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## **Actual Causes of Death in the United States.**

[Review]

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### **Abstract**

Objective: To identify and quantify the major external (nongenetic) factors that contribute to death in the United States.

Data Sources: Articles published between 1977 and 1993 were identified through MEDLINE

searches, reference citations, and expert consultation. Government reports and compilations of vital statistics and surveillance data were also obtained.

**Study Selection-**Sources selected were those that were often cited and those that indicated a quantitative assessment of the relative contributions of various factors to mortality and morbidity.

**Data Extraction:** Data used were those for which specific methodological assumptions were stated. A Table quantifying the contributions of leading factors was constructed using actual counts, generally accepted estimates, and calculated estimates that were developed by summing various individual estimates and correcting to avoid double counting. For the factors of greatest complexity and uncertainty (diet and activity patterns and toxic agents), a conservative approach was taken by choosing the lower boundaries of the various estimates.

**Data Synthesis:** The most prominent contributors to mortality in the United States in 1990 were tobacco (an estimated 400 000 deaths), diet and activity patterns (300 000), alcohol (100 000), microbial agents (90 000), toxic agents (60 000), firearms (35 000), sexual behavior (30 000), motor vehicles (25 000), and illicit use of drugs (20 000). Socioeconomic status and access to medical care are also important contributors, but difficult to quantify independent of the other factors cited. Because the studies reviewed used different approaches to derive estimates, the stated numbers should be viewed as first approximations.

**Conclusions:** Approximately half of all deaths that occurred in 1990 could be attributed to the factors identified. Although no attempt was made to further quantify the impact of these factors on morbidity and quality of life, the public health burden they impose is considerable and offers guidance for shaping health policy priorities.

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In 1990, approximately 2 148 000 US residents died. Certificates filed at the time of death indicate that their deaths were most commonly due to heart disease (720 000), cancer (505 000), cerebrovascular disease (144 000), accidents (92 000), chronic obstructive pulmonary disease (87 000), pneumonia and influenza (80 000), diabetes mellitus (48 000), suicide (31 000), chronic liver disease and cirrhosis (26 000), and human immunodeficiency virus (HIV) infection (25 000) [1]. Often referenced as the 10 leading causes of death in the United States, they generally indicate the primary pathophysiological conditions identified at the time of death, as opposed to their root causes. These conditions actually result from a combination of inborn (largely genetic) and external factors.

Because most diseases or injuries are multifactorial in nature, a key challenge is sorting out the relative contributions of the various factors. For heart disease, well-established external risk factors include tobacco use, elevated serum cholesterol levels, hypertension, obesity, and decreased physical activity; for various cancers, such risk factors include tobacco use, dietary patterns, certain infectious agents, and environmental or occupational exposure to carcinogenic agents. Even motor vehicle injuries can be associated with multiple factors, including alcohol use, failure to use passenger protection systems, poor roadway design, and inadequate law enforcement. These factors may act independently of each other, the risks being additive according to the effect of each, or they may act synergistically, the interaction of factors

presenting a greater total risk than the sum of their individual effects.

Available analyses of the roles of various external factors in these conditions suggest that the most prominent identifiable contributors to death among US residents are tobacco, diet and activity patterns, alcohol, microbial agents, toxic agents, firearms, sexual behavior, motor vehicles, and illicit use of drugs. When these contribute to deaths, those deaths are by definition premature and are often preceded by impaired quality of life. Although mortality is but one measure of the health status of a nation, the public health burden imposed by these contributors offers both a mandate and guidance for shaping health policy priorities.

## **METHODS** [+](#)

This article summarizes published reports that attributed deaths to these contributors and presents a composite approximation of the totals reported for each [Table 1](#). Articles published between 1977 and 1993 were identified through MEDLINE searches, reference citations, and expert consultation. Government reports and compilations of vital statistics and surveillance data were also obtained. All relevant analyses were reviewed in full. Those selected for use in developing estimates were those most often cited and those for which the methodological assumptions could be identified.

Cause	Deaths	
	Estimated No.*	Percentage of Total Deaths
Tobacco	400 000	19
Diet/activity patterns	300 000	14
Alcohol	100 000	5
Microbial agents	90 000	4
Toxic agents	60 000	3
Firearms	35 000	2
Sexual behavior	30 000	1
Motor vehicles	25 000	1
Illicit use of drugs	20 000	<1
<b>Total</b>	<b>1 060 000</b>	<b>50</b>

\*Composite approximation drawn from studies that use different approaches to derive estimates, ranging from actual counts (eg, firearms) to population attributable risk calculations (eg, tobacco). Numbers over 100 000 rounded to the nearest 100 000; over 50 000, rounded to the nearest 10 000; below 50 000, rounded to the nearest 5000.

Table 1. No caption available

The limitations in the data should be underscored both with respect to deficiencies in the primary databases (eg, the paucity of data on the role of drugs in motor vehicle fatalities or on long-term exposure levels of populations to various toxic agents) and to the disparate approaches used in the studies reviewed to arrive at estimates of the contribution of a factor to a particular health outcome. In some cases, assignments were attempted through simple tallies of available information about the presence or absence of a factor in association with a given outcome (eg, whether or not a driver in a motor vehicle fatality had a blood alcohol concentration above a certain level). In other cases, population-attributable risk calculations were used to arrive at estimates based on determinations of the relative risk for a particular health outcome of a population exposed to a specified health risk. Some of the studies presented meta-analyses of reports in the literature on a given topic. Estimates were often limited by the adequacy of information as to disease prevalence, risk factor prevalence, and the nature of the relationship to other contributing risk factors for the disease.

Despite their limitations, the results of such studies provide a sense of the relative impact of

various factors on health in the United States. Derivation of the numbers presented in the [Table](#) is explained below in the discussion of each category. Where well-established methodologies have been developed for making the estimates, as with tobacco and alcohol, they have been used approximately as reported. For areas of greater uncertainty, such as diet and activity patterns and toxic agents, a sum of the lower boundaries of the estimates for various disease outcomes has been used. Although several of these factors are interrelated in their actions, care has been taken to avoid double counting. Given the fragility of the database involved and the fact that the studies cited use different approaches to derive estimates, these numbers should be viewed as first approximations.

## RESULTS [↑](#)

### Tobacco [↑](#)

Tobacco accounts for approximately 400 000 deaths each year among Americans. It contributes substantially to deaths from cancer (especially cancers of the lung, esophagus, oral cavity, pancreas, kidney, and bladder, and perhaps of other organs), cardiovascular disease (coronary artery disease, stroke, and high blood pressure), lung disease (chronic obstructive pulmonary disease and pneumonia), low birth weight and other problems of infancy, and burns [\[2\]](#). In a major effort that drew on analyses that had been commissioned to assess the mortality, morbidity, and financial burden imposed by each of 15 priority health problems [\[3\]](#), the Carter Center's Closing the Gap project attributed 17% (338 000) of all deaths in 1980 and 13% of all potential years of life lost from death before 65 years of age to tobacco [\[4\]](#). Other estimates have placed tobacco's contribution in the range of 11% to 30% of cancer deaths [\[5,6,7,8,9,10\]](#), 17% to 30% of cardiovascular deaths [\[7,10,11,12,13,14,15,16\]](#), 30% of lung disease deaths [\[7,10\]](#), 24% of pneumonia and influenza deaths [\[17\]](#), 10% of infant deaths [\[17,18\]](#), and 20% to 30% of low-birth-weight infants [\[19,20\]](#). Approximately 3000 lung cancer deaths annually among nonsmokers have been attributed to environmental tobacco smoke [\[21\]](#). The sum of the lower and upper boundaries, respectively, for these estimates would yield an approximate range of 257 000 to 468 000 tobacco-attributable deaths in 1990. Using a specially developed software package [\[22\]](#), the Centers for Disease Control and Prevention (CDC) estimated that 418 690 deaths were caused by tobacco in 1990, including approximately 30% of all cancer deaths and 21% of cardiovascular disease deaths [\[17,23\]](#). The CDC estimates have been widely accepted and provide the basis for the 400 000 Figure included in the Table.

### Diet and Activity Patterns [↑](#)

Dietary factors and activity patterns that are too sedentary are together accountable for at least 300 000 deaths each year. Dietary factors have been associated with cardiovascular diseases (coronary artery disease, stroke, and high blood pressure), cancers (colon, breast, and prostate), and diabetes mellitus [\[24\]](#). Physical inactivity has been associated with an increased risk of death for heart disease [\[16,25,26,27\]](#) and colon cancer [\[26,28\]](#). The interdependence of dietary factors and activity patterns as risk factors for certain diseases is illustrated by the case of obesity, which is associated with increased risk for cardiovascular disease, certain cancers, and diabetes, and is clearly related to the balance between calories consumed and calories expended through metabolic and physical activity. Similarly, high blood pressure, a major risk for stroke, can be affected by dietary sodium, obesity, and sedentary lifestyle. The Carter Center review of deaths in 1980 attributed 290 000 deaths to overnutrition and another 297 000 to high blood pressure [\[4\]](#). Sedentary lifestyles have been linked to 23% of deaths from the leading chronic diseases [\[29\]](#). An assessment of the decline in coronary artery disease mortality from 1968 to 1976 credits reductions in serum cholesterol levels with about a third of the improvement [\[13\]](#). Some studies

credit changes in sodium consumption with the potential to lower death rates for coronary heart disease by 16% to 30% and stroke death rates 23% to 39% [30,31]. Half of all type II diabetes (non-insulin-dependent diabetes mellitus) is estimated to be preventable by obesity control [32]. A 50% reduction in consumption of animal fats might result in a proportionate reduction in risk for colon cancer [33]. In the most extensive analysis to date of studies on risk factors for cancer, Doll and Peto established 35% as their best estimate for the proportion of all cancer deaths attributable to diet [6,34]. Other studies have associated dietary factors or sedentary lifestyles with 22% to 30% of cardiovascular deaths [7,10,11,14], 20% to 60% of fatal cancers [5,6,7,8,9,10,35], and 50% to 80% of diabetes mellitus cases [7,32,36], including 30% of diabetes deaths [7,10]. If the boundaries of these various estimates were summed, they would yield a range of approximately 309 000 to 582 000 deaths in 1990 related to diet and activity patterns. Because of the complexity of the issues and the difficulty of the analyses relating diet and activity patterns to disease outcomes, the lower bound is used as the basis for the 300 000 deaths Figure presented in the Table.

## Alcohol [+](#)

Misuse of alcohol accounts for approximately 100 000 deaths each year, but the related health, social, and economic consequences of alcohol extend far beyond the mortality tables. An estimated 18 million US residents suffer from alcohol dependence [23,37], and some 76 million are affected by alcohol abuse at some time [38]. Estimates of alcohol's death toll range from 3% to 10% of deaths [37,39]. Various estimates have placed alcohol's contribution in the range of 60% to 90% of cirrhosis deaths [40], 40% to 50% of motor vehicle fatalities [12,39,41], 16% to 67% of home injuries, drownings, fire fatalities, and job injuries [7,39,42], and 3% to 5% of cancer deaths [6,7,9]. The Carter Center project estimated that 5% of deaths and 15% of potential years of life lost before age 65 were attributable to alcohol use [4]. Summing the boundaries of these estimates yields an approximate range of 67 000 to 107 000 alcohol-related deaths in 1990. The CDC used clinical case studies and analytic epidemiologic studies to determine alcohol-attributable fractions of various diagnoses and concluded that a total of 105 095 deaths were caused by alcohol in 1987, including approximately 30 000 deaths from unintentional injuries, 19 600 from digestive diseases including liver cirrhosis, 17 700 from intentional injuries, and 16 000 from cancers [43]. Because the CDC estimate is the one most often reported, it has been applied to 1990 death rates and serves as the basis for the 100 000 alcohol-related deaths included in the Table.

## Microbial Agents [+](#)

Infectious agents--apart from those counted elsewhere with causes of the human immunodeficiency virus (HIV) infection or consequent to use of tobacco, alcohol, or drugs--currently account for approximately 90 000 deaths per year. Infections were once the leading killer in the United States, and they are still a prominent threat, especially to persons with other health impairments. Infectious agents also exert great influence on society through an estimated 740 million nonfatal illnesses caused by symptomatic infections that occur annually among Americans [44].

Although immunizations and infection control measures may already prevent as many as 135 million infections and 63 000 deaths annually in the United States [44], a substantial fraction of the infections and deaths that do occur are also preventable. The major contributors to death from infectious agents are pneumococcal pneumonia, nosocomial infections (in both acute and chronic care facilities), legionellosis, Staphylococcal aureus infection, hepatitis, and group A

streptococcal infections. Vital statistics reports for 1990 indicated the number of deaths from infectious and parasitic diseases to be 55 612, plus another 79 513 from pneumonia and influenza and 1289 from meningitis and encephalitis [45]. The Carter Center study of deaths occurring in 1985 estimated that nearly 200 000 deaths could be attributed to infections, of which 13% were potentially preventable with current vaccines [44]. Hepatitis B infection is a good example. Approximately 5000 deaths in 1988 resulted from hepatitis B infection, including about 25% of all deaths from primary liver cancer, although a vaccine has been available since 1982 [46,47,48]. Tuberculosis, which ranked second as a cause of death in 1900, accounted for 1810 of the infectious disease deaths in 1990 [1], and with the spread of antibiotic-resistant strains, tuberculosis gives evidence of increasing in this decade [49].

The difficulty of assigning responsibility for infectious disease deaths is illustrated by the fact that, while the number of classic bacterial pneumonia deaths increased about 10% from 1980 to 1990, those classified as "other" and "unspecified organism" increased by more than 50% and now account for approximately 90% of all pneumonia deaths [45]. A substantial part of the growth in these categories reflects the impact of the HIV epidemic, but most of those deaths are counted in this review under deaths attributable to unprotected intercourse or drug use [50]. Moreover, many deaths from pneumonia occur among cancer, heart, lung, and liver disease patients and are therefore traceable to other causes such as tobacco, diet, and alcohol (eg, the 24% and 4% of pneumonia and influenza deaths ascribed to tobacco [17] and alcohol [43], respectively). Other pneumonia deaths that may also be related to more proximal causes, but which are as yet unassigned, are counted here as general infectious disease deaths. Hence, the 90 000 deaths included here for microbial agents represent the sum of 1990 deaths from key International Classification of Diseases codes 001 through 139 (infectious and parasitic diseases), 320 through 323 (meningitis and encephalitis), and 480 through 482 (pneumonia and influenza), and not including those from codes 042 through 044 (HIV infection) and those otherwise estimated to be attributable to tobacco use, alcohol use, sexual behavior, and illicit use of drugs.

## Toxic Agents [↗](#)

Estimates of the deaths attributable to toxic agents vary widely, and because measurement techniques and the recognition of health effects are still evolving, the number of 60 000 per year included in the Table maybe the most uncertain of the figures indicated for the various causes.

Toxic agents may pose a threat to human health as occupational hazards, environmental pollutants, contaminants of food and water supplies, and components of commercial products. They can contribute to conditions that are potentially lethal, including cancer and other diseases of the heart, lungs, liver, kidneys, bladder, and neurological system. Estimates of the total cancer deaths caused each year by synthetic chemicals in the environment or occupational settings range upward from about 30 000 [6,51], including an estimated 9000 from asbestos exposure [52]. Occupational exposures alone have been estimated to cause 1% to 3% of all cardiovascular, chronic respiratory, renal, and neurological disease deaths, as well as all pneumoconioses [53]. In addition, occupational exposures have been linked with about 4% to 10% of all cancer deaths [6,8,9,53], and pollutants with approximately another 2% of all cancer deaths [6]. Although evidence is generally unavailable for the long-term effects of ambient pollutants on cardiovascular or pulmonary death rates [54], significant elevations of respirable pollutants such as particulates, sulfur dioxide, and carbon monoxide have been associated with transient increases in daily mortality rates of 4% to 16% [55,56,57].

Indoor air may present a greater burden of pollutants than outdoor air [58,59]. Environmental tobacco smoke is an established carcinogen [21], and estimates of radon's contribution to lung cancer deaths range from about 7000 deaths per year to nearly 24 000 deaths per year [6,60,61]. In all, geophysical factors such as background ionizing radiation and ultraviolet light may be accountable for some 3% of cancer deaths [6].

The sum of the boundaries for these estimates approximates a range of 57 000 to 108 000 deaths in 1990 related to toxic agent exposure. The nonfatal effects of toxic exposures in the environment may present even more widespread consequences. For example, fatal lead poisoning is rare, but the toll from high blood lead levels may be lifelong learning impairment for some of the more than 230 000 children now exposed to blood lead levels greater than 1.20 micromole/L (25 micrograms/dL) [62]. Urgent questions are also raised about environmental changes such as atmospheric warming and ozone depletion. Given the uncertainties related to toxic environmental exposures and the ubiquitous character of their impact, an even more compelling challenge than identification of their current mortality burden is clarification of the nature of the issues, the exposure trends, and their likely long-term consequences. The Figure of 60 000 presented in the Table forestimated total deaths from toxic agents represents the sum of the lower boundaries of various estimates of the contribution of toxic agents to deaths from cancers and (for occupational exposures only) other diseases of the lung, cardiovascular, renal, and neurological systems.

## Firearms [↑](#)

Firearms caused more than 36 000 deaths among Americans in 1990, including about 16 000 homicides, 19 000 suicides, and 1400 unintentional deaths [45]. The number of deaths caused by firearms is now higher than those caused by motor vehicle crashes in five states and the District of Columbia (unpublished data, National Center for Health Statistics, September 8, 1993). Comparison data indicate that firearm-related homicide rates for young males in the United States are 12 to 273 times the rates in other industrialized nations, whereas non-firearm-related homicide rates are 1.4 to 9.2 times greater than those elsewhere [63]. For example, in 1986 there were 1043 firearm-related homicides among US males aged 15 to 19 years, compared with six such deaths in Canada and two in Japan [64]. Firearm-related deaths now comprise 11% of all childhood deaths and 17% for those aged 15 to 19 years, including 41% of deaths among black males of this age [64]. Firearm-related suicides among black teenage males aged 15 to 19 years doubled from 1982 to 1987, and although the rate for white males the same age did not change substantially during this period, it was nearly twice as high [64]. The risk of suicide among adolescents has been found to be nearly three times greater in homes where a gun is kept [65,66]. Moreover, guns kept in homes as protection have been found to be several times more likely to kill a family member than an intruder [63]. The prominent, detrimental effect of firearms on overall death rates in the United States is unique in comparison with other countries [67].

## Sexual Behavior [↑](#)

Unprotected sexual intercourse was accountable for approximately 30 000 deaths in 1990. Sexual behavior is associated with substantially increased risk for preventable disease and disability and is the source of some of today's most prominent social challenges. Each year, 12 million persons (two thirds of whom are under 25 years of age) are newly infected with a sexually transmitted disease [68]. An estimated 56% of all pregnancies among US women are unintended [23], including most of the 1 million that occur among US teenagers each year [69]. One of the most rapidly increasing causes of serious illness is hepatitis B infection, of which



about a third is estimated to be sexually transmitted [70]. Among women, pelvic inflammatory disease is a severe complication of lower genital tract infections such as gonorrhea and chlamydia. Each year pelvic inflammatory disease affects an estimated 1 million US women [71], of whom perhaps as many as 150 000 become sterile as a result [72].

The 30 000 deaths in 1990 attributed in the Table to unprotected sexual intercourse include approximately 5000 from excess infant mortality rates among those whose pregnancies were unintended [73], 4000 from cervical cancer [74,75,76], 1600 from sexually acquired hepatitis B infection [46,70], and 21 000 from sexually acquired HIV infection [50]. As indicated by the nearly 20% increase over deaths in the previous year from sexually acquired HIV infection, unprotected intercourse now represents one of the most rapidly increasing causes of death in the country.

## Motor Vehicles [↑](#)

Motor vehicle injuries to passengers and pedestrians caused about 47 000 deaths in 1990 [11]. Nearly 40% of all deaths among those aged 15 to 24 years were caused by motor vehicles [23]. The chances of surviving a serious motor vehicle crash are increased severalfold if an occupant is protected. Lap and shoulder belts have been shown to reduce the risk of death by about 45% to 65%, and of serious injury by about 40% to 55% [42,77]. Airbags have been shown to yield a 30% reduction in fatalities and a 35% reduction in serious injury in frontal crashes [42]. Child passenger restraints can reduce fatalities by 50% to 90% [42]. Use of motorcycle helmets can reduce fatalities by 30% and serious head injuries by 75% [12]. The estimate of 25 000 deaths attributed in the Table to motor vehicles does not include those already recorded as relating to alcohol or drug use [12,39,41,78].

## Illicit Use of Drugs [↑](#)

Approximately 20 000 deaths were caused in 1990 by illicit use of drugs. It is estimated that some 3 million people in the United States have serious drug problems [79]. Illicit use of drugs contributes to infant deaths and to deaths reported for such causes as overdose, suicide, homicide, motor vehicle injury, HIV infection, pneumonia, hepatitis, and endocarditis. In 1990, approximately 9000 deaths nationwide were attributed to illicit use of drugs (both legal and illegal) by vital statistics reports. This figure, however, does not include those indirectly related, such as deaths from accidents, homicides, infections with HIV, and hepatitis [11]. In 1990, approximately 9000 HIV deaths resulted from intravenous drug use (20% more than 1989) [50], as did at least another 1300 hepatitis B-related deaths [46,47,70]. In addition, the National Highway Traffic Safety Administration estimated in 1988 that other drugs, often in association with alcohol, may be a factor in 10% to 22% of highway crashes [78]. The problem of accurately identifying drug-related deaths is illustrated by a study of the Drug Abuse Warning Network (DAWN) data and the national vital statistics reports of cocaine-related deaths in 25 metropolitan areas, which found that about 75% more cocaine-related deaths were reported by DAWN than by the vital statistics system from 1983 to 1988 [80,81]. A study of deaths from 1978 to 1986 in New York City identified 1091 deaths in 1986 as "narcotics-related," only 247 of which had been specifically attributed by vital statistics to drugs. Some 241 deaths were attributed to unspecified pneumonia, 172 to liver disease, and 113 to endocarditis [82]. The findings of that study suggest that there may be a substantial undercount of the role of intravenous drug abuse relative to these and other causes of death. Although local vital statistics reports indicated an increase of 50% in drug-related deaths from 1978 to 1986, the study cited found a much more rapid increase of more than 400% for the same period [82]. Further complicating this analysis is the fact that the use of illegal drugs by pregnant women increases the risk for a poor pregnancy outcome,

including infant death. The National Commission to Prevent Infant Mortality reported in 1992 that such drugs may be used by as many as one in five pregnant women nationwide [20]. The 20 000 deaths attributed in the Table to drug use represents deaths reported to the vital statistics system as drug-related, as well as those from drug-related HIV infection, automobile injuries, and hepatitis infections. It, too, is expected to increase substantially in future years as a result of HIV deaths associated with intravenous drug use.

## Other Factors

Lack of access to a reliable source of primary care is also associated with an increased risk of death from a variety of causes, although quantifying the impact is complicated by the challenges of appropriately characterizing the various elements of access and distinguishing their effects on a given health outcome from other confounding variables. Comparisons of the health status profiles of various developed countries suggest that residents of countries that provide relatively greater access to a full range of primary care services generally fare better than residents of countries with poorer access [83]. The Carter Center project estimated that gaps in primary care, as indicated by lack of access to standard primary care, screening, and preventive interventions, accounted for 7% of premature deaths and 15% of potential years of life lost before age 65 in 1980, of which substantial portions were due to infant deaths [4]. Limitations on access and use of appropriate primary care services require very close scrutiny as important determinants of health status for many Americans and present an obvious target of opportunity for a nation with 15% of the population currently uninsured [84].

Poverty too has its own direct effect on mortality rates, although it is difficult to separate the effect of lack of access to primary care from that of social and economic status. In the United Kingdom, which guarantees universal access to services, a substantial differential remains in health status outcomes by social class despite improved access [83,85], and overall scores in health status indicators are somewhat lower than those for other more socially homogeneous Western European countries [83]. Similarly, reports indicate that poor Canadians have a projected 11 fewer years of disability-free life than their more affluent counterparts, despite guaranteed access to medical care [86]. Several studies that have controlled for other risk factors have shown that populations characterized by low educational or income status experience poorer health prospects [85,87,88,89,90,91,92,93,94]. People who are poor have higher mortality rates for heart disease, diabetes mellitus, high blood pressure, lung cancer, neural tube defects, injuries, and low birth weight, as well as lower survival rates from breast cancer and heart attacks [89,95,96]. For example, a study of the relative contribution of various risk factors and income levels to mortality among blacks estimated that 38% of excess mortality could be accounted for by family income and 31% by six risk factors (smoking status, blood pressure, cholesterol level, body mass index, alcohol use, and diabetes), with 31% remaining unexplained [97]. Efforts to improve health must take into account the special challenges to those who are poor.

## COMMENT AND CONCLUSIONS

Approximately half of all deaths that occurred among US residents in 1990 could be attributed to the factors identified. Despite their approximate nature, the estimates presented here hold implications for program priorities. At the most basic level, they compel examination of the way the United States tracks its health status. Clearly, there is a need to improve the assessment of the contributory effects of etiologic factors on deaths among US residents and to clarify the role of factors such as poverty and restricted access to health services. There is also a need to look more specifically at how these factors affect the 50% of all deaths that occur before age 75. Moreover,

there is a need to assess how they affect our measures on the increasingly important dimensions of morbidity and quality of life. Our national efficiency in changing the health profile is dependent on our ability to identify and monitor trends for the major factors that give direct shape to that profile.

The most important implications of this assessment of the actual causes of death in the United States are found in the way the nation allocates its social resources and shapes its program emphases. In 1993, health care costs in the United States are expected to reach approximately \$900 billion [98], an average of more than \$14 000 annually for each family of four, if equally allocated across the population. The preponderance of this expenditure will be devoted to treatment of conditions ultimately recorded on death certificates as the nation's leading killers. Only a small fraction will go the control of many of the factors that the [Table](#) indicates imposed a substantial public health burden. The national investment in prevention is estimated at less than 5% of the total annual health care cost [99].

There can be no illusions about the difficulty of the challenges in changing the impact these factors have on health status. Of those identified here, the three leading causes of death--tobacco, diet and activity patterns, and alcohol--are all rooted in behavioral choices. Behavioral change is motivated not by knowledge alone, but also by a supportive social environment and the availability of facilitative services. The most rapidly increasing among these causes of death--sexual behavior and illicit use of drugs--take place behind closed doors and are difficult to confront directly even in a putatively open society. Several of the causes of death, such as firearms, are the focal point of powerful lobbies that impede constructive exploration of the full range of social options.

Nonetheless, the central public health focus for each of these factors must be the possibility for improvement. Change can occur. In recent years, trends have been salutary on several dimensions, eg, reductions in tobacco use, saturated fat consumption, and motor vehicle fatalities. The discouraging trends with respect to the effects of sexual behavior, firearms, and illicit use of drugs need not be inexorable. If the nation is to achieve its full potential for better health, public policy must focus directly and actively on those factors that represent the root determinants of death and disability.

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