The economic costs of illness: A replication and update

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The economic burden resulting from illness, disability, and premature death is of major importance in the allocation of health care resources and in the evaluation of health research and programs. This article updates the 1963 and 1972 studies of the costs of illness. In 1980, the estimated total economic costs of illness were $455 billion: $211 billion for direct costs, $68 billion for morbidity, and $176 billion for mortality. Diseases of the circulatory system and injuries and poisonings were the most costly, with variations in the diagnostic distributions among the three types of costs and by age and sex.

Introduction

The economic costs of illness continue to play an important role in decisionmaking regarding the allocation of resources in the health sector. They represent the monetary burden on society of illness and premature death. Economic costs represent forgone alternatives and are measured in terms of direct and indirect costs. Direct costs are the value of resources that could be allocated to other uses in the absence of disease, and indirect costs are the value of lost output because of cessation or reduction of productivity caused by morbidity and mortality. Morbidity costs are wages lost by people who are unable to work because of illness and disability and an imputed value for those persons too sick to perform their usual housekeeping services. Mortality costs are the present value of future earnings lost by people who die prematurely.

Cost-of-illness estimates continue to be in demand by health planners, policymakers, and researchers. Estimates are used to set priorities, make program policy decisions, prepare and deliver Congressional testimony, and to support agency budgets. There have been more than 200 separate cost-of-illness studies in the last 20 years (Hu and Sandifer, 1981). Some of these are national in scope, but most are limited to a selected population of geographic area, and all but a few are restricted to one or a few disease categories.

Several recent legislative interests and developments illustrate the importance of cost-of-illness data and the need for updating the earlier national estimates. The Health Services Research, Health Statistics, and Health Care Technology Act of 1978, Public Law 95-623, specifically discusses the methodology for estimating the costs of illness in its request that a study of the costs of environment-related health effects be conducted by the Institute of Medicine of the National Academy of Sciences. A comprehensive report was prepared, including a review of the methodologies used in developing such estimates. The report states: "There is a need for continuing estimates of the economic costs of disease that are national in scope and cover a broad spectrum of disease categories." (Institute of Medicine, 1981).

An important example of the use of these estimates is in their application to the health risks associated with smoking. Morbidity and mortality associated with smoking drain our economy heavily by reducing economic production through excess morbidity and premature death and by diverting scarce resources from other needs. The Office of Smoking and Health in the U.S. Public Health Service, the Office of Technology Assessment, and the U.S. Congress recently have focused on the need for improving the methodology for estimating the economic costs of smoking. Special interest has been expressed by the House Ways and Means Committee in the estimates of costs of smoking. The authors are currently developing more refined estimates of the economic costs of smoking by applying the proportion of health care services, illness, and deaths attributed to smoking to the total economic costs of illness presented in this article (Rice and Hodgson, 1983).

The direct costs of illness in 1980 by type of care, sex, and age disaggregated for major diagnostic categories were presented in an article by Hodgson and Kopstein (1984). This article complements the earlier one, presenting the indirect and total economic costs of illness in 1980 by age and sex and for the 16 major diagnostic categories of the *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM). Also presented here are the trends in the economic costs of illness by diagnosis since 1963, the first year such data were estimated (Rice, 1966). The economic assumptions, concepts, and methodology are summarized at the end of this article.

Total economic costs in 1980

Total economic costs of illness in 1980 amounted to $455 billion based on a 4-percent discount rate of the value of productivity forgone in succeeding years as a result of premature mortality in that year (Table 1) and $416 billion at a 6-percent discount rate (Table 2). Of the $455 billion, direct costs comprised 46 percent of the total; morbidity costs, 15 percent; and mortality costs, 39 percent.

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Table 1

Estimated amounts and percent distribution of total economic costs, by diagnosis and type of cost: 1980

Diagnosis	Total	Direct costs	Indirect costs		Total	Direct costs	Indirect costs	
			Morbidity	Mortality[2]			Morbidity	Mortality
	Amount in millions				Percent distribution			
Total	$454,882	$211,143	$67,827	$175,912	100.0	100.0	100.0	100.0
Infectious and parasitic diseases	10,266	4,300	4,107	1,859	2.3	2.0	6.1	1.1
Neoplasms	50,538	13,049	5,778	31,711	11.1	6.2	8.5	18.0
Endocrine, nutritional, metabolic diseases, and immunity disorders	12,840	7,329	2,237	3,274	2.8	3.5	3.3	1.9
Diseases of blood and blood-forming organs	2,050	1,155	281	614	0.5	0.5	0.4	0.3
Mental disorders	30,685	19,824	8,917	1,944	6.7	9.4	13.1	1.1
Diseases of the nervous system and sense organs	22,991	17,132	2,616	3,243	5.1	8.1	3.9	1.8
Diseases of the circulatory system	85,008	32,488	11,448	41,072	18.7	15.4	16.9	23.3
Diseases of the respiratory system	33,120	16,661	10,146	6,313	7.3	7.9	15.0	3.6
Diseases of the digestive system	42,437	30,974	3,441	8,022	9.3	14.7	5.1	4.6
Diseases of the genitourinary system	15,414	12,313	1,762	1,339	3.4	5.8	2.6	0.8
Diseases of the skin and subcutaneous tissue	6,600	5,940	539	121	1.5	2.8	0.8	0.0
Diseases of the musculoskeletal system and connective tissue	20,588	13,124	6,938	526	4.5	6.2	10.2	0.3
Congenital anomalies	6,319	1,345	—	4,974	1.4	0.6	—	2.8
Symptoms, signs, and ill-defined conditions	10,710	3,815	1,847	5,048	4.3	1.8	2.7	2.9
Injury and poisoning	82,959	18,684	7,234	57,041	18.2	8.8	10.7	32.4
Other conditions[1]	18,093	8,746	536	8,811	2.0	4.1	0.8	5.0
Unallocated expenditures	4,265	4,265	—	—	0.9	2.0	—	—

[1] Includes complications of pregnancy, childbirth, and puerperium and certain conditions originating during the perinatal period.
[2] Present value of lifetime earnings discounted at 4 percent.

NOTE: Numbers and percents may not add due to rounding.

Table 2

Estimated amounts and percent distribution of total economic costs, by diagnosis and type of cost: 1980

Diagnosis	Total	Direct costs	Indirect costs		Total	Direct costs	Indirect costs	
			Morbidity	Mortality[2]			Morbidity	Mortality
	Amount in millions				Percent distribution			
Total	$415,918	$211,143	$67,827	$136,948	100.0	100.0	100.0	100.0
Infectious and parasitic diseases	9,793	4,300	4,107	1,386	2.4	2.0	6.1	1.0
Neoplasms	45,821	13,049	5,778	26,994	11.0	6.2	8.5	19.7
Endocrine, nutritional, metabolic diseases, and immunity disorders	12,211	7,329	2,237	2,645	2.9	3.5	3.3	1.9
Diseases of blood and blood-forming organs	1,900	1,155	281	464	0.5	0.5	0.4	0.3
Mental disorders	30,312	19,824	8,917	1,571	7.3	9.4	1.3	1.1
Diseases of the nervous system and sense organs	22,087	17,132	2,616	2,339	5.3	8.1	3.9	1.7
Diseases of the circulatory system	79,658	32,488	11,448	35,722	19.2	15.4	16.9	26.1
Diseases of the respiratory system	31,872	16,661	10,146	5,065	7.7	7.9	15.0	3.7
Diseases of the digestive system	41,109	30,974	3,441	6,694	9.9	14.7	5.1	4.9
Diseases of the genitourinary system	15,171	12,313	1,762	1,096	3.6	5.8	2.6	0.8
Diseases of the skin and subcutaneous tissue	6,578	5,940	539	99	1.6	2.8	0.8	0.0
Diseases of the musculoskeletal system and connective tissue	20,489	13,124	6,938	427	4.9	6.2	10.2	0.3
Congenital anomalies	4,057	1,345	—	2,712	1.0	0.6	—	2.0
Symptoms, signs, and ill-defined conditions	8,959	3,815	1,847	3,297	2.2	1.8	2.7	2.4
Injury and poisoning	67,995	18,684	7,234	42,077	16.3	8.8	10.7	30.7
Other conditions[1]	13,642	8,746	536	4,360	3.3	4.1	0.8	3.2
Unallocated expenditures	4,265	4,265	—	—	1.0	2.0	—	—

[1] Includes complications of pregnancy, childbirth, and puerperium and certain conditions originating during the perinatal period.
[2] Present value of lifetime earnings discounted at 6 percent.

NOTE: Numbers and percents may not add due to rounding.

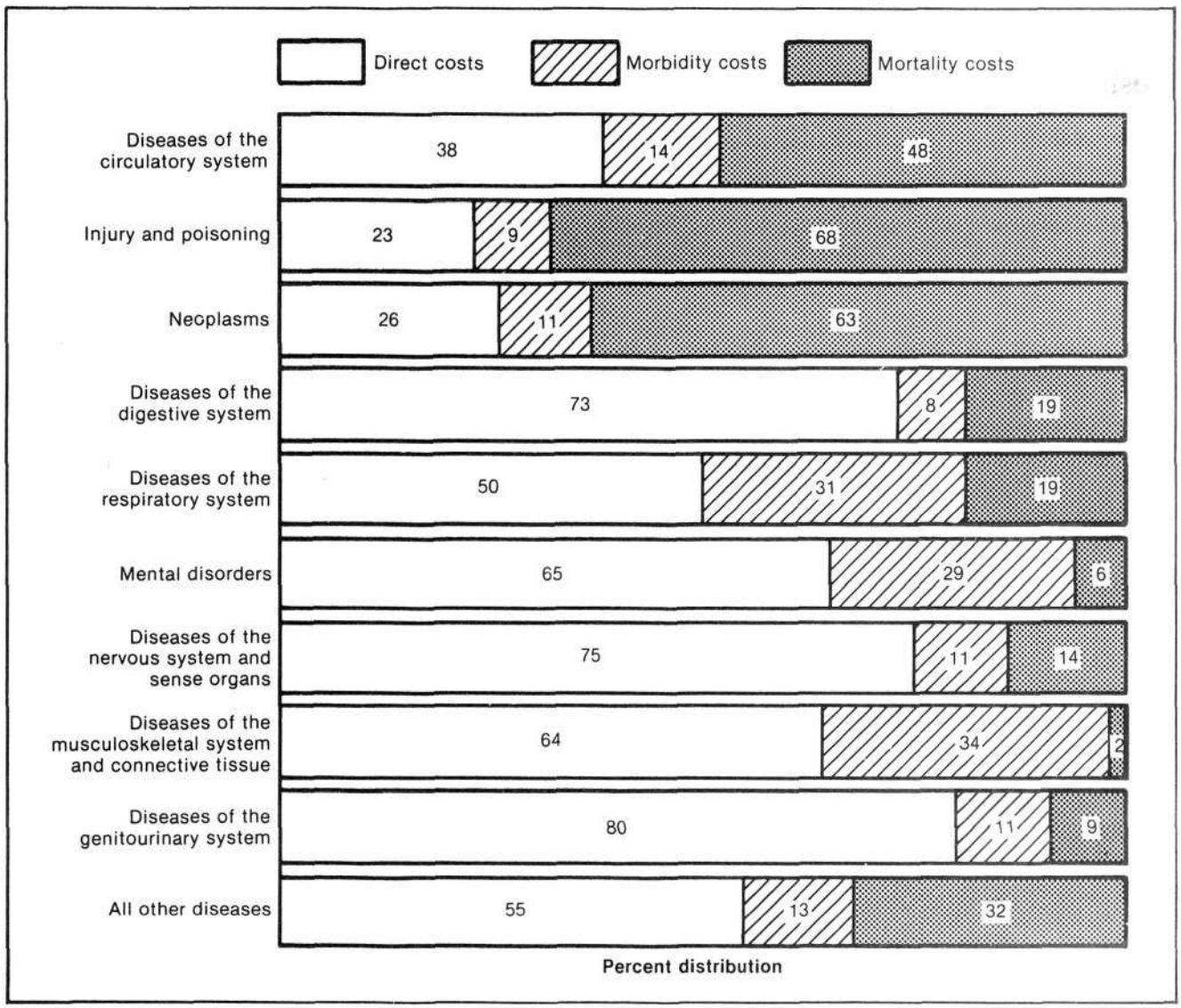
The distribution by diagnosis of total economic costs shows the greatest losses are caused by diseases of the circulatory system and injury and poisoning, accounting for $85 billion and $83 billion, respectively. Neoplasms ($51 billion), diseases of the digestive system ($42 billion), diseases of the respiratory system ($33 billion), and mental disorders ($31 billion) were the next most costly diseases. Together these six diseases accounted for 71 percent of the economic costs of illness.

There is considerable variation in the diagnostic distribution among the three cost components of the total (i.e., direct costs, morbidity costs, and mortality costs), reflecting the differing age, sex, medical care use, morbidity, and mortality patterns for each diagnostic group. Of the $211 billion for annual direct expenditures, the greatest amounts are for persons with diseases of the circulatory system ($32 billion or 15 percent) followed closely by those for persons with diseases of the digestive system ($31 billion or 15 percent, including $15 billion spent for dental care). Third in magnitude are expenditures for persons with mental disorders ($20 billion), followed by those with injury and poisoning ($19 billion).

Annual morbidity losses amount to $68 billion. Of this total, losses are highest for persons with diseases of the circulatory system ($11 billion), followed by those for persons with diseases of the respiratory system ($10 billion) and mental disorders ($9 billion). The distribution by diagnosis of mortality costs differs considerably from that of annual direct costs and morbidity losses. Of the $176 billion losses due to deaths in 1980, injury and poisoning rank highest, accounting for $57 billion, almost one-third of the total. Diseases of the circulatory system and neoplasms ranked second and third, respectively.

Figure 1

Percent distribution of economic costs of illness, by diagnosis and type of cost: 1980



Together these three major diseases account for almost three-fourths of the total mortality costs. The economic costs of illness employing a 6-percent discount rate show similar distributions by diagnosis (Table 2).

Figure 1 shows the distribution of each cost component (direct, morbidity, and mortality) by diagnosis. As expected, for those diagnostic groups where mortality is high, the value of these losses represent a considerably larger proportion of the total than the annual direct and morbidity cost. For example, approximately two-thirds of the total economic costs of injury and poisoning and of neoplasms represent lost lifetime earnings resulting from deaths in 1980. For diseases of the genitourinary system where mortality is low, direct expenditures comprise the largest proportion of the total— 80 percent. Likewise, about three-fourths of the total economic costs of diseases of the nervous system and sense organs and of the digestive system are direct costs.

Morbidity losses are relatively high (about 30 percent) for diseases of the musculoskeletal system and connective tissues, mental disorders, and diseases of the respiratory system.

Costs of illness by age and sex

The total economic costs of illness for males are almost one-third higher than those for females—$260 billion compared with $195 billion (Figure 2). The distribution by sex varies considerably by type of cost. One-third of the total for males compared with two-thirds for females are direct costs. Females represented 52 percent of the population in 1980, but accounted for 59 percent of the total direct costs. Data from the National Health Interview Survey indicate that females have more days of restricted activity, more days in bed, and a higher incidence of acute conditions. They also use medical care services at a higher rate than males do, whether it be hospital or nursing home care, physicians' or dentists' services (Hing, Kovar, Rice, 1983).

Although morbidity rates for females are higher than those for males, when their lower labor force participation rates and lower earnings are applied, morbidity costs for males are 2½ times those for females—$48.3 billion compared with $19.5 billion. Mortality costs show a similar sex relationship—these costs for males are about 2.4 times those for females—$123.7 billion compared with $52.2 billion. The higher morbidity and mortality costs for males reflect their higher labor force participation rates, earnings, and death rates. Almost one-half of the total economic costs for males compared with one-quarter for females are mortality costs.

Patterns of losses by disease differ for males and females (Table 3). Injury and poisoning ranks highest for males and fourth for females. Diseases of the circulatory system ranks highest for females and second for males. Neoplasms is second for females and third for males.

The economic costs of illness by diagnosis for two broad age groups—under age 65 and 65 years of age or over—are shown in Table 4. The elderly (persons 65 years of age or over) comprised only 11.3 percent of the total population in 1980 and 18.2 percent of the total economic costs, but the differences by type of cost are significant. Chronic illnesses increase with age, and the elderly use significantly more medical care services as reflected in the high proportion (31 percent) of the direct costs they incur. Their indirect costs, however, are significantly lower—about 7 percent of the total—because of their shorter life expectancy, lower labor force participation rates and lower earnings. Thus, almost four-fifths of the total economic costs for the elderly but only two-fifths for persons under age 65 are direct costs.

The rankings by disease of the economic costs of illness vary substantially by age. For the population under age 65, the economic costs of injury and poisoning rank highest ($78 billion), accounting for 21 percent of the total for this age group and reflecting the relatively high value of lost productivity for the large number of premature deaths at younger ages from this cause. Diseases of the circulatory system ranks second in economic costs for persons under age 65, representing 15 percent of the total. For the elderly, the economic costs of diseases of the circulatory system far outrank all other diseases—amounting to $29 billion, or 35 percent of the total. In second place is neoplasms, constituting 11 percent of total economic costs for the elderly.

Direct costs

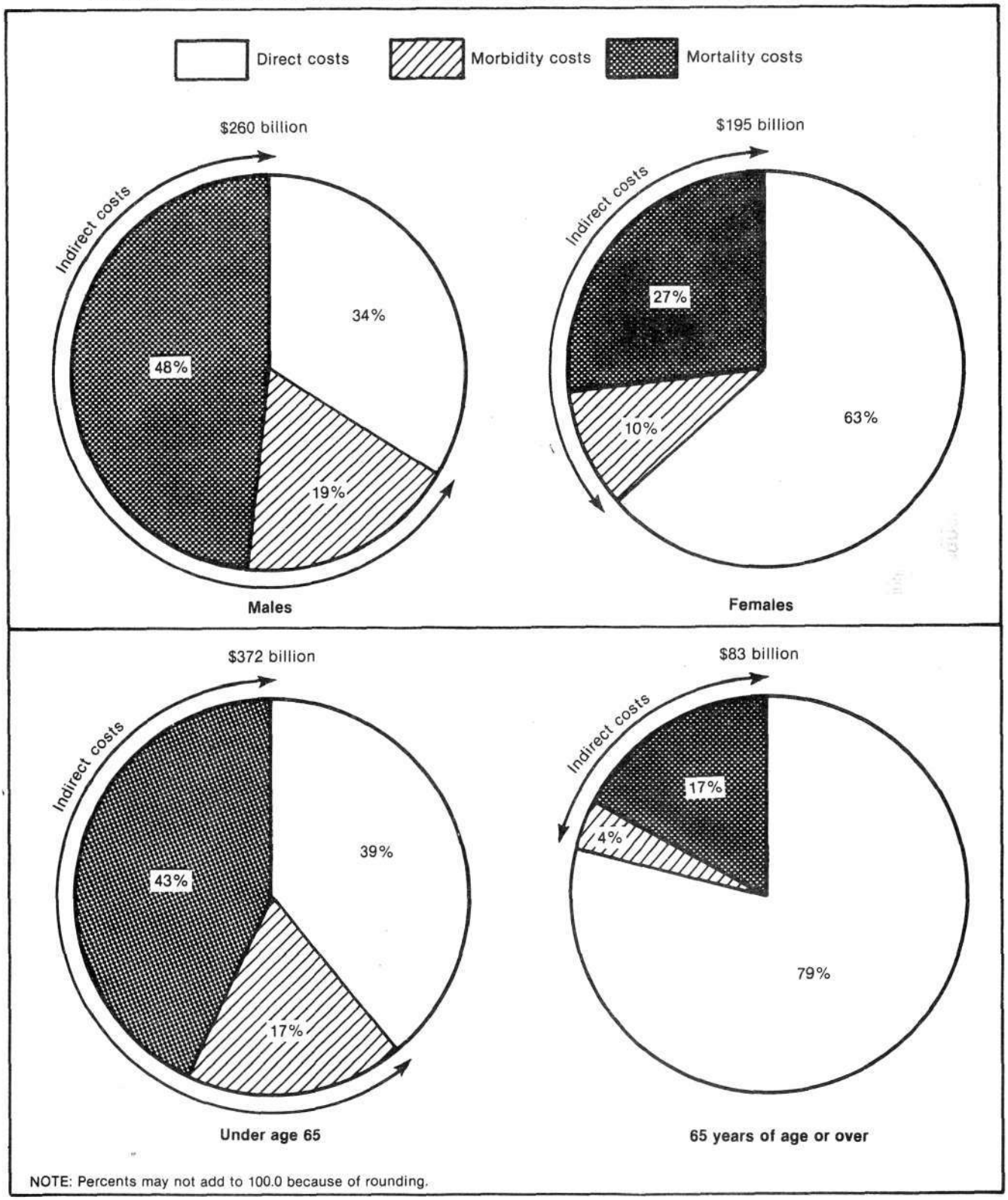
Direct personal health care costs amounted to $211 billion in 1980 (Table 5). Ranking the direct costs by major diagnostic categories reveals that diseases of the circulatory system is highest followed by diseases of the digestive system, mental disorders, and injury and poisoning. Costs for diseases of the digestive system include all expenditures for dental services, which account for almost one-half the total direct costs of this category.

Of the total direct personal health care costs, $124 billion (or 59 percent) are attributed to females who comprised 51 percent of the total population in 1980. The relatively higher direct costs for females reflect the larger number of females, especially older ones requiring medical care services, and their greater use of medical services throughout the age range.

Medical care costs increase significantly with age; the elderly consume 31 percent of the direct costs. The diagnostic rankings for the two age groups vary substantially. For the age group under 65 years, diseases of the digestive system and injury and poisoning rank first and second, respectively. For the elderly, diseases of the circulatory system far outranked all other diseases, comprising 31 percent of the total direct costs. Mental disorders, diseases of the digestive system, and neoplasms follow, each representing about 9 percent of the total.

Figure 2

Percent distribution of economic costs of illness, by sex, age, and type of cost: 1980



NOTE: Percents may not add to 100.0 because of rounding.

Table 3

Estimated amounts of total economic costs, by diagnosis, sex, and type of cost: 1980

Diagnosis	Male				Female			
	Total	Direct costs	Indirect costs		Total	Direct costs	Indirect costs	
			Morbidity	Mortality[2]			Morbidity	Mortality[2]
	Amount in millions							
Total	$259,601	$87,618	$48,305	$123,678	$195,281	$123,525	$19,522	$52,234
Infectious and parasitic diseases	5,818	1,820	2,845	1,153	4,448	2,840	1,262	706
Neoplasms	28,139	5,647	4,138	18,354	22,399	7,402	1,640	13,357
Endocrine, nutritional, metabolic diseases, and immunity disorders	5,835	2,354	1,673	1,808	7,005	4,975	564	1,466
Diseases of blood and blood-forming organs	952	427	171	354	1,098	728	110	260
Mental disorders	17,895	9,330	7,024	1,541	12,790	10,494	1,893	403
Diseases of the nervous system and sense organs	11,566	7,558	1,905	2,103	11,425	9,574	711	1,140
Diseases of the circulatory system	51,905	13,932	9,185	28,788	33,103	18,556	2,263	12,284
Diseases of the respiratory system	18,629	8,096	6,403	4,130	14,491	8,565	3,743	2,183
Diseases of the digestive system	21,238	13,428	2,237	5,573	21,199	17,546	1,204	2,449
Diseases of the genitourinary system	5,062	3,509	779	774	10,352	8,804	983	565
Diseases of the skin and subcutaneous tissue	3,052	2,573	419	60	3,548	3,367	120	61
Diseases of the musculoskeletal system and connective tissue	10,341	5,053	5,114	174	10,247	8,071	1,824	352
Congenital anomalies	3,629	626	—	3,003	2,690	719	—	1,971
Symptoms, signs, and ill-defined conditions	6,210	1,654	1,125	3,341	4,500	2,161	722	1,617
Injury and poisoning	62,071	9,783	5,267	47,001	20,888	8,901	1,947	10,040
Other conditions[1]	5,762	331	—	5,431	12,331	8,415	536	3,380
Unallocated expenditures	1,496	1,496	—	—	2,769	2,769	—	—

[1] Includes complications of pregnancy, childbirth, and puerperium and certain conditions originating during the perinatal period.
[2] Present value of lifetime earnings discounted at 4 percent.

NOTE: Numbers and percents may not add due to rounding.

Table 4

Estimated amounts of total economic costs, by diagnosis, age, and type of cost: 1980

Diagnosis	Under 65 years				65 years or over			
	Total	Direct costs	Indirect costs		Total	Direct costs	Indirect costs	
			Morbidity	Mortality[2]			Morbidity	Mortality[2]
	Amount in millions							
Total	$372,172	$146,191	$64,168	$161,813	$82,708	$64,950	$3,659	$14,099
Infectious and parasitic diseases	9,438	3,731	3,963	1,744	828	569	144	115
Neoplasms	41,340	7,727	5,552	28,061	9,196	5,320	226	3,650
Endocrine, nutritional, metabolic diseases, and immunity disorders	9,345	4,362	2,096	2,887	3,496	2,968	141	387
Diseases of blood and blood-forming organs	1,541	706	265	570	509	449	16	44
Mental disorders	24,638	14,136	8,622	1,880	6,048	5,689	295	64
Diseases of the nervous system and sense organs	18,226	12,661	2,467	3,098	4,765	4,471	149	145
Diseases of the circulatory system	56,282	12,384	10,258	33,640	28,727	20,105	1,190	7,432
Diseases of the respiratory system	27,656	12,520	9,793	5,343	5,464	4,141	353	970
Diseases of the digestive system	36,095	25,303	3,270	7,522	6,342	5,671	171	500
Diseases of the genitourinary system	12,673	9,873	1,666	1,134	2,742	2,441	96	205
Diseases of the skin and subcutaneous tissue	5,399	4,796	502	101	1,201	1,144	37	20
Diseases of the musculoskeletal system and connective tissue	16,276	9,300	6,496	480	4,312	3,824	442	46
Congenital anomalies	6,218	1,257	—	4,961	101	88	—	13
Symptoms, signs, and ill-defined conditions	9,562	3,044	1,612	4,906	1,148	771	235	142
Injury and poisoning	78,223	14,478	7,070	56,675	4,736	4,206	164	366
Other conditions[1]	18,034	8,687	536	8,811	59	59	—	—
Unallocated expenditures	1,229	1,229	—	—	3,036	3,036	—	—

[1] Includes complications of pregnancy, childbirth, and puerperium and certain conditions originating during the perinatal period.
[2] Present value of lifetime earnings discounted at 4 percent.

NOTE: Numbers and percents may not add due to rounding.

Table 5

Estimated amounts of direct costs, by sex, age, and diagnosis: 1980

Diagnosis	Total	Sex		Age	
		Male	Female	Under years 65	65 years or over
	Amount in millions				
Total	[2]$211,143	$87,618	$123,525	$146,191	$64,950
Infectious and parasitic diseases	4,300	1,820	2,480	3,731	569
Neoplasms	13,049	5,647	7,402	7,727	5,322
Endocrine, nutritional, metabolic diseases, and immunity disorders	7,329	2,354	4,975	4,362	2,968
Diseases of blood and blood-forming organs	1,155	427	728	706	449
Mental disorders	19,824	9,330	10,494	14,136	5,689
Diseases of the nervous system and sense organs	17,132	7,558	9,574	12,661	4,471
Diseases of the circulatory system	32,488	13,932	18,556	12,384	20,105
Diseases of the respiratory system	16,661	8,096	8,565	12,520	4,141
Diseases of the digestive system	30,974	13,428	17,546	25,303	5,671
Diseases of the genitourinary system	12,313	3,509	8,804	9,873	2,441
Diseases of the skin and subcutaneous tissue	5,940	2,573	3,367	4,796	1,144
Diseases of the musculoskeletal system and connective tissue	13,124	5,053	8,071	9,300	3,8245
Congenital anomalies	1,345	626	719	1,259	88
Symptoms, signs, and ill-defined conditions	3,815	1,654	2,161	3,044	771
Injury and poisoning	18,684	9,783	8,901	14,478	4,206
Other conditions[1]	8,746	331	8,415	8,687	59
Unallocated expenditures	4,265	1,496	2,769	1,229	3,036

[1] Includes complications of pregnancy, childbirth, and puerperium and certain conditions originating during the perinatal period.
[2] Excludes $8.3 billion of personal health care expenditures that could not be allocated by age and sex.

NOTE: Numbers may not add to totals due to rounding.

SOURCE: Hodgson, T. A., and Kopstein, A. N.: Health care expenditures for major diseases in 1980. *Health Care Financing Review.* HCFA Pub. No. 03173. Office of Research and Demonstrations. Health Care Financing Administration. Washington. U.S. Government Printing Office, June 1984.

Table 6

Selected economic variables used in estimating indirect costs, by age and sex: 1980

Age	Percent of population with earnings		Mean annual earnings[1]		Mean annual value of housekeeping services[2]		
					Female not in labor force	In the labor force	
	Male	Female	Male	Female		Male	Female
15-19 years	62.9	57.4	$3,456	$ 2,753	$ 8,274	$1,895	$5,592
20-24 years	90.6	80.9	9,977	6,947	10,402	2,044	6,352
25-29 years	94.5	74.0	16,681	10,140	12,595	2,402	7,996
30-34 years	96.3	71.0	21,076	10,497	12,479	2,532	8,861
35-39 years	96.1	68.7	24,626	10,512	11,952	2,481	8,512
40-44 years	94.4	70.2	25,077	10,600	11,222	2,483	7,972
45-49 years	93.8	68.2	25,978	10,543	10,557	2,328	7,351
50-54 years	90.4	62.0	25,048	10,605	10,035	2,328	7,015
55-59 years	85.1	53.1	24,501	10,461	8,732	2,877	6,812
60-64 years	67.2	39.6	20,410	10,035	7,100	2,339	5,539
65-69 years	35.2	18.4	11,861	5,877	5,430	1,789	4,236
70-74 years	23.0	9.4	9,904	4,968	3,866	1,274	3,016
75-79 years	15.0	5.1	8,266	4,205	2,631	867	2,052
80-84 years	9.7	2.6	6,893	3,554	1,530	504	1,193
85 years or over	6.2	1.7	5,755	3,006	866	285	676

[1] Mean annual earnings for year-round full-time workers, including supplements, consisting mainly of employer's contributions to social insurance.
[2] Values are imputed by multiplying hours spent in each kind of domestic task by the wages for corresponding occupations.

SOURCES: U.S. Bureau of the Census, *Current Population Reports*, Series P-60, No. 132, "Money Income in 1980 of Families and Persons in the United States." Tables 50 and 52. U.S. Government Printing Office, Washington, DC. Walker, K. E., and Gauger, W. H., "The Dollar Value of Household Work," New York State College of Human Ecology, Information Bulletin 60, Cornell University, Ithaca, New York, 1971 and revised 1980. Brody, W. H. "The Economic Value of a Housewife." *Research and Statistics Note 9,* DHEW Pub. No. SSA 75-11701. Washington, DC, Social Security Administration, Office of Research and Statistics, August 28, 1975.

Table 7

Estimated total person years lost to productivity and morbidity costs, by sex, age, and diagnosis: 1980

Diagnosis	Total	Sex		Age		Total	Sex		Age	
		Male	Female	Under 65 years	65 years or over		Male	Female	Under 65 years	65 years or over
	Person years lost in thousands					Morbidity costs in millions				
Total	6,218	2,853	3,365	4,359	1,859	$67,827	$48,305	$19,522	$64,168	$3,659
Infectious and parasitic diseases	293	147	146	266	27	4,107	2,845	1,262	3,963	144
Neoplasms	426	216	210	355	71	5,778	4,138	1,640	5,552	226
Endocrine, nutritional, metabolic diseases, and immunity disorders	238	101	137	131	107	2,237	1,673	564	2,096	141
Diseases of blood and blood-forming organs	26	10	16	26	6	281	171	110	265	16
Mental disorders	1,023	514	509	690	333	8,917	7,024	1,893	8,622	295
Diseases of the nervous system and sense organs	217	107	110	163	54	2,616	1,905	711	2,467	149
Diseases of the circulatory system	1,388	601	787	569	819	11,448	9,185	2,263	10,258	1,190
Diseases of the respiratory system	807	353	454	704	103	10,146	6,403	3,743	9,793	353
Diseases of the digestive system	266	116	150	227	39	3,441	2,237	1,204	3,270	171
Diseases of the genitourinary system	154	42	112	138	16	1,762	779	983	1,666	96
Diseases of the skin and subcutaneous tissue	40	22	18	31	9	539	419	120	502	37
Diseases of the musculoskeletal system and connective tissue	555	261	294	406	149	6,938	5,114	1,824	6,496	442
Symptoms, signs, and ill-defined conditions	153	62	91	114	39	1,847	1,125	722	1,612	235
Injury and poisoning	578	301	277	491	87	7,234	5,287	1,947	7,070	164
Other conditions[1]	54	—	54	54	—	536	—	536	536	—

[1] Includes complications of pregnancy, childbirth, and puerperium and certain conditions originating during the perinatal period.

Morbidity costs

Calculations of morbidity costs involve applying average earnings to work-loss years for the currently employed, attaching a dollar value to housekeeping services for those unable to perform these services because of illness, and applying labor force participation rates and earnings to persons who are too sick to be employed. Work-loss years are derived from work-loss days and days of housekeeping lost from bed-disability days among females usually keeping house—estimated by the National Health Interview Survey (NHIS). Persons too sick to be employed include noninstitutionalized persons unable to work and residents of institutions. The number unable to work is published by the Bureau of Labor Statistics and includes persons unable to work because of long-term physical or mental illness. This is a conservative estimate, excluding those persons who expect to return to work within 6 months. The total number unable to work is allocated to diagnoses according to the distribution of persons unable to work and the main cause of limitation of activity in the NHIS. The number of persons in institutions is reported by the U.S. Bureau of the Census and is allocated to diagnoses according to the type of institution. For example, persons in mental hospitals, residential treatment centers, and homes for the mentally handicapped are classified under mental disorders; those in homes for the aged and in chronic disease hospitals are classified according to the distribution of primary diagnoses among nursing home residents in the National Nursing Home Survey. Table 6 shows the economic variables used in estimating morbidity costs.

In 1980, employed males and females, females usually keeping house, those unable to work, and institutionalized persons lost the equivalent of 6.2 million person years at a value of $67.8 billion (Table 7). About 46 percent of the person years lost were for males whose morbidity costs represented 71 percent of the total because of their higher labor force participation and earnings. Person years lost for those under age 65 comprised 70 percent of the total, but their productivity losses represented 95 percent of the total. Diseases of the circulatory system ranked highest in person years lost for both men and women and for those persons 65 years of age or over. For males, productivity losses from diseases of the circulatory system ranked highest; for females productivity losses from diseases of the respiratory system ranked highest. For both age groups, morbidity costs were highest for those with diseases of the circulatory system.

Lifetime earnings

If individuals had not died prematurely, they would have continued to be productive for a number of years. It is the present value of future productivity losses that constitute an important component of the indirect costs of a disease. For mortality, the estimated cost or value to society of all deaths is the product of the number of deaths and the expected value of an individual's future earnings with sex and age taken into account. This method of derivation takes into consideration life expectancy for different age and sex groups, changing patterns of earnings at successive ages, varying labor force participation rates, imputed value for housekeeping services, and the appropiate discount rate to convert a stream of costs or benefits into its present worth. This approach is commonly known as the human capital approach, and it will be discussed further in the section, Economic assumptions, concepts, and methodology.

The present value of future earnings discounted at 4 and 6 percent is shown in Table 8 and Figure 3. For a male infant under age 1, the expected lifetime earnings discounted at 4 percent are $415,998. The present value of male lifetime earnings reaches a peak of $604,379 for the age group 20-24, and decreases steadily to $914 for those 85 years of age or over.

The level of expected lifetime earnings for females is somewhat lower than that for males up to age 69. An infant female can be expected to earn $330,065 in her lifetime, or 79 percent of that for males. The highest expected lifetime earnings ($448,982) are for females in the age group 20-24. Peak male earnings are about 35 percent higher than those for females.

Beginning with the age group 65-69, female earnings are higher. Discounted at 4 percent, the present value of lifetime earnings for females in this age group is $37,104 compared with $25,887 for males. At ages 85 and over, female lifetime earnings are valued at $1,197 compared with only $914 for males. The higher expected earnings for females in the older age groups are the result of the relatively small number of males in the labor force and the larger number of females keeping house.

Application of a 6-percent discount rate results in a similar pattern, but with somewhat lower figures. The present value of expected earnings for the male infant is $200,992, or less than one-half of the earnings for this age group discounted at the lower rate of 4 percent. The peak earnings for males are in the age group 25-29—amounting to $446,490, or three-fourths the amount obtained with a 4-percent discount rate. Female earnings discounted at 6 percent follow the same pattern as those calculated at the lower rate.

Mortality costs

Applying the expected lifetime earnings by age and sex to the almost 2 million deaths in 1980 results in a loss of approximately 35 million person years, representing a loss of $176 billion to the economy at a 4-percent discount rate and $137 billion at a 6-percent discount rate (Table 9). For the more than 1 million males who died in 1980, an estimated total of 19.4 million person years were lost, valued at $124 billion, at a 4-percent discount rate and $96 billion at a 6-percent discount rate. About 915,000 females died in 1980— representing a loss of 15.8 million person years, or 45 percent of all the years lost. Because of the higher earnings of males, losses for

Table 8

Present value of lifetime earnings discounted at 4 percent and 6 percent, by age and sex: 1980

Age	Male		Female	
	4 percent	6 percent	4 percent	6 percent
	Amount in millions			
Under 1 year	$415,998	$200,992	$330,065	$166,303
1-4 years	438,242	222,067	347,443	183,597
5-9 years	479,294	264,604	379,771	218,641
10-14 years	529,007	321,232	418,954	265,301
15-19 years	576,855	382,235	448,842	308,166
20-24 years	604,379	429,152	448,982	325,736
25-29 years	597,040	446,490	418,703	314,918
30-34 years	557,084	434,295	372,595	288,221
35-39 years	492,083	397,573	322,318	256,285
40-44 years	412,732	344,695	270,522	221,311
45-49 years	325,967	281,249	216,805	182,338
50-54 years	235,464	209,546	163,014	140,696
55-59 years	145,110	132,720	111,643	98,510
60-64 years	67,446	62,538	67,282	60,224
65-69 years	25,887	23,810	37,104	33,453
70-74 years	12,666	11,750	20,557	18,772
75-79 years	6,108	5,719	10,952	10,159
80-84 years	3,002	2,847	4,340	4,115
85 years or over	914	892	1,197	1,169

females are significantly lower, amounting to $52 billion at a 4-percent discount rate and $41 billion at a 6-percent discount rate. Thus, males account for 54 percent of the deaths, 55 percent of the person years lost, and 70 percent of the productivity losses. Diseases of the circulatory system ranked highest for both male and female deaths and person years lost. The pattern is different for productivity losses, however; injury and poisoning ranked highest for males and neoplasms for females. Premature deaths from these causes are very costly to the Nation.

The number of deaths, person years lost, and discounted earnings vary by age for each category of loss (Table 10). The highest number and proportion of deaths are among the aged, representing more than two-thirds of the total. The total person years lost, a function of both age and number of deaths, shows a different picture. Persons 65 years of age or over who died would have had relatively few remaining years of life; and their deaths, therefore, represented only 38 percent of the person years lost. In terms of lost earnings, at a 4–percent discount rate, this age group accounts for only 8 percent of the total. The much higher earnings losses for those who died at ages under 65 are the result of their considerably higher expected lifetime earnings.

Table 10 also presents the number of deaths, person years, and productivity losses for the major diagnostic categories by the two broad age groups, showing the effect of age on each of these measures of loss. Diseases of the circulatory system primarily affect the aged who have relatively low future earnings; these diseases represent one-half of all deaths but one-third of the years lost and less than one-quarter of the productivity losses. Considerable variation also is found among the diagnoses. As expected, for those diagnoses where the younger age groups account for a substantial number of deaths, these same age groups represent a considerably larger proportion of the person years lost and of the expected lifetime earnings. For example, 80 percent of the deaths in 1980 due to injury and poisoning are of persons under 65 years of age, accounting for 95 percent of person years lost and 99 percent of the productivity losses for that cause.

For those diseases where the majority of deaths are of persons 65 years of age or over, the pattern is different; this age group accounts for a smaller proportion of the total years lost than of deaths and an even smaller proportion of the total earnings lost. An example is deaths from diseases of the circulatory system of which 80 percent were of persons 65 years of age or over representing 61 percent of the years lost but only 18 percent of the lost earnings at the 4–percent discount rate. It is clear that for each diagnostic group the age distribution of deaths directly affects the distribution of the total earnings lost.

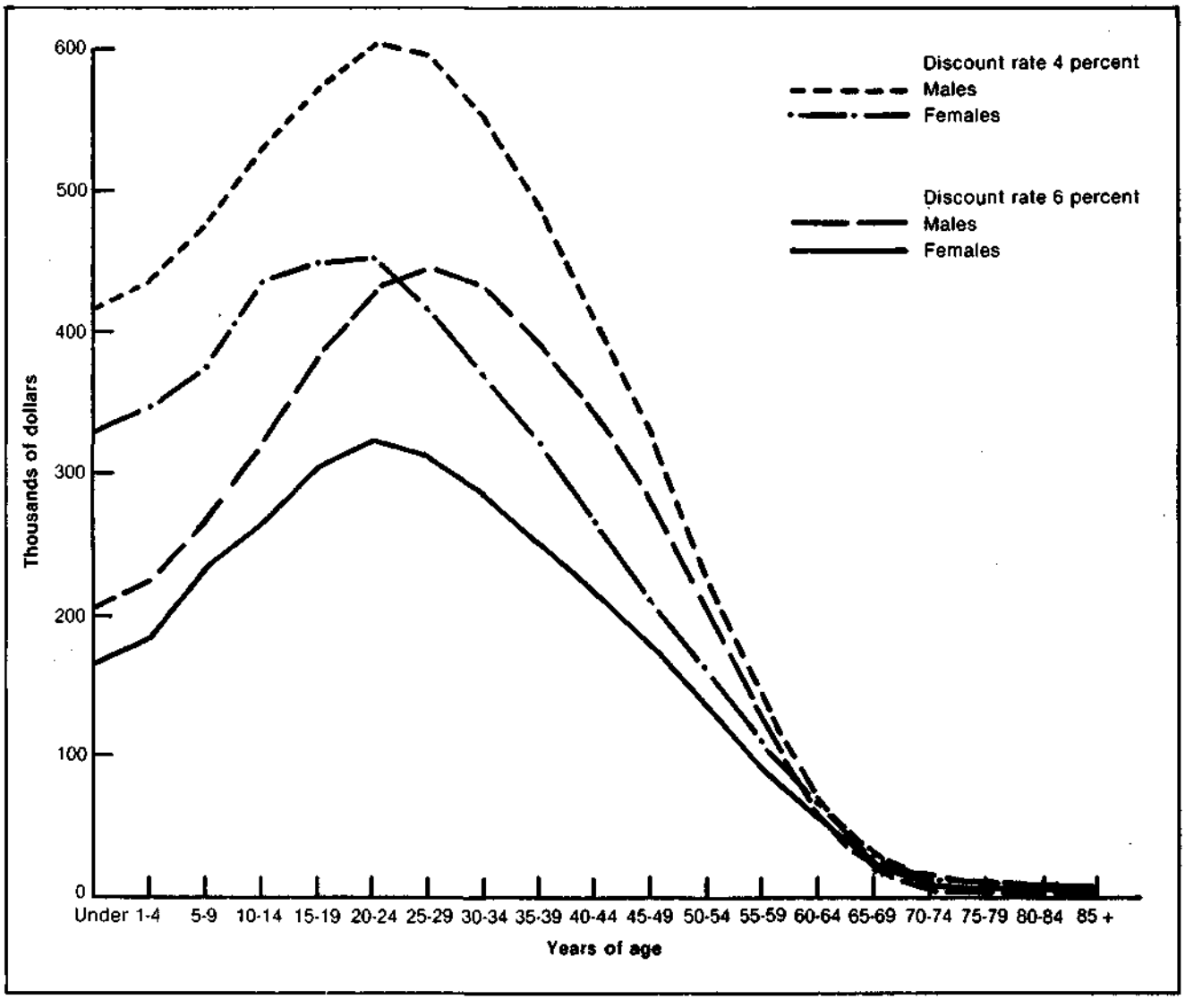
Economic costs of illness trends

Previous comparable data on the economic costs of illness have been estimated for the following years: 1963 (Rice, 1966), 1972 (Cooper and Rice, 1976), 1975 (Paringer and Berk, 1977), and 1977 (Hodgson, 1983; Rice, 1983; and Rice and Hodgson, 1981). Data for 1963, 1972, and 1980 are shown in Tables 11 and 12, enabling examination of the trends in the economic costs of illness over more or less comparable intervals—9 years between 1963 and 1972 and 8 years between 1972 and 1980.

For comparative purposes, the 1980 economic costs of illness based on the present value of lifetime earnings discounted at 6 percent are also shown in the tables. These costs represent estimates of lifetime earnings at the 6-percent discount rate adjusted for a 2–percent annual change in productivity. They are equivalent to the estimates in 1963 and 1972 of the

Figure 3

Present value of lifetime earnings, by sex and discount rate: 1980



economic costs of illness incorporating lifetime earnings at the 4-percent discount rate. The 4-percent rate in 1963 and 1972 is a net discount rate obtained by adjusting a 6-percent discount rate by a 2-percent rise in productivity (1.06/1.02 = 1.04).

The trends in the distribution of economic costs of illness by diagnosis are shown in Table 11. The costs of illness caused by diseases of the circulatory system have steadily declined as a proportion of the total—from 22 percent in 1963 to 19 percent in 1980, reflecting the decline in death rates for this major cause during this period. The economic costs of injury and poisoning, on the other hand, have grown in importance—rising from 12.6 percent of the total in 1963 to 14.1 percent in 1972 and to 16.3 percent in 1980, reflecting the rise in deaths from these causes, especially at the younger ages. The economic costs of neoplasms have also risen, from 9.2 percent in 1972 to 11.0 percent in 1980 because of the continued rise in cancer mortality. In 1963, deaths from neoplasms comprised 16 percent of total deaths; in 1980 it was 23 percent.

Table 12 reveals the tremendous rise in the economic costs of illness over the 17-year period, 1963–80. The total rose almost 350 percent during this period, representing an average annual growth rate of 9.2 percent. During this period of very high inflation in the medical care market, direct costs increased 837 percent, an average annual growth rate of 14.1 percent. Between 1965 and 1980, price increases accounted for 58 percent of the growth in health care expenditures. Changes in use and/or kinds of services and supplies were responsible for 33 percent of the growth in expenditures, and 9 percent of the increase resulted from changes in population size (National Center for Health Statistics, 1981). Indirect costs, on the other hand, rose at a much slower rate—189 percent in the 17-year period, an average annual rate of 6.4 percent. Indirect costs reflect in part the slower rate of growth in wages

Table 9

Number of deaths, estimated total person years lost, and discounted productivity losses, by sex and diagnosis: 1980

Diagnosis	Total	Male	Female	Total	Male	Female	Productivity losses discounted at 4 percent			Productivity losses discounted at 6 percent		
	Number of deaths			Person years lost in thousands			Amount in millions					
Total	1,989,841	1,075,078	914,763	35,144	19,359	15,785	$175,912	$123,678	$52,234	$136,948	$96,232	$40,716
Infectious and parasitic diseases	17,288	9,028	8,260	359	181	178	1,859	1,153	706	1,386	860	526
Neoplasms	422,702	228,827	193,875	7,239	3,508	3,731	31,711	18,354	13,357	26,994	15,713	11,281
Endocrine, nutritional, metabolic diseases, and immunity disorders	46,360	19,286	27,074	772	312	460	3,274	1,808	1,466	2,645	1,456	1,189
Diseases of blood and blood-forming organs	6,376	3,009	3,367	121	55	66	614	354	260	464	265	199
Mental disorders	14,026	8,104	5,922	275	175	100	1,944	1,541	403	1,571	1,249	322
Diseases of the nervous system and sense organs	21,744	11,622	10,122	553	290	263	3,243	2,103	1,140	2,339	1,510	829
Diseases of the circulatory system	993,348	506,154	487,194	12,515	6,524	5,991	41,072	28,788	12,284	35,722	25,110	10,612
Diseases of the respiratory system	128,828	77,191	51,637	1,788	1,009	779	6,313	4,130	2,183	5,065	3,334	1,731
Diseases of the digestive system	75,202	41,101	34,101	1,416	772	644	8,022	5,573	2,449	6,694	4,675	2,019
Diseases of the genitourinary system	29,082	14,562	14,520	385	178	207	1,339	774	565	1,096	633	463
Diseases of the skin and subcutaneous tissue	2,855	1,071	1,784	37	13	24	121	60	61	99	49	50
Diseases of the musculoskeletal system and connective tissue	5,533	1,695	3,838	109	28	81	526	174	352	427	143	284
Congential anomalies	13,938	7,496	6,442	892	458	434	4,974	3,003	1,971	2,712	1,625	1,087
Symptoms, signs, and ill-defined conditions	28,808	16,465	12,343	891	506	385	5,048	3,431	1,617	3,297	2,259	1,038
Injury and poisoning	160,551	116,416	44,135	6,100	4,437	1,663	57,041	47,001	10,040	42,077	34,725	7,352
Other conditions[1]	23,200	13,051	10,149	1,692	913	779	8,811	5,431	3,380	4,360	2,626	1,734

[1] Includes complications of pregnancy, childbirth, and puerperium and certain conditions originating during the perinatal period.

Table 10

Number of deaths, estimated person years lost, and discounted productivity losses, by age and diagnosis: 1980

Diagnosis	Total	Under 65 years	65 years or over	Total	Under 65 years	65 years or over	Productivity losses discounted at 4 percent: Total	Productivity losses discounted at 4 percent: Under 65 years	Productivity losses discounted at 4 percent: 65 years or over	Productivity losses discounted at 6 percent: Total	Productivity losses discounted at 6 percent: Under 65 years	Productivity losses discounted at 6 percent: 65 years or over
	Number of deaths[2]			Person years lost in thousands			Amount in millions					
Total	1,989,841	647,425	1,341,848	35,144	21,814	13,330	$175,912	$161,813	$14,099	$136,948	$123,964	$12,984
Infectious and parasitic diseases	17,288	6,626	10,656	359	252	107	1,859	1,744	115	1,386	1,280	106
Neoplasms	422,702	160,488	262,186	7,239	4,313	2,926	31,711	28,061	3,650	26,994	23,644	3,350
Endocrine, nutritional, metabolic diseases, and immunity disorders	46,360	13,703	32,651	772	428	344	3,274	2,887	387	2,645	2,290	355
Diseases of blood and blood-forming organs	6,376	2,075	4,301	121	79	42	614	570	44	464	423	41
Mental disorders	14,026	6,253	7,765	275	206	69	1,944	1,880	64	1,571	1,512	59
Diseases of the nervous system and sense organs	21,744	10,297	11,445	553	430	123	3,243	3,098	145	2,339	2,206	133
Diseases of the circulatory system	993,348	198,328	794,844	12,515	4,938	7,577	41,072	33,640	7,432	35,722	28,866	6,856
Diseases of the respiratory system	128,828	27,115	101,690	1,788	823	965	6,313	5,343	970	5,065	4,169	896
Diseases of the digestive system	75,202	33,728	41,451	1,416	981	435	8,022	7,522	500	6,694	6,235	459
Diseases of the genitourinary system	29,082	5,472	23,606	385	167	218	1,339	1,134	205	1,096	907	189
Diseases of the skin and subcutaneous tissue	2,855	500	2,355	37	15	22	121	101	20	99	81	18
Diseases of the musculoskeletal system and connective tissue	5,533	2,163	3,370	109	72	37	526	480	46	427	385	42
Congential anomalies	13,938	13,099	836	892	882	10	4,974	4,961	13	2,712	2,700	12
Symptoms, signs, and ill-defined conditions	28,808	15,314	13,430	891	758	133	5,048	4,906	142	3,297	3,166	131
Injury and poisoning	160,551	129,070	31,260	6,100	5,778	322	57,041	56,675	366	42,077	41,740	337
Other conditions[1]	23,200	23,194	2	1,692	1,692	0	8,811	8,811	0	4,360	4,360	0

[1] Includes complications of pregnancy, childbirth, and puerperium and certain conditions originating during the perinatal period.
[2] Includes 568 deaths for which age is not available.

Table 11

Comparison of estimated amounts of total economic costs, by diagnosis: Selected years 1963-80

Diagnosis	1963	1972	1980	1963	1972	1980
	Amount in millions[2]			Percent distribution[2]		
Total	$93,500	$188,789	$415,918	100.0	100.0	100.0
Infectious and parasitic diseases	2,135	3,443	9,793	2.3	1.8	2.4
Neoplasms	10,590	17,367	45,821	11.3	9.2	11.0
Endocrine, nutritional, metabolic diseases, and immunity disorders	2,623	5,930	12,211	2.8	3.1	2.9
Diseases of blood and blood-forming organs	373	921	1,900	0.4	0.5	0.5
Mental disorders	7,277	13,917	30,312	7.8	7.4	7.3
Diseases of the nervous system and sense organs	6,795	10,951	22,087	7.3	5.8	5.3
Diseases of the circulatory system	20,948	40,060	79,658	22.4	21.2	19.2
Diseases of the respiratory system	7,413	16,454	31,872	7.9	8.7	7.7
Diseases of digestive system	7,837	17,487	41,109	8.4	9.3	9.9
Diseases of the genitourinary system	2,560	6,456	15,171	2.7	3.4	3.6
Diseases of the skin and subcutaneous tissue	450	2,052	6,578	0.5	1.1	1.6
Diseases of the musculoskeletal system and connective tissue	2,783	8,948	20,489	3.0	4.7	4.9
Congenital anomalies	1,243	1,903	4,057	1.3	1.0	1.0
Injury and poisoning	11,811	26,678	67,995	12.6	14.1	16.3
Other[1]	8,663	16,226	26,866	9.3	8.6	6.5

[1] Includes complications of pregnancy, childbirth, and puerperium; certain conditions originating during the perinatal period; and symptoms, signs, and ill-defined conditions.

[2] Present value of lifetime earnings discounted at 6 percent before adjusting for an annual change in productivity of 2 percent.

NOTE: Numbers and percents may not add due to rounding.

relative to medical care costs and a relatively small increase in the number of deaths—10 percent.

The effects of direct and indirect costs on the total costs of illness have been changing over time, with a dramatic increase in direct costs relative to indirect costs in recent years. In her landmark study of the cost of illness from 1900 to 2000, Mushkin (1978) estimated that indirect costs were 8 times that of direct costs in 1900. By 1930, the relative magnitude of indirect costs dropped slightly so that they represented less than 7 times the direct costs. In 1963, indirect costs were about 3 times that of direct costs; by 1972, they were only 1½ times the direct costs. By 1980, direct costs had increased so rapidly that the long-term relationship between the two types of costs was reversed. Direct costs were slightly higher than indirect costs, indicating the varying impacts of such factors as inflation in medical care costs and wage increases that determine the cost of illness.

Direct costs also play a significant role in the trends in the distribution of the costs of specific diseases. Several conditions that have high medical costs and low death rates have gained in relative importance since 1963. For example, diseases of the digestive system rose from 8.4 to 9.9 percent of their total economic costs from 1963 to 1980. Direct costs, including expenditures for dental services, comprised 53 percent of the total economic costs for this major diagnostic category in 1963; by 1980, the proportion

Table 12

Comparison of estimated amounts, percent distributions, and percent increases of total economic costs, by type of cost: Selected years 1963-80

Type of cost	1963	1972	1980
	Amount in millions		
Total	$93,500	$188,789	$415,918
Direct	22,530	75,231	211,143
Indirect	70,970	113,558	204,775
Morbidity	21,042	142,323	67,827
Mortality	[1]49,928	[1]71,235	136,948
	Percent distribution		
Total	100.0	100.0	100.0
Direct	24.1	39.8	50.8
Indirect	75.9	60.2	49.2
Morbidity	22.5	22.4	16.3
Mortality	53.4	37.7	32.9
	Percent increase		
Total	—	101.9	120.3
Direct	—	233.9	180.7
Indirect	—	60.0	80.3
Morbidity	—	101.1	60.3
Mortality	—	42.7	92.2

[1] Present value of lifetime earnings discounted at 6 percent before adjusting for an annual change in productivity of 2 percent.

SOURCES: 1963—Rice, D. P.: Estimating the cost of illness. *Health Economics Series, No. 6*, Publication No. 9478. Washington, DC: U.S. Public Health Services, 1966. 1972—Cooper, B. S., and Rice, D. P.: The economic cost of illness revisited. *Social Security Bulletin*, 39:21-36, 1976.

rose to 75 percent. Another example is diseases of the skin and subcutaneous tissue. Direct costs for this category represented 55 percent of the total economic costs in 1963; by 1980, this proportion rose to 90 percent. In both years, deaths from these causes comprised less than 2 percent of the total.

Economic assumptions, concepts, and methodology

The detailed methodology for estimating the economic costs of illness has been documented elsewhere (Rice, 1966; Cooper and Rice, 1976; Hodgson and Kopstein, 1984). The 1980 estimates in this article replicate the methodology used in developing the 1976 estimates, where the major change from the 1963 estimates was in the valuation of housekeeping services discussed later. The economic assumptions, principles, and methodological problems in estimating the direct costs and the value of losses of output resulting from illness and death are summarized later.

Human capital and willingness-to-pay approaches

There are two principal methodologies for estimating the cost of illness: the human capital method and the willingness-to-pay method. The former method, used in this study, is called the human capital or output accounting approach because an employed person is seen as producing a stream of output over the years that is valued at the individual's earnings. The main criticism of this methodology is that it excludes intangibles, only counts earnings, and undervalues some groups relative to others because earnings may not accurately reflect one's ability to produce. Thus males are more highly valued than females, white persons more than black persons, and middle-aged people more than the young and elderly, with part of the difference a result of racial and sexual discrimination.

The willingness-to-pay method values human life according to the amount people are willing to spend to obtain reductions in the probability of death (Schelling, 1968 and Acton, 1975). This method could be helpful in indicating how individuals value health and life, in deriving social preferences regarding public policy, and in assessing the burden of pain and suffering, which have an intangible quality that is not amenable to evaluation in terms of the monetary value of resources used or foregone (Rice and Hodgson, 1982). Objections to this method are that the value of individual lives depends on the income distribution, with the rich able to pay more than the poor, and that it is exceedingly difficult for persons to place a value on small reductions in the probability of death. The strengths and weaknesses of these two methodologies are discussed fully in two recent articles on the state of the art of cost-of-illness estimation by Hodgson and Meiners (1982) and by Hodgson (1983).

The human capital and willingness-to-pay methods are not simply alternatives. Together or separately, each can contribute to greater understanding of the burden of disease and other hazards. Unfortunately, the precise nature of the relationship between values calculated by the human capital approach and those implied by the willingness-to-pay method has not been determined. Although it is not known to what extent the two values would differ if willingness to pay for small reductions in mortality risk could be calculated, lifetime earnings as estimated by the human capital method may at least be a lower bound to a person's willingness to pay for a decreased risk of death (Linnerooth, 1979; Institute of Medicine, 1981; and Landefeld and Seskin, 1982).

The human capital approach is still most often used in cost-benefit and cost-effectiveness analyses that seek to evaluate alternative demands for scarce health care resources and promote economic rationality in health services policy, planning, and management. Many studies use the human capital approach for it provides valuable information based on reliable statistics, so long as one realizes its limitations (Hu and Sandifer, 1981).

Prevalence and incidence estimates

Two approaches can be used in estimating the costs of illness by the human capital method. Prevalence-based costs provide an estimate of the direct and indirect economic burden incurred in a period of time (the base period) as a result of the prevalence of disease during this same base period, most often a year. Included are the costs of the base year manifestations or sequelae of disease that may have had its onset in the base year or at any time prior to the base year. Prevalence costs measure the value of resources used or lost during a specified period of time, regardless of the time of disease onset. The economic costs of illness estimates in this article employ the prevalence-based approach.

Incidence costs represent the lifetime costs resulting from the disease or illness. In the aggregate, incidence costs in a given base year refer to the total lifetime costs of all cases with onset of disease in the base year. Incidence costs are difficult to estimate because they require knowledge of the likely course of a disease and its duration, including survival rates since onset; medical care that will be used and its cost during the duration of the disease; and the impact of the disease on employment, housekeeping, and earnings (Hodgson, 1983 and Scitovsky, 1982).

Relatively few incidence-based studies exist, but the current state of the art is illustrated by Hartunian, Smart, and Thompson (1980), who estimate the costs of cancer, coronary heart disease, stroke, and motor vehicle injuries; Policy Analysis, Inc. (1981), who examine the costs of breast cancer, diabetes melitus, rheumatoid arthritis, stroke, and acute lymphocytic leukemia; and Oster, Colditz, and Kelly (1984), who estimate the costs of smoking and benefits of quitting.

Nonhealth sector costs

The direct costs of illness presented here do not include certain costs borne by patients and other individuals. These nonhealth sector costs include costs of transportation to health providers, certain household expenditures, costs of relocating, and certain property losses. Illness can force a family to incur expenses in caring and providing for the sick member of the family, including extra expenditures for household help; special diets; special clothing; items such as exercycles, vaporizers, humidfiers, and dehumidfiers for rehabilitation and comfort; alterations of property, such as elevators for invalids and other special housing facilities; vocational, social, and family counseling services. Property losses include destruction of property resulting, for example, from alcoholism and alcohol abuse and criminal activity brought on by drug addiction. Another example is the depressed value of property because of risks to health because of environmental conditions, such as air and water pollution, solid waste areas, and nuclear power plants. Other costs originating in disease or illness are expenditures for retraining or reeducation and care provided by family and friends (Hodgson, 1983 and Scitovsky, 1982). All of these nonhealth sector costs are omitted from the cost-of-illness estimates presented here. Consideration should be given, however, to estimating these costs when cost-benefit analyses are conducted.

Psychosocial costs

Illness and disease are responsible for a wide variety of deteriorations in the quality of life that are frequently referred to as psychosocial costs. Victims of illness and disease, families of victims, friends and coworkers of victims, and those who render care may all be affected. Victims may suffer loss of a body part or speech, disfigurement, disability, the pain and grief of impending death. They and those around them may be forced into economic dependence and social isolation, unwanted job changes, loss of opportunities for promotion and education, relocation of living quarters, and other undesired changes in life plans (Hodgson and Meiners, 1982). The combination of financial strain and psychosocial problems can be especially devastating; but because these costs are difficult to estimate, they are omitted from the cost estimates in this article.

Multiple diseases

The presence of multiple disease presents problems for estimating both the direct and indirect costs of illness (Scitovsky, 1982). The primary diagnosis is used for estimating hospital and nursing home direct costs of the disease. Basic data available from the National Health Interview Survey for measuring losses in output for currently employed persons and for housewives include multiple listing of conditions, with no indication as to the primary cause of work loss. In the 1980 estimates as in previous years, reported work-loss days associated with acute and chronic conditions are uniformly adjusted downward for each diagnosis to eliminate duplication caused by disability for which more than one disease or condition was mentioned. The same procedure is followed for females keeping house who reported that more than one condition prevented them from carrying on the major activity of keeping house. The effect is to reduce the loss in output associated with each cause of disability; to have added the multiple conditions would have resulted in overstating the total losses in output for these groups of disabled persons. It is recognized that application of a uniform factor assumes that all associated conditions are evenly distributed, which is obviously not the case. For example, heart disease conditions are much more likely than cancer to be secondary causes of disability.

Employment

The estimates of lifetime earnings takes into account varying labor force participation rates. The assumption is that people will be working and productive during their expected lifetime in accordance with the current pattern of work experience for their sex and age group. For this calculation, the percent of the population with earnings in 1980 published by the U.S. Bureau of Census were used (Table 6).

There is considerable evidence that a radical change has taken place among American females in recent years in many dimensions of labor supply (Norwood, 1982). More than one-half of the females of working age now are employed compared with about one-third in the early 1950's. Each successive cohort of females has higher levels and more continuous patterns of labor force attachment than the preceding one. For each age group, however, a significantly higher proportion of males than of females were employed in 1980, with the highest proportion of males at ages 30-34 (96.3 percent) and the highest proportion of females at ages 20-24 (80.9 percent). The largest differential, however, is at the older age groups, where relatively few females are employed.

Earnings

The appropriate measure of output loss for individuals is earnings, and the proper measure of expected earnings is the arithmetic average or mean.

In this article, output losses are based on annual mean earnings in 1980 by age and sex, adjusted for wage supplements such as employer contributions for social insurance, private pensions, and welfare funds.

Cross-sectional profiles of mean earnings by age and sex are used to estimate lifetime earnings. In applying these data, it is assumed that the future pattern of earnings for an average individual within a sex group will follow the pattern reported by the Census Bureau during the base year of 1980. This model recognizes that individuals, on the average, may expect their earnings to rise with age and experience in accordance with the cross-sectional data for 1980.

The differentials in earnings continue to be large between the sexes. As indicated in Table 6, male earnings are higher for each age group, ranging from 26 percent higher for the youngest working ages to 146 percent higher for ages 45-49. Use of higher labor force participation rates and higher earnings for males in measuring output losses has a significant impact on the economic costs of illness for males and females.

Household work

Marketplace earnings underestimate the loss resulting from females' illnesses, and the value of household work must be added to earnings. Based on a time-motion study of housekeepers, the relevant market wages for various services performed were multiplied by the time required for doing that service to obtain an estimate of the cost of replacing the houskeeper's duties with person hours from the labor force (Walker and Gauger, 1980). The value of housekeeping services for females not in the labor force and for employed males and females are estimated and shown in Table 6. Imputed household values plus marketplace earnings result in total earnings, which were used to compute the present value of lifetime earnings.

The discount rate

The calculation of the present value of expected lifetime earnings raises questions about the importance of discounting and choosing the appropriate discount rate. From the economist's viewpoint, the arithmetic sum of lifetime earnings overstates the present value of an individual. Determining the present value of the future earnings stream is the correct way to measure economic value over a period of time; discounting converts a stream of earnings into its present value.

Economists agree that comparison of streams of earnings over varying timespans should employ the process of discounting. It is now generally agreed that the benefits of public projects for which costs-of-illness estimates are used should be discounted at the social rate of time preference. This rate correctly states society's preference for present versus future consumption. Unfortunately, the social rate of time preferences is unobservable and the actual value is uncertain. Hodgson and Meiners (1982) discuss the discount rate in more detail and recommend that investigators employ at least two and preferably three discount rates ranging from 2.5 percent to 10 percent.

The higher the discount rate, the lower the present value of a given stream. With a high discount rate, earnings far into the future yield a relatively small present value. Conversely, lowering the discount rate increases the present value of future earnings. It is important for policymakers to know whether cost estimates are appreciably affected by alternative discount rates.

The discount rate can be adjusted for expected changes in productivity. An annual increase in productivity of 2 percent, for example, can be incorporated into the discounting calculations to obtain a net effective discount rate. Thus a 6-percent discount rate adjusted for an annual 2-percent rise in productivity will yield an effective discount rate of approximately 4 percent (1.06/1.02=1.039). An 8-percent discount rate similarly adjusted results in a rate of 6-percent (1.08/1.02-1.059). The present values of lifetime earnings by age and sex for discount rates of 4 and 6 percent, adjusted for an annual increase in productivity of 2 percent a year, are given in Table 8.

Consumption

In the past it has been questioned whether the cost of morbidity and mortality caused by illness is the output of individuals or the output minus their consumption (Weisbrod, 1961). The concern of this study is with the cost of illness to society. Individuals, not just the output they contribute in excess of consumption, are valued by society. Economists today generally agree that consumption should not be deducted (Mishan, 1971).

Summary and conclusions

This article presents a replication and update of the economic costs of illness—the economic burden resulting from illness, disability, and death in 1980. It employs the human capital approach in which morbidity and mortality are translated to direct and indirect costs to society as a result of these losses. The greatest losses are for diseases of the circulatory system and for injury and poisoning, with variations in the diagnostic distributions among the three types of costs and by age and sex. Some shifts in the ranking of the major diseases were observed over the 17-year period, 1963-80, for which cost-of-illness data are available.

It is important to remember that an inherent limitation to the approach to valuing life is the difference in economic rewards accruing to males and females. The differentials in earnings continue to be large between the sexes. Males also have higher labor force participation rates. Use of these higher labor force participation rates and higher earnings for

males in measuring output losses resulting from morbidity and premature mortality has a significant impact on the economic costs for males and females.

Lower economic costs are potential benefits of reduced morbidity and mortality. Knowledge of the costs of specific diseases is an aid to more rational decisionmaking with respect to allocating scarce resources among competing ends. The methodology employed is a means for estimating the burden of disease on society.

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