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Preventable Causes of Death in Wisconsin, 2004

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ABSTRACT

Introduction: While heart disease, cancer, and injuries are leading proximate causes of death, research has demonstrated that about half of all deaths in the United States are actually due to preventable causes, including tobacco use, poor diet, and physical inactivity. Using state vital statistics data and findings from national studies, we report on the trends in the preventable causes of death in Wisconsin from 1992 to 2004.

Methods: The leading proximate causes of death in Wisconsin were obtained from Wisconsin Interactive Statistics on Health (WISH) data derived from individual death certificates. Information on the preventable causes of death was either obtained from the underlying cause information on the death certificate or from peer-reviewed epidemiologic studies.

Results: While the overall age-adjusted death rate declined from 837 to 744 per 100,000 from 1992 to 2004, the top 10 causes of death remain largely unchanged. Nearly half of the deaths in Wisconsin in 2004 resulted from 11 preventable causes, similar to the findings in 1992.

Discussion: Epidemiologic research demonstrates that nearly half of all deaths in Wisconsin are due to preventable causes. Programs and policies must continue to address these preventable causes of disease if Wisconsin is to meet its goal of promoting and protecting population health.

INTRODUCTION

Vital statistics and data on the leading causes of death represent a fundamental way to measure progress in public health. The classic work of John Snow and William Farr brought these statistics to life in the late 19th century, as these 2 physicians were the first to make the shift to thinking about disease prevention by identifying disease "determinants," such as water contamination and unsanitary conditions, and labeling them as causes of death.[1] What began with Farr's work in the late 1800s as rudimentary vital statistics has since evolved in modern times to allow us to identify heart disease, cancer, and injuries as the leading proximate causes of death in today's society.

Over the past century, epidemiologic studies have identified preventable causes of most of the leading proximate causes of death. We now understand that diseases evolve over a continuum from a state of health to risk factors, conditions, diseases, and finally death (Figure 1). Traditionally, health care professionals have intervened "downstream" in the transition from disease to death, and causes of death listed on the death certificate are most often attributed to the diseases that are most proximate to death.

In 1993, McGinnis and Foege proposed that we change our approach to thinking about the "causes" of death, moving from the proximate diseases to the major risk factors leading to death, referring to these external factors as the "actual causes of death."[2] They showed that almost half of all the deaths occurring in the United States were due to preventable causes. Mokdad et al continued tracking these data on a national basis, incorporating new methods and updating the number of deaths for the year 2000,[3] continuing to look further "upstream" at the more distal causes of death, here referred to as preventable causes of death.

However, only 1 study, published just over 10 years ago, has attempted to adapt these numbers to Wisconsin.[4] Given the wide variation between states in the number of deaths due to specific causes,[5] it is important that public health stakeholders and policymakers in Wisconsin understand the burden of disease due to preventable risk factors within our own state.

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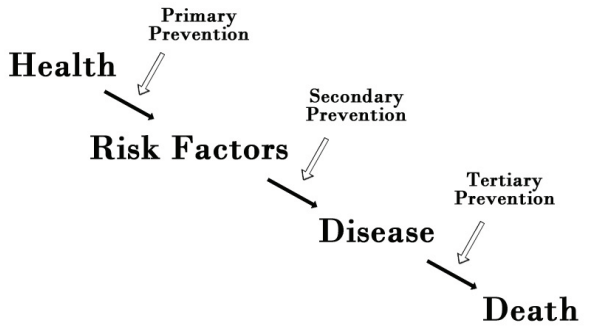

Figure 1. The disease continuum.

METHODS

Proximate Causes of Death

First, we obtained the number of deaths and death rates from the WISH database[6] for the 10 leading proximate causes of death in 2004 to compare with the data previously published for 1992.[4] In order to establish trends in cause-specific mortality by the leading proximate causes of death, we multiplied the 1992 age-adjusted death rates by the comparability ratios provided by Anderson et al in order to account for the change in the International Classification of Diseases (ICD) from the 9th to the 10th revision in 1999.[7] These comparability ratios adjust for differing rates of diagnosis based on the switch from ICD-9 to ICD-10, allowing us to compare the number of deaths and death rates from 1992 with 2004 data without bias (Table 1).

Preventable Causes of Death

We then calculated the number of deaths due to the leading preventable causes in 2004 to compare to the numbers previously reported for 1992,[4] and added 2 additional preventable causes of death in 2004. We used 4 sources of information to calculate the number of deaths in 2004 from the causes identified by McGinnis and Foege (tobacco use, poor diet and physical inactivity, alcohol consumption, microbial agents, toxic agents, motor vehicles, firearms, sexual behavior, and illicit drug use), as well as causes identified by the Institute of Medicine (uninsurance, medical errors):

1. *Deaths due to microbial agents, motor vehicles, and firearms.* When available, information on the cause of death was obtained from information on the underlying cause of death listed on Wisconsin death certificates. This information is accessible through the WISH database published by the Wisconsin Department of Health and Family Services (DHFS).[6]
2. *Deaths due to tobacco use.* Information about mortality attributable to smoking was obtained from epidemiologic studies of tobacco-related mortality for Wisconsin.[8]
3. *Deaths due to poor diet and physical inactivity, alcohol consumption, toxic agents, sexual behavior, and illicit drug use.* Since no Wisconsin-specific information was available from either of the first 2 sources, results published by Mokdad et al were adapted to Wisconsin. The study by Mokdad et al used a broad review of the literature published from 1980 to 2002 to identify epidemiologic, clinical, and laboratory studies establishing an association between mortality and the corresponding risk factors. Using conservative estimates, the study obtained the number of deaths in the US population due to the major risk factors identified in the published literature, including smoking, physical activity, diet, obesity, alcohol, microbial agents, toxic agents, motor vehicles, firearms, sexual behavior, and illicit drug use. (For measures of microbial agents, motor vehicles, firearms, and smoking, the estimates from Mokdad et al were not used, as Wisconsin-specific data were available.) The formula used to derive these estimates was $[(P_0 + \Sigma P_i\ (RR_i)) - 1]/[P_0 + \Sigma P_i\ (RR_i)]$, where P_0 represented the percentage of US individuals not engaging in the risk behavior, P_i was the percentage of US individuals engaging in the risk behavior, and RR_i was the risk ratio for the risk behavior in the general population. To apply these figures to Wisconsin, we divided the census estimate of the population of Wisconsin in 2004 by the census estimate of the population of the US in 2004 to obtain the proportion of the population of the US residing in Wisconsin. We then multiplied this proportion by the estimated number of deaths from the Mokdad et al report and rounded to the nearest hundred.
4. *Deaths due to uninsurance and medical error.* Finally, results published by the Institute of Medicine were similarly adapted to Wisconsin by taking the national estimate and multiplying it by the Wisconsin proportion of the US population to obtain a Wisconsin estimate. The Institute of Medicine studied the issue of people lacking health insurance, and subsequently released several reports, providing an estimate of the number of deaths attributable to the lack of health insurance in the United States,[9] and we assumed the same death rate for the uninsured population in the US applied to the Wisconsin uninsured population. For the estimate of deaths due to medical error, we used a conservative estimate

Table 1. Leading Proximate Causes of Death in Wisconsin in 1992 and 2004[6]

Cause of Death	ICD-9 Code(s)	ICD-10 Code(s)	1992 Deaths	% of Total 1992 Deaths	2004 Deaths	% of Total 2004 Deaths
Heart Disease	390-398, 402, 404, 410-429	100-109, 111, 113, 120-151	14,028	33.3	11,883	26.1
Cancer	140-208	C00-C97	10,310	24.4	10,838	23.8
Stroke	430-434, 436-438	160-169	3304	7.8	3064	6.7
Chronic lung disease	490-494, 496	J40-J47	1634	3.9	2310	5.1
Unintentional injuries	E800-E869, E880-E929	V01-X59	1505	3.6	2273	5.0
Alzheimer's disease*	331	G30	376	0.9	1419	3.1
Diabetes mellitus	250	E10-E14	1043	2.5	1310	2.9
Pneumonia and influenza	480-487	J10-J18	1605	3.8	1138	2.5
Nephritis/nephrosis	580-589	N00-N07, N17-N19, N25-N27	422	1.0	924	2.0
Suicide	E950-E959	X60-X84, Y87.0	584	1.4	656	1.4
All other causes	—	—	7368	17.5	9673	21.3
Total	—	—	42,179	100	45,488	100

ICD=International Classification of Diseases.
*Alzheimer's disease was not included in the top 10 leading causes of death in Wisconsin in 1992. Other arterial diseases were included in 1992, but are not shown in this table, as they were no longer a leading cause of death in 2004.

from an observational study[10] using methods from the Harvard Medical Practice Study.[11]

RESULTS

Proximate Causes of Death

The top 10 leading proximate causes of death for Wisconsin in 2004, based on the underlying cause of death recorded on the death certificate, have changed little from those reported just over 10 years ago (Table 1, Figure 2). Alzheimer's disease is a new addition to the list in 2004, with arterial diseases no longer in the top 10. Otherwise, the top causes remain almost unchanged, except that unintentional injuries and diabetes mellitus each now cause more deaths than pneumonia and influenza, and deaths due to nephritis/nephrosis now cause more deaths than suicide (Figure 2).

The number of deaths increased in 2004 to about 45,000 deaths, up from 42,000 in 1992. To account for a growing as well as older population in 2004, age-adjusted rates were calculated. The overall age-adjusted death rate declined from 837 deaths per 100,000 to 744 deaths per 100,000 (Table 2).

Since 1992, the top 3 proximate causes of death, including heart disease, cancer, and stroke, all declined in rate after adjusting for age and ICD revision. Overall, these top 3 proximate causes of death contributed to 65% of deaths in 1992, decreasing to 57% of deaths by 2004. The pneumonia and influenza mortality rate also decreased. The death rate due to suicide and diabetes mellitus remained relatively unchanged from 1992 to 2004, while the death rate due to Alzheimer's disease, chronic lung disease, unintentional injuries, and nephritis/nephrosis all increased.

Estimate of Preventable Causes

In Wisconsin in 2004, 48% of all deaths resulted from 11 preventable causes. Excluding the 1100 preventable deaths from 2 causes not measured in 1992 (medical errors and uninsurance), the remaining 20,900 preventable deaths in 2004 represent a slight decrease from the 21,100 in 1992. The percentage of total deaths from the 9 preventable causes measured in both 1992 and 2004 has declined from 50% to 46%, respectively (Table 3).

Tobacco—Tobacco use accounts for an estimated 8100 deaths annually in Wisconsin, through several well-established mechanisms including cardiovascular disease, cancer, respiratory disease, and low birth weight. This estimate was obtained from data based on Smoking Attributable Mortality and Morbidity Economic Costs (SAMMEC) simulations, which take into account the age- and gender-specific smoking prevalence to estimate the relative risk of smoking-related disease, and was obtained from a study specific to Wisconsin.[8] Included in these deaths are infant deaths caused by maternal smoking, as well as deaths caused by secondhand smoking. The proportion of deaths due

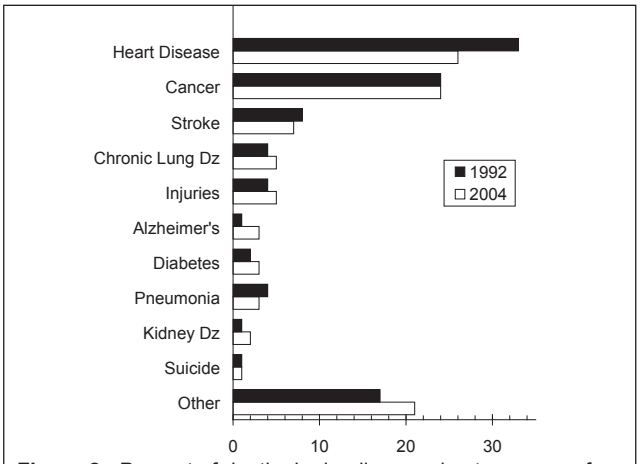

Figure 2. Percent of deaths by leading proximate causes of death in Wisconsin, 1992 and 2004.

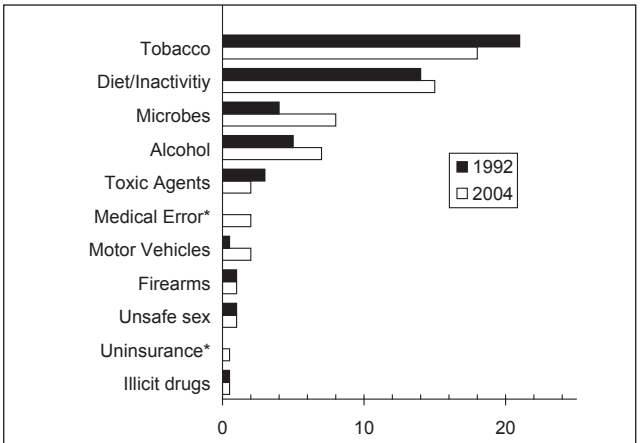

Figure 3. Percent of preventable deaths by cause in Wisconsin, 1992 and 2004.

* Not available in 1992.

to tobacco use decreased from 21% in 1992 to 18% in 2004.

Poor Diet and Physical Inactivity—Poor diet and physical inactivity leads to approximately 6900 deaths a year in Wisconsin, based on US mortality estimates for this risk factor.[3] This is an increase from 5900 deaths a year in 1992, consistent with the increasing prevalence of obesity in the same time period.[12]

Microbial Agents—Microbial agents cause approximately 1700 deaths a year in Wisconsin, based on Wisconsin death certificates listing salmonella, tuberculosis, septicemia, meningitis, and influenza and pneumonia as a cause of death.[6] While microbial agents are no longer the leading cause of death in the United States as they were in the early 20th century, they remain a significant cause of death. The most significant diseases in this category are pneumonia and influenza, causing 1138 deaths in Wisconsin in 2004 (Table 1).

Alcohol Consumption—Alcohol use leads to approximately 1600 deaths in Wisconsin per year, based on US estimates.[3] This estimate does not include the socioeconomic costs associated with alcoholism and alcohol abuse but includes deaths due to causes such as cirrhosis and motor vehicle crashes where alcohol was a contributing factor. The number of deaths caused by alcohol consumption decreased from 1900 in 1992.

Toxic Agents—Toxic agents account for roughly 1000 deaths a year in Wisconsin, based on US estimates.[3] Mokdad et al point out that this number may be the most challenging of the risk factors to estimate due to limited research and methodological difficulties in measuring exposure and outcomes.

Medical Errors—Deaths due to medical errors account for approximately 800 deaths a year in Wisconsin, based on US estimates.[10] This number represents the midpoint of the range in the potential number of deaths caused by medical errors in the United States, as reported by the Institute of Medicine. It is possible that as many as 1850 deaths a year occur in Wisconsin due to adverse events caused by medical errors, based on results from Localio et al.[11] The Institute of Medicine released a report in 2002 examining the occurrence of medical errors, and determined that anywhere from 44,000 to 98,000 deaths due to medical error occur each year in the United States, along with 1 million injuries.[13]

Motor Vehicles—Motor vehicle accidents cause roughly 800 deaths a year in Wisconsin, based on Wisconsin death certificates listing a motor vehicle accident as the cause of death (including alcohol related crashes).[6] Although hospital discharge data does not identify whether alcohol was related to the crash, a recent study estimated about 43% of motor vehicle crash deaths were due to alcohol use by a driver or pedestrian.[14] Subtracting this alcohol-related proportion from the estimated 800 deaths leaves about 500 deaths per year, just slightly higher than the original 1992 estimate that excluded deaths due to alcohol misuse. Motor vehicle deaths replaced firearms as the 6th most common preventable cause of death in 2004.

Firearms—Firearms cause approximately 400 deaths a year in Wisconsin, and resulted in 364 firearm injury-related hospitalizations in 2004. These numbers were obtained from Wisconsin-specific data.[6]

Table 2. Trends in Death Rates, Adjusted for Age and ICD-Code Changes, Wisconsin, 1992-2004

Proximate Cause of Death	1992 Age-Adjusted Rate per 100,000	Corrected* 1992 Rate	2004 Age-Adjusted Rate per 100,000	% Change (1992*-2004)
Heart Disease	274	270	190	-30
Cancer	207	208	183	-12
Stroke	69	73	48	-34
Chronic lung disease	34	36	38	7
Unintentional injuries	31	32	38	19
Alzheimer's disease	11	17	22	29
Diabetes mellitus	21	21	22	4
Pneumonia and influenza	22	15	18	17
Nephritis/nephrosis	10	12	15	22
Suicide	12	12	12	0
Total	837	N/A	744	-11

ICD=International Classification of Diseases; N/A=Not applicable.
*Corrected for the change from ICD-9 to ICD-10 using correction factors from Anderson, et al.[7]

Table 3. Preventable Causes of Death in Wisconsin in 1992 and 2004[4,6,8]

Preventable Cause	Number	1992 % of preventable deaths	% of all deaths	Number	2004 % of preventable deaths	% of all deaths
Tobacco	8700	41	21	8100	37	18
Poor diet and physical inactivity	5900	28	14	6900	31	15
Microbial agents	1500	7	4	1700	8	4
Alcohol consumption	1900	9	5	1600	7	4
Toxic agents	1200	6	3	1000	5	2
Medical error	N/A	N/A	N/A	800	4	2
Motor vehicles*	400	2	1	500	2	1
Firearms	500	2	1	400	2	1
Sexual behavior	600	3	1	400	2	1
Illicit drug use	400	2	1	300	1	1
Uninsurance	N/A	N/A	N/A	300	1	1
Total preventable deaths	21,100	100	50	22,000	100	48
Total deaths	42,179	N/A	100	45,488	N/A	100

N/A=Not available.
*The listed number is deaths due to motor vehicles not including those associated with alcohol use. In 2004, if motor vehicle deaths associated with alcohol use are included, the estimate increases to 800.

Unsafe Sex—Risky sexual behavior accounts for roughly 400 deaths a year in Wisconsin, based on US estimates.[3] This number represents a decrease from 600 deaths in 1992.

Uninsurance—A lack of health insurance causes approximately 300 deaths a year in Wisconsin, based on US estimates as reported by the Institute of Medicine.[9] Not having health insurance is a strong barrier to accessing health care services, and leads to premature deaths across all age groups of a population.

Illicit Drug Use—Illicit drug use causes approximately 300 deaths in Wisconsin every year, based on US estimates.[3] However, because drug use information is not explicitly listed on the death certificate, this number is most likely an underestimate.

DISCUSSION

Death certificates and other epidemiologic data and techniques are invaluable tools to assess the burden of mortality and the causes of death in a population. Sometimes, death certificates list "actual" causes of death (or preventable causes of death, as we have defined them here), such as tobacco and alcohol use, but these factors are, unfortunately, often not recorded when reporting the cause of death on the certificate. Even though a check-

box was recently added to Wisconsin death certificates to assess whether tobacco contributed to the death, it is unclear how often this checkbox is used when applicable. Yet proximate causes of death across a population provide important information and feedback to health care professionals and public health practitioners alike, allowing resources to be targeted appropriately.

As first reported by McGinnis and Foege in 1993, almost half of all deaths in the United States are due to preventable causes, and this proportion is similar in Wisconsin. While the crude number of deaths in Wisconsin has increased since 1992, there was a corresponding increase in population, and so the overall age-adjusted preventable death rate in Wisconsin actually declined by about 10%. Wisconsin has also seen progress since 1992 in reducing the overall proportion of deaths due to preventable causes, which has decreased from 50% to 46% (48% if deaths due to uninsurance and medical error are included).

It is encouraging to see that since 1992, the number of deaths has increased for only 3 of the 9 preventable causes of death. However, if current trends continue, poor diet and physical inactivity will soon become the leading preventable cause of death in Wisconsin. This is not surprising, since in 2004, the state proportion of overweight and obesity surpassed the national statewide median, with 60.5% of our state population being overweight or obese.[15]

The lack of progress in reducing deaths due to poor diet and physical inactivity and microbial agents, as well as the increase in some leading causes of death such as chronic lung disease, unintentional injuries, and Alzheimer's disease present a public health burden that must be addressed if we are to meet the state's public health goals for the year 2010.[16] In the near future, genetic testing may even allow better targeting of behavioral risk factor modification, as modern genetic research has led to an increased understanding of gene-environment interaction in disease.

This type of report thus provides policymakers and public health practitioners around Wisconsin with a tool to monitor the progress of public health interventions and policies as reflected in the number of preventable deaths in the state. With tobacco and poor diet and physical inactivity at the top of the list of leading preventable causes of death in Wisconsin, we should consider evidence-based policies to reduce smoking (eg indoor smoking bans) and increase physical activity (eg ensure availability of sidewalks and green space), for example. It will take time to see the results of investments and interventions to address diseases like Alzheimer's and chronic lung disease, since both have long latent periods and develop over many years. On the other hand, greater attention to unintentional injuries, the leading cause of death from ages 1-44 in Wisconsin in 2003,[17] will likely result in more rapid improvements in death rates.

One limitation of this analysis is that there may be some overlap in the various categories examined in estimating the total number of deaths due to preventable causes. For example, it is possible that deaths due to medical error or lack of health insurance may have been caused by one of the other causes of death such as tobacco or poor diet and physical inactivity. One landmark study on medical errors showed that patients with more comorbidities were more likely to experience an adverse event due to a medical error,[11] suggesting some interaction between deaths due to medical error and other preventable causes of death. However, while each number is an estimate rather than a true reflection of the mortality attributable to specific causes, we make use of the best available evidence for developing each estimate.

It is worth noting that we have defined preventable causes of death in this report as mitigating factors that, if stopped in time, could reduce the number of deaths in the population. While it is unrealistic to assume that *all* of these could have been prevented, the number of deaths due to each specific cause could be substantially reduced. Future research could examine the baseline level of deaths due to each cause as defined by the lowest observed death rate in a population, setting this level as a benchmark for other communities to follow, as done by Kempf et al for all-cause mortality.[18]

This study estimates that almost half of all deaths in Wisconsin in 2004 were preventable, and identifies several behavioral and environmental risk factors responsible for these preventable deaths. While we attempt to move the focus more "upstream," away from looking at merely proximate causes of death such as cardiovascular disease and cancer, one must consider that these preventable factors are still only "midstream" factors, as other societal risk factors have a large impact on the leading preventable causes of death as identified in this analysis. Underlying socioeconomic risk factors such as income, education, unemployment, social support, and the built environment, could be said to be true "upstream" factors. Increasing the overall health of Wisconsin, however, will require consideration of all factors along the continuum, from disease to behaviors,

health care, environment, and social and economic factors in populations.

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