obtained from the National Center for Health Statistics (NCHS). The deaths have been categorized by anatomic site of the cancer, sex, and age at death for each calendar year.

For each cancer death which occurred in either 1970 or 1984, the PYLL was estimated by taking the difference between the actual age at which the person died and the expectation of remaining life for an individual matched by age and sex for each of 1970 and 1984 as obtained from life tables published yearly by the NCHS.^{5,6} These differences were then summed over all persons dying of cancer for 1970 and for 1984.

The AYLL is a statistical average arrived at by simply dividing the total PYLL by the number of people affected. From Table 1, 4,564 women died prematurely from cancer of the cervix uteri in 1984 for a total of 105,899 person-years of life lost or an average of 23.2 years of life lost for each of the 4,564 women.

Results

Tables 1, 2, and 3 have for both 1970 and 1984 the numbers of cancer deaths in the United States, the total number of person-years of life lost due to cancer, and the average years of life lost for those who died of cancer. The cost in average years of life lost was greater for women (17.1) than for men (13.5) in 1984, due in part to the greater life expectancy for women compared to men, 78.2 years and 71.2 years, respectively. Even though there were fewer women than men dying from cancer in 1984 (210,687 versus 242,763), the women lost more potential years of life, 3.6 million compared to 3.3 million for men. For both sexes combined, lung cancer caused the loss of the most total person-years of life in 1984 followed by breast and colorectal cancer (Figure 1). Deaths due to testicular cancer, because of the small numbers of deaths, cost the fewest total person-years of life among those cancer sites investigated.

In contrast, the greatest average years of life lost per person dying of cancer was for childhood cancers (Figure 2), followed by deaths due to testicular cancer, Hodgkin's disease, cancer of the cervix uteri, brain cancer and finally malignant melanoma, each of which caused death more than 20 years before the life expectancy.

In 1984 the most costly cancer for women was cancer of the breast which caused a loss of over 760,000 person-years of life among 39,470 women, up 28 percent from 1970. These women died an average of 19.3 years earlier than expected. Mass screening programs have suggested that the mortality

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TABLE 1—Potential Years of Life Lost (PYLL) and Average Years of Life Lost (AYLL) due to Premature Deaths from Cancer in the United States, all Races, both Sexes, 1970 and 1984

Cancer Sites	Number of Deaths		PYLL		AYLL	
	1970	1984	1970	1984	1970	1984
All sites	329,375	453,450	5,303,668	6,881,281	15.1	15.2
Oral cavity	7,610	8,461	117,854	134,095	15.5	15.8
Esophagus	5,969	8,657	87,905	126,758	14.7	14.6
Stomach	16,020	14,246	209,706	191,045	13.1	13.4
Colon & rectum	45,924	57,510	615,264	744,941	13.4	13.0
Pancreas	17,885	23,154	246,952	315,020	13.8	13.6
Lung	65,003	118,565	989,335	1,757,001	15.2	14.8
Melanoma (skin)	3,146	5,377	66,900	110,765	21.3	20.6
Breast	29,912	39,720	597,050	763,511	20.0	19.2
Cervix uteri	6,547	4,564	146,261	105,899	22.3	23.2
Corpus uteri	5,468	5,965	88,100	89,563	16.1	15.0
Ovary	9,831	11,208	193,462	200,279	19.7	17.9
Prostate gland	17,249	25,400	156,281	228,597	9.1	9.0
Testis	760	401	26,693	14,343	35.1	35.8
Urinary bladder	9,011	9,714	101,023	103,176	11.2	10.6
Kidney	6,103	8,411	100,310	127,937	16.4	15.2
Brain & CNS	6,027	9,866	153,882	215,805	25.5	21.9
Hodgkin's disease	3,410	1,960	89,249	53,022	26.2	27.1
Non-Hodgkin's lymphoma	9,592	14,486	176,232	232,071	18.4	16.0
Multiple myeloma	4,417	7,470	63,042	100,736	14.3	13.5
Leukemia	14,492	17,212	333,439	320,480	23.0	18.6
Childhood	3,611	1,884	233,435	125,951	64.6	66.9

TABLE 2—Potential Years of Life Lost (PYLL) and Average Years of Life Lost (AYLL) due to Premature Deaths from Cancer in the United States, all Races, Males, 1970 and 1984

Cancer Sites	Number of Deaths		PYLL		AYLL	
	1970	1984	1970	1984	1970	1984
All sites	179,352	242,763	2,558,996	3,284,558	14.0	13.5
Oral cavity	5,495	5,764	79,810	87,527	14.5	15.2
Esophagus	4,442	6,312	62,308	90,091	14.0	14.3
Stomach	9,802	8,469	121,490	107,681	12.4	12.7
Colon & rectum	22,117	27,989	269,512	338,649	12.2	12.1
Pancreas	10,061	11,516	130,937	149,202	13.0	13.0
Lung	52,680	82,385	751,081	1,113,112	14.3	13.5
Melanoma (skin)	1,735	3,207	34,394	62,209	19.8	19.4
Breast	265	250	3,552	3,409	13.4	13.6
Prostate gland	17,249	25,400	156,281	228,597	9.1	9.0
Testis	760	401	26,693	14,343	35.1	35.8
Urinary bladder	6,257	6,600	66,853	66,762	15.3	14.4
Kidney	3,858	5,201	59,091	74,664	15.3	14.4
Brain & CNS	3,434	5,395	81,686	111,329	23.8	20.6
Hodgkin's disease	2,016	1,204	50,566	31,461	25.1	26.1
Non-Hodgkin's lymphoma	5,233	7,312	94,256	115,937	18.0	15.9
Multiple myeloma	2,340	3,737	30,269	46,449	12.9	12.4
Leukemia	8,128	9,378	174,139	166,464	21.4	17.8
Childhood	2,039	1,073	125,194	68,257	61.4	63.6

from breast cancer can be reduced by 30 percent through screening.^{7,8} If so, a screening program could prevent about 11,800 breast cancer deaths per year. If these 11,800 women were to live to their full life expectancy, about 227,000 person-years of life could be saved yearly.

The 36,180 women who died from lung cancer in 1984 lost a total of 643,889 person-years of life, almost triple the 1970 figure of 238,254 person-years. In 1984, these women died an average of 17.8 years before expected, an improvement over 1970 when female lung cancer victims died 19.3 years before their life expectancy. It is believed that about 75 percent of lung cancer deaths among women are caused by cigarette smoking.⁹ Preventing 75 percent of these lung cancer deaths could result in the postponement of death by

some 19 years for over 27,000 women annually. This would result in the saving of over 500,000 person-years of life every year.

Additionally, 75 percent of the deaths due to cancer of the cervix uteri are thought to be preventable through screening with the Pap smear.¹⁰ Pap smear screening could potentially extend the lives of 3,400 women by 23 years each for a total savings of 78,200 person-years of life.

Dramatic improvements have been noted in the person-years of life lost among women between 1970 and 1984 for Hodgkin's disease with a 44 percent decrease and, most dramatically, childhood cancers with less than half as many person-years of life lost in 1984 than in 1970. Smaller decreases are seen for cancers of the stomach and for

TABLE 3—Potential Years of Life Lost (PYLL) and Average Years of Life Lost (AYLL) due to Premature Deaths from Cancer in the United States, all Races, Females, 1970 and 1984

Cancer Sites	Number of Deaths		PYLL		AYLL	
	1970	1984	1970	1984	1970	1984
All sites	150,023	210,687	2,744,672	3,596,723	18.3	17.1
Oral cavity	2,115	2,697	38,043	46,568	18.0	17.3
Esophagus	1,527	2,345	25,597	36,667	16.8	15.6
Stomach	6,218	5,777	88,216	83,364	14.2	14.4
Colon & rectum	23,807	29,521	345,751	406,293	14.5	13.8
Pancreas	7,824	11,638	116,015	165,817	14.8	14.2
Lung	12,323	36,180	238,254	643,889	19.3	17.8
Melanoma (skin)	1,411	2,170	32,507	48,556	23.0	22.4
Breast	29,647	39,470	593,498	760,102	20.0	19.3
Cervix uteri	6,547	4,564	146,261	105,899	22.3	23.2
Corpus uteri	5,468	5,965	88,100	89,563	16.1	15.0
Ovary	9,831	11,208	193,462	200,279	19.7	17.9
Urinary bladder	2,754	3,114	34,171	36,414	12.4	11.7
Kidney	2,245	3,210	41,219	53,273	18.4	16.6
Brain & CNS	2,593	4,471	72,197	104,476	27.8	23.4
Hodgkin's disease	1,394	756	38,683	21,561	27.7	28.5
Non-Hodgkin's lymphoma	4,359	7,174	81,976	116,135	18.8	16.2
Multiple myeloma	2,077	3,733	32,773	54,287	15.8	14.5
Leukemia	6,364	7,837	159,300	154,015	25.0	19.7
Childhood	1,572	811	108,241	57,695	68.9	71.1

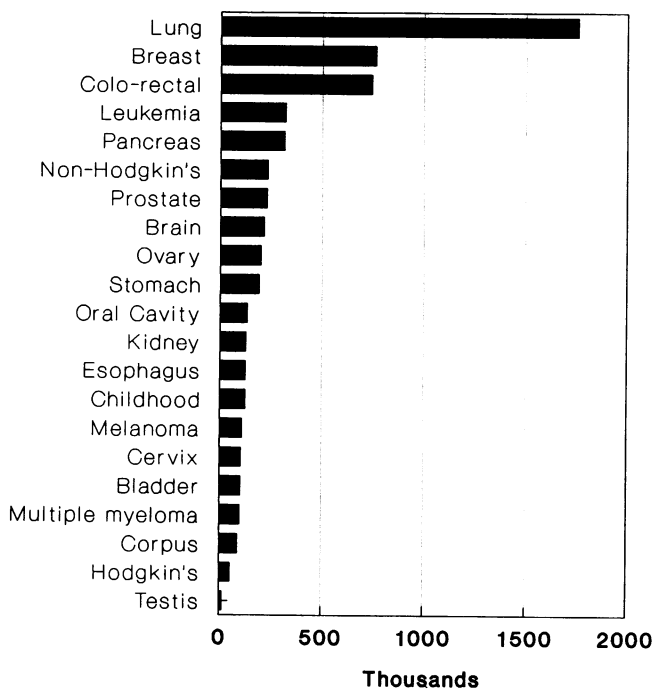


FIGURE 1—Person-Years of Life Lost (PYLL) due to Cancer, all Races, both Sexes, 1984

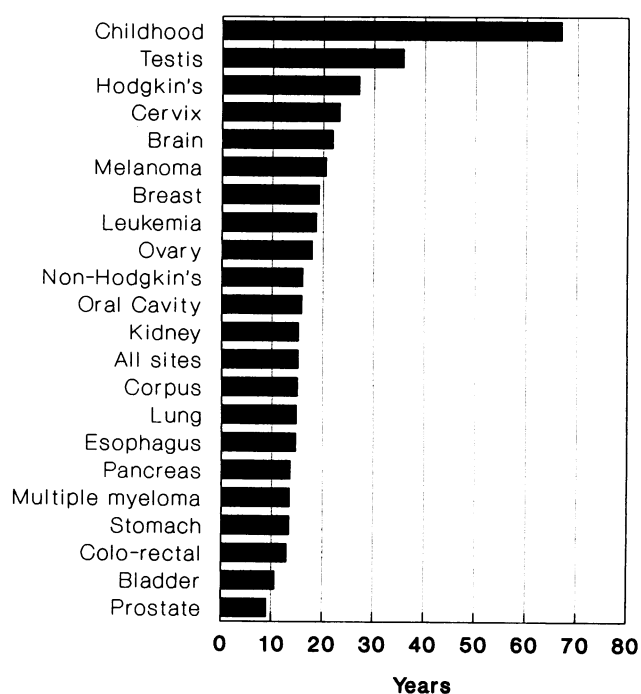


FIGURE 2—Average Years of Life Lost (AYLL) due to Cancer Deaths, all Races, both Sexes, 1984

leukemias.

Among men, lung cancer was the most deadly cancer causing the loss of the most person-years of life in 1984. Over 1.1 million person-years of life were lost among 82,385 men who died of lung cancer an average of 13.5 years earlier than otherwise expected. If 80 percent of these deaths could be avoided through prevention, almost 900,000 person-years of life could be gained annually.

Colorectal cancer deaths accounted for 338,649 lost person-years of life in 1984, up by 26 percent since 1970. Each man who died from colorectal cancer in 1984 died, on the

average, 12.1 years before he would have otherwise expected to die.

Deaths from prostatic cancer among 25,400 men cost almost 229,000 person-years of lost life in 1984 as these men died nine years before their average life expectancy would predict.

Five cancer sites among those examined actually demonstrated decreases in the number of person-years of life lost due to cancer deaths between 1970 and 1984. Both testicular and childhood cancer had decreases in the person-years of life lost of about 45 percent from 1970 to 1984 amounting to

a savings of 69 thousand person-years of life in 1984 alone. The improvement in testicular cancer is primarily due to the development of curative chemotherapy for nonseminoma cases which has increased the five-year survival rate to over 80 percent.^{14,15} Although testicular cancer is relatively rare, it causes death an average of 35.8 years before the normal life expectancy. Male childhood cancer victims died 63.6 years earlier than expected in 1984 with 68,257 person-years of life lost among 1,073 boys. Additional savings are seen for Hodgkin's disease, a 38 percent improvement; stomach cancer, an 11 percent improvement; and a 4 percent improvement for leukemia.

Discussion

The methodology used here differs from that used in previous investigations in that here we have used the life expectancy as the endpoint rather than age 65.¹¹⁻¹³ We believe that the life expectancy is a more appropriate endpoint for such an analysis because a large proportion of cancer deaths, about 65 percent, as well as 70 percent of non-cancer deaths occur over the age of 65 and today people remain productive and active well beyond the classical retirement age of 65. Further, we would argue that any death which is either preventable or avoidable, and which occurs before the end of the affected person's normal lifespan, is premature and hence should contribute to person-years of life lost. It should be noted that in 1984, a person 65 years old could expect to live for another 16.8 years.

The PYLL and AYLL are estimates of the differences between the actual age at death and the expected age at death considering all possible causes of death weighted by their occurrence in the population at large. These estimates do not depend on the date of diagnosis nor on the time between diagnosis and death (survival) and thus are free of some of the problems inherent in the interpretation of trends in incidence and survival rates due to diagnostic artifacts such as lead time bias.

Ideally we would like the PYLL to decrease over time. However, due to the aging of the population and to the increasing size of the population and therefore the greater numbers of persons at risk of death from cancer, it is possible for the PYLL to increase without an increase in the age-sex-specific risk of dying of cancer. The PYLL then estimates the actual impact of the cancer deaths on the population in terms of total person-years of life lost every year. As the impact of competing causes of death on the population lessens, the PYLL due to cancer will continue to become numerically larger in the United States for the reasons outlined above.

On the other hand, the AYLL (Average Years of Life Lost) estimates the joint effects of the changes in the cancer patients' ages at death and the change in the population life expectancy. The life expectancy at birth of the United States

population increased by almost four years between 1970 and 1984, from 70.9 to 74.7, respectively. The expectation of remaining life also increased between 1970 and 1984 for all races combined, for each sex, and at every age with larger increases for younger persons and lesser increases for older persons. For making comparisons over time, we can artificially hold the overall life expectancy constant. In so doing, the comparison of two AYLLs shows the change in the average loss of expected life-years per cancer death.

It is important to note that the AYLL is based only on those people who die from cancer and therefore does not provide an estimate of either cure or prevention. For example, the number of people dying from testicular cancer decreased from 760 in 1970 to 401 in 1984 due to the advent of curative treatment but the AYLL increased because of different age and stage distributions between those who died and those who were cured. We also note that with no change in cancer patient survival, the AYLL would be expected to increase in accordance with the increasing life expectancy of the United States population. Therefore, we consider any changes in AYLL as a conservative (pessimistic) estimate of the curative life extension impact of cancer treatment.

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