

Minnesota Cancer Surveillance System Biennial Report October 2001

THE OCCURRENCE OF CANCER IN MINNESOTA 1992-1997: Incidence, Mortality, Trends



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SUMMARY

This report presents a statistical summary of the rates and trends of newly-diagnosed cancers among Minnesota residents for the years 1992 through 1997, with special emphasis on the most recent year (1997). These data come from the Minnesota Cancer Surveillance System within the Minnesota Department of Health. For completeness, this report also provides summary information on the rates of cancer deaths (mortality) during the same time period. Death certificate data come from the Minnesota Center for Health Statistics. Highlights of this report are described below, along with references to where additional details can be found.

- During 1997, 20,775 new cancers were diagnosed in Minnesota residents. There were 10,732 new cancers were diagnosed in males and 10,043 new cancers diagnosed in females. During the same year, 4,556 and 4,178 cancer deaths occurred among males and females, respectively (Sections 2A and 3B).
- For males, the age-adjusted rate of new cancers was 456 per 100,000 persons. For females, the rate was 344 per 100,000 persons. Cancer rates were higher in males than females for all but a few types of cancer.
- There are well over 100 different types of cancer; however, relatively few types of cancer account for the majority of cancer incidence (Figures S.1 and S.2). Among men, the most common cancer was prostate cancer, which represented one-third (32.4 percent) of new cancers. The number of prostate cancers diagnosed in 1997 (3,447) exceeded the number of lung, colon, and rectum cancers combined (2,706). Cancers of the prostate, lung, colon and rectum combined accounted for 57.3 percent of all new cancers in Minnesota males. In women, breast cancer was the most common type of cancer, accounting for approximately one-third (32.3 percent) of new cancer cases. The annual number of breast cancers (3,217) exceeded the number of lung, colon, and rectum cancers combined (2,285). Cancers of the breast, lung, colon and rectum accounted for 54.8 percent of all new cancers in women, while cancers of the uterus and ovary accounted for another 10.5 percent (Section 2A).
- Cancer incidence and mortality did not deviate substantially from the trends observed in previous years (Section 2A and 3B).

Figure S.1: Relative Frequencies of New Cancers Diagnosed Among Minnesota Males 1993-1997

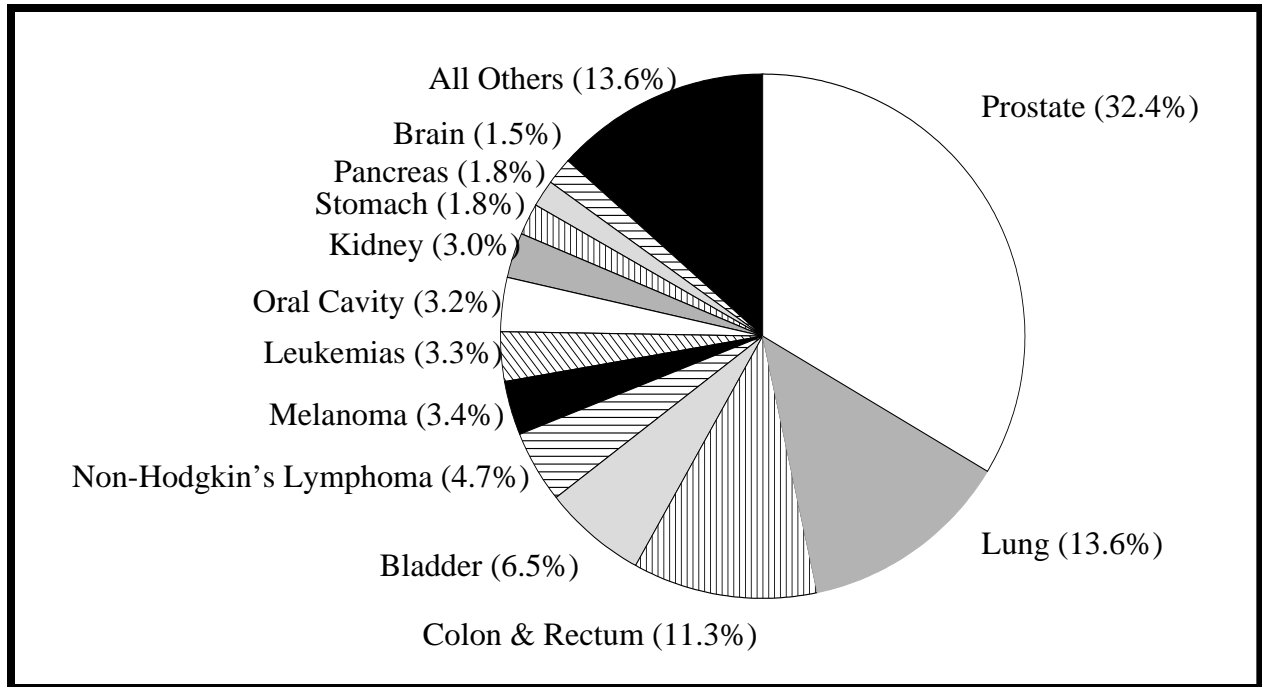
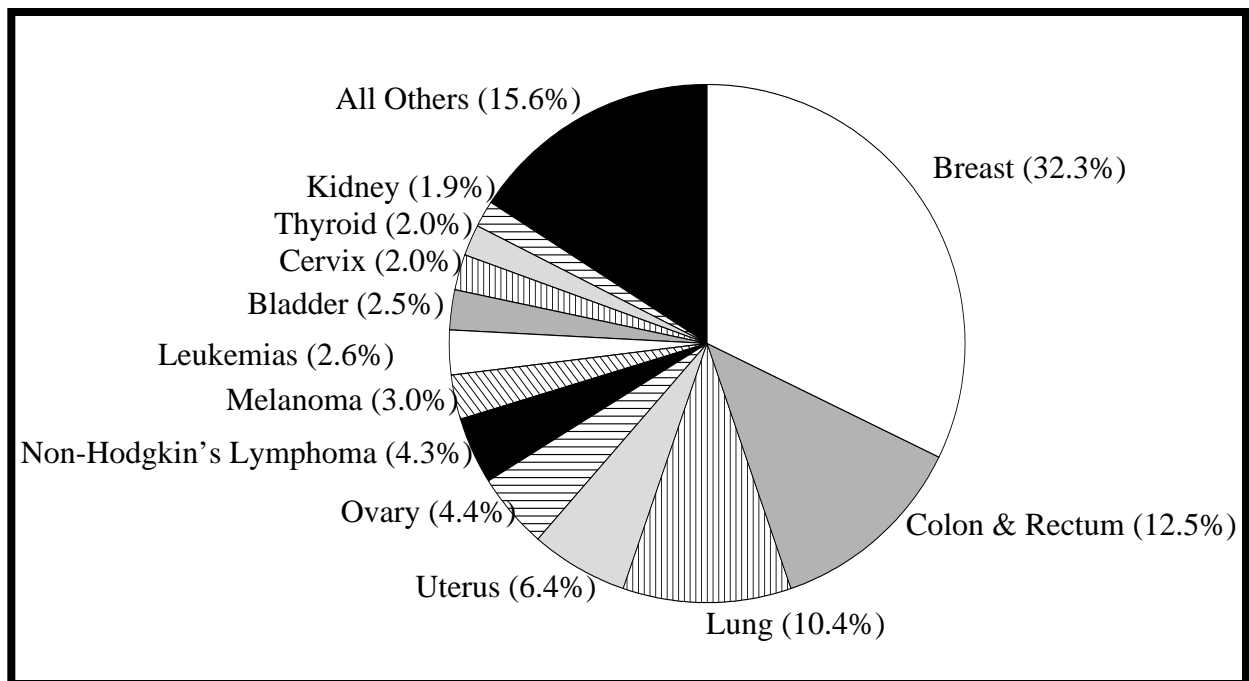


Figure S.2: Relative Frequencies of New Cancers Diagnosed Among Minnesota Females 1993-1997



SECTION 1: Overview

A. Background and Data Sources

This report contains information on the incidence and mortality of cancer in Minnesota for the six-year period, 1992-1997. Cancer incidence and mortality provide two important measures of the impact of cancer in Minnesota. Incidence measures how many newly-diagnosed cases of the

This section describes the background and the operations of the MCSS, the completeness and quality of MCSS data, and how the MCSS is accomplishing each of its five major objectives.

disease occur; while mortality measures how many people die of the disease. Both measures are often expressed as the annual rate of occurrence per 100,000 people. The Minnesota Department of Health (MDH) collects and analyzes data on both incidence and mortality of cancer. Incidence data in this report are compiled by the Minnesota Cancer

Surveillance System (MCSS), and mortality data are compiled by the Minnesota Center for Health Statistics (MCHS). According to common practice, all incidence and mortality rates presented in this report are age-adjusted to the 1970 United States standard population. Age-adjustment minimizes the effect of differences in age distributions when comparing rates among different populations.

The MCSS is an ongoing program within the Section of Chronic Disease and Environmental Epidemiology at the MDH. The MCSS systematically collects demographic and diagnostic information on all Minnesota residents with newly-diagnosed cancers. The primary objectives of the MCSS are to: (1) monitor the occurrence of cancer in Minnesota and describe the risks of developing cancer, (2) inform health professionals and educate citizens regarding specific cancer risks, (3) answer the public's questions and concerns about cancer, (4) promote cancer research, and (5) guide decisions about how to target cancer control resources.

The need for accurate information about the occurrence of cancer was recognized by the Minnesota legislature in 1981, when legislation was introduced to establish a statewide cancer surveillance system. In 1987, following a six-year process which included consensus building, development of methods, and a feasibility study, legislation (Minnesota Statutes 144.671-144.69) was passed to establish the MCSS, and on January 1, 1988, the MCSS began operations.

Funds for the enhancement of the MCSS became available in 1994 through the National Program of Cancer Registries (NPCR), which is administered by the U.S. Centers for Disease Control and

Prevention (CDC). NPCR funding began in October 1994 and is scheduled to last at least through June 2005. The support of the NPCR has enabled the MCSS to collect additional information on each case of cancer, perform death clearance, perform quality control studies, and provide specialized training to Minnesota professionals who collect and code cancer data.

An attempt has been made to minimize the use of technical jargon in this report. However, because of the nature of the material and the diverse audience that this report must serve, some technical terms remain. The Glossary (Appendix C) and the Technical Appendices (B and D) will serve those desiring more basic definitions, as well as those requiring additional detail.

In order to minimize reproduction of discussion and materials presented in previous reports, liberal cross-referencing is employed. The five previous reports are: *The Occurrence of Cancer in Minnesota - 1988*; *The Occurrence of Cancer in Minnesota 1988-1990: Incidence, Mortality, and Trends*; *The Occurrence of Cancer in Minnesota 1988-1992: Incidence, Mortality, and Trends*; *The Occurrence of Cancer in Minnesota 1988-1994: Incidence, Mortality, and Trends* and *The Occurrence of Cancer in Minnesota 1988-1996: Incidence, Mortality, and Trends*. These reports will be referenced as MCSS 1991, MCSS 1993, MCSS 1995, MCSS 1997, and MCSS 1999, respectively; they are available from the MCSS at the MDH. (MCSS 1999 is available on the web (<http://www.health.state.mn.us>.)

• Data Sources and Operations

Incidence Data

The MCSS collects information on malignant tumors, as well as benign tumors occurring in the head and spinal cord, that are diagnosed in Minnesota residents. It does not collect information on the most common form of skin cancer, basal and squamous cell carcinoma. The MCSS has three important characteristics: it is population-based, it is pathology-based, and it is an active (vs. passive) system. Population-based surveillance means that data are collected from a defined population base (i.e., the state of Minnesota) so that incidence rates (risk) can be calculated. Pathology-based surveillance means that cancers are identified through the pathology laboratories where tissues are examined and the diagnosis of cancer is made. Active surveillance means that cancers are required to be reported to the MCSS by Minnesota statutes and that pathology reports in the state and surrounding border referral centers are reviewed by MCSS Field Service staff to ensure completeness of ascertainment.

Enough information is collected so that the MCSS can classify each new diagnosis by type of tumor (primary site, histologic cell type), tumor stage (how advanced the cancer is), and demographic characteristics of the patient (age, sex, and address) as of the date of diagnosis of the

cancer, as well as a summary of the first course of cancer-directed treatment. Information about the patient, cancer, stage, and/or treatment that the pathology laboratory cannot provide is obtained from hospital-based cancer registries or the patient's hospital or clinic record.

Hospitals and pathology laboratories provide data to the MCSS in two main ways. Hospitals that have computerized cancer registries containing summaries for each cancer patient treated at the hospital submit these computerized case reports. The remaining cancer diagnoses are reported through pathology laboratories, which submit photocopies of the pathology report which contains information about the cancer, and the medical record face sheet or an equivalent form which contains the patient's demographic data. Since the MCSS began operations, a total of more than 485,000 reports of cancer representing approximately 290,000 different cancers have been registered with the MCSS as of January 2001. For the period covered by this report (January 1, 1992 to December 31, 1997), 120,735 newly diagnosed, invasive cancers were registered. Non-invasive (*in situ*) cancers of the urinary bladder are included with the invasive cancers of that site in order for Minnesota data to be consistent with the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) program—the source of national cancer statistics.

The data upon which this report is based are dynamic. That is, they are always being updated and improved. For example, in the first legislative report on the MCSS (MCSS 1991), filed ten years ago, 17,728 cancers were included in the analyses of 1988 data. The current database for 1988 contains information on 17,943 cancers (some of the increase is because the data reported for 1988 did not include *in situ* cancers of the bladder). MCSS staff are constantly updating data for all years when new information becomes available. In this regard, all data are subject to change when appropriate. For purposes of analyses, the data are “frozen” (closed) in order that numbers and rates be consistent throughout the report. The date of closure for the data included in this report was December 6, 1999. Data for 1998 are not yet ready for presentation because of delays related to a complete rewrite of a key MCSS data processing system during the year 2000.

Mortality Data

Mortality data are obtained from death certificates. Death certificates are collected, coded, and computerized by the MCHS. Although the MCHS codes contributing causes of death, as well as the underlying cause of death, only the underlying cause of death was used in calculating cancer mortality rates.

Population Data

Age-, sex-, and county-specific intercensal population estimates obtained from the U.S. Census Bureau were used for the six years 1992-1997.

• **Completeness and Quality of Data**

MCSS Field Service staff first identified 10.3 percent of all the cancer diagnoses reportable to the MCSS during their independent review of pathology reports. This review is an important feature of MCSS quality control in that it assures that virtually all eligible cancers are included in the data. For all of the individual cancers diagnosed during 1992-1997, 4.3 percent of these would have been missed without this review. It is estimated that more than 3 million pathology reports were reviewed during the six-year period included in this report.

Death clearance is an important quality control activity which the MCSS began in 1995. Cancer-related deaths are linked with the MCSS database to identify cancer cases that were missed by the routine reporting processes. Potentially missed cancers are then followed back to determine if the cancer indeed should have been included in the MCSS database. Unresolved cancers are included in the database as “Death Certificate Only” (DCO) cases. Death clearance can identify sources where cancer reporting might be improved. Results to date indicate that MCSS case ascertainment is excellent. Only 1.2 percent of all cancers diagnosed between 1995 and 1997 (the years for which death clearance has been performed) had the death certificate as the source of casefinding. A high-quality cancer registry should have between 1 percent and 3 percent of its cases as DCO.

MCSS data are very complete and of very high quality. This is documented by several measures of data quality which are available for the MCSS. First, in December 1999 the MCSS submitted a non-identified file of its provisional data for 1997 to the Registry Certification Committee of the North American Association of Central Cancer Registries (NAACCR). The NAACCR is the organization in North America which develops standards and models for the collection of cancer data in central cancer registries. Table 1.1 contains the results of the certification process. The MCSS achieved the highest rating, the Gold Standard, for all criteria.

Second, the NAACCR performed an external audit of the completeness and quality of MCSS data in 1996 (MCSS 1997). Case completeness was estimated at 99.6 percent. Data quality estimates varied by the data field and the type of cancer. The error rates for all audited data items were comparable to the median error rates found in other states audited by NAACCR, except for race—a field for which reporting has improved since the audit took place. Third, the MCSS has also completed four studies of the accuracy of the data contained in the central registry. These indicate that MCSS data are of comparable quality to data of other central cancer registries in the United States (MCSS Quality Control Reports 97:2, 99:1, 2000:1, and 2001:1). Special attention has been paid to the data fields that were new to the MCSS in 1995—stage at diagnosis and the information on the first course of cancer therapy.

Table 1.1: NAACCR Registry Certification Results: Quality, Completeness and Timeliness of 1997 Data—Minnesota Cancer Surveillance System

Registry Element	Gold Standard	Silver Standard	MCSS Measure	Standard Achieved
1. Completeness of case ascertainment	95%	90%	101.0%	Gold
2. Completeness of information recorded				
• Missing/unknown “age at diagnosis”	<= 2%	<= 3%	0.0%	Gold
• Missing/unknown “sex”	<= 2%	<= 3%	0.0%	Gold
• Missing/unknown “race”	<= 3%	<= 5%	1.0%	Gold
• Missing/unknown “county”	<= 2%	<= 3%	0.0%	Gold
3. Death certificate only cases	<= 3%	<= 5%	1.4%	Gold
4. Duplicate primary cases	<= 0.1%	<= 0.2%	0.04%	Gold
5. Passing EDITS	99%	97%	100.0%	Gold
6. Timeliness	Data submitted within 24 months of close of calendar year			Gold

Another measure of data quality is the amount of missing information in all data collected to date. MCSS Field Service staff perform follow-up to obtain missing information and to resolve conflicting information on all cancers reported. During the process of preparing 1997 diagnoses for this report, contacts with hospitals, clinics, or physicians’ offices were required for nearly 7,000 cases to ensure that the data were complete and accurate. The primary elements for surveillance are age at diagnosis, sex, race, date of diagnosis, county of residence, primary site (organ in which cancer first developed, e.g., lung), and histology (microscopic description of the cancerous cells). For the period 1992-1997, only 0.08 percent of the records contained missing information on one or more of those variables (Table 1.2).

Table 1.2: Missing Information from MCSS Final Data (1992-1997)

Item	Number Missing	Percent Missing
Age at diagnosis	2	0.00
Sex	0	0.00
Date of diagnosis	44	0.04
County of residence	21	0.02
Primary site	45	0.04
Histology	0	0.00
Race (1995+)	504	0.83
TOTAL	616	0.08

Race is one of the important variables for cancer surveillance. Unfortunately, this information is not always available in the medical records submitted to the MCSS, and prior to the 1995 diagnosis year the MCSS did not have the resources to perform active follow-up to find the missing information. This is reflected in the fact that no indication of the patient's race was reported for close to one-thirteenth (7.65 percent) of the cancers incident during the period 1992-1994. The percentage can be improved by assuming that individuals are white if they live in counties that were more than 95 percent white in the 1990 census, and no other racial information is available. After making this assumption, race was "unknown" for only 2.6 percent of the cancers incident during the period 1992-1997. The effect of active follow-up is demonstrated by the fact that the percent with unknown race was much lower for cancers diagnosed in 1995 through 1997 (2.77 percent before and 0.8 percent after making an assumption based on county of residence).

Despite the recent improvement in the completeness of racial data, the quality of racial data available to the MCSS may still be inadequate for meaningful surveillance. Active follow-up to find missing racial information has improved the completeness of the data, but the number of non-whites is quite small. Furthermore, because there are no counties where a 95 percent accurate assumption could be made about race for people of color, a disproportionate number of people of color and American Indians are coded as "unknown race." Even when the race is reported for people of color and American Indians, their race or ethnicity was often recorded by a clerk based on the clerk's perception of the person's race. This process can create two errors.

First, errors in racial or ethnic designation can more easily occur if patients are not queried about their race and, thus, allowed to identify their own racial/ethnic designation. Second, the racial data collected without querying the patient are not comparable to racial data contained in the U.S. census. The census determination of race is through self-identification. The census data serve to define the Minnesota population by age, sex, and race. Cancer incidence is calculated using the census data, and if incidence data for people of color and American Indians are to be meaningful, racial information on cancer patients must be collected in a similar manner (i.e., through self-identification). Because many of the communities of color represent very small populations, inconsistencies between the two types of racial data can lead to very large errors in the apparent cancer incidence in these populations. For these and other reasons discussed in Section 2 of the MCSS 1993 report, cancer incidence is reported here only for all races combined. Despite these problems, it is important to assess health disparities among Minnesotans; therefore a special report on the occurrence of cancer by race in Minnesota is currently in preparation. Another issue related to race is the fact that a person is assumed to be of only one race, even though an individual can be of mixed racial descent. The federal Office of Management and Budget has issued a directive that affects how racial data will be collected in the United States. In the Year 2000 Census, individuals

were allowed to report multiple races. The cancer registry community is prepared to collect data in a comparable manner, so that it will still be possible to calculate race-specific rates.

Although extensive efforts are directed at completeness and accuracy of MCSS data, the MCSS's total costs of operation are substantially less than those of other population-based cancer surveillance systems in the country. A major contributor to this efficiency is the sophisticated computerization of many tasks that are normally done manually elsewhere (MCSS 1991; Section 2).

B. Uses of MCSS Data

As previously stated the MCSS has five primary objectives. The following is a brief summary of how the MCSS is accomplishing each objective.

Monitoring the occurrence of cancer in Minnesota and describing the risks of developing cancer. Sophisticated computer programs have been written to support the MCSS epidemiologists in describing the risks of developing cancer. The results of these analyses are partially included in this report. Cancer mortality data have also been analyzed and included in this MCSS description of cancer occurrence in Minnesota.

MCSS staff conduct also special analyses of the surveillance data. Emphasis is placed on integrating these findings into an epidemiologic and public health context. Recent examples include: Cancer Incidence and Mortality in Minnesota 1997, Cancer Occurrence in Goodhue County, and Incidence of Breast Cancer In Situ in Minnesota Women, 1988-1996.

Informing health professionals and educating citizens regarding specific cancers. Since 1990, dozens of formal presentations have been made before legislative, local public health, community, and regulatory groups on the occurrence of cancer in Minnesota.

Answering the public's questions and concerns about cancer. The MCSS receives approximately 100 to 150 requests per year for information on cancer rates or cancer risks. These inquiries represent all geographic regions of the state. Although most of these inquires are from individual citizens, inquiries also frequently come from citizens' groups, schools, and workplaces, as well as the public health, scientific, and medical communities. Responses to these public and scientific inquiries range from provision of simple, descriptive statistics to detailed record linkage studies of a defined cohort.

Promoting cancer research. The MCSS has assisted cancer researchers by providing information and data needed for the planning and support of grant applications. The MCSS has also

received 25 data use applications since 1988, which are described in Table 1.3. The involvement of the MCSS in the approved studies has varied from providing information about the completeness of case finding to providing rapid ascertainment of cases for case-control studies. In addition, MCSS data have been used to investigate concerns about cancer occurrence in the workplace.

Table 1.3: Applications Requesting MCSS Data for Research as of May 2001

Year ^a	Nature of Study	Status (Institution)
1989	International study of the effectiveness of screening for neuroblastoma at birth	Ongoing: study period = 1989-1998. Minnesota is one of the control areas. (University of Minnesota)
1990	Population-based, case-control study of the epidemiology of childhood acute lymphoblastic leukemia	Completed: MCSS provided data on the completeness of ascertainment. (University of Minnesota)
1991	International, population-based, case-control study of renal cell carcinoma	Completed: MCSS provided rapid ascertainment for identification of cases. (University of Minnesota)
1991	National, multi-center, population-based, case-control study of colon cancer	Completed: MCSS provided rapid ascertainment for identification of cases. (University of Minnesota)
1993	Record linkage with a 4,000-member cohort characterized for cardiovascular disease risk factors	Biennial linkage project. Third linkage completed Winter 1999. (University of Minnesota)
1994	Record linkage with a 14,000-member cohort who completed a nutrition survey (American Cancer Society CPS-II Nutrition study)	Completed: Pilot linkage to estimate sensitivity and specificity of cancer identification using central cancer registries. (American Cancer Society - National Home Office)
1994	Record linkage with the list of women screened through the Minnesota Breast and Cervical Cancer Control Program	Annual linkage project. Second linkage completed Fall 1996. (Minnesota Department of Health)
1995	Record Linkage with Indian Health Service patient registries to characterize cancer incidence	Completed: Report describing cancer incidence in American Indians in Minnesota was released Fall 1996. (Minnesota Department of Health)
1995	Multi-center, population-based, case-control study of gliomas in rural areas	Completed: MCSS provided rapid ascertainment for identification of cases. (University of Minnesota)

Table 1.3: Applications Requesting MCSS Data for Research as of May 2001

Year ^a	Nature of Study	Status (Institution)
1996	Multi-center, population-based, case-control study of proximity to toxic waste sites and occurrence of Wilms tumor	Application denied because of major methodological flaws. (ATSDR)
1996	Randomized trial to assess whether risk-appropriate counseling increases utilization of screening by individuals with a first-degree relative who had colorectal cancer	Application withdrawn before peer review because study was not funded. (Minnesota Department of Health)
1997	Multi-center, population-based, case-control study of acoustic neuromas and use of cellular phones	Application not active because of funding issues. (University of Illinois - Chicago)
1997	Randomized, controlled clinical trial to determine whether screening for fecal occult blood reduces colorectal cancer mortality	Completed: MCSS validated cancer incidence in the 46,000 study participants via record linkage. MCSS also linked the study cohort with 1995 MCSS data. (University of Minnesota)
1997	Population-based study of the role of aromatic amines in pancreatic cancer etiology	Completed: MCSS provided rapid ascertainment for identification and recruitment of cases. MCSS also linked the study cases with incidence and mortality data to assist in estimating response rates. (University of Minnesota)
1997	Population-based pilot study of the quality of life in cancer survivors	Completed: MCSS identified and recruited a random sample of cases. (American Cancer Society - National Home Office)
1997	Occupational cohort linkage study to describe cancer incidence in a group of workers	In Progress: MCSS will link a list of workers with MCSS data and provide aggregated results to the investigator. (3M)
1997	Occupational cohort linkage study to describe cancer incidence in two groups of workers	In Progress: MCSS is linking lists of workers with MCSS and death certificate data and compare the results of incidence follow-up with the results of mortality follow-up. (Minnesota Department of Health)

Table 1.3: Applications Requesting MCSS Data for Research as of May 2001

Year ^a	Nature of Study	Status (Institution)
1997	Identification and recruitment of families at high risk of colorectal cancer into a Familial Colorectal Cancer Registry	In Progress: MCSS is identifying individuals diagnosed with colorectal cancer between 1997 and 1999 who will be invited to provide information on familial cancer histories and possibly to participate in a national database which would be used to investigate the genetics of colorectal cancer. (Mayo Clinic and the University of Minnesota)
1998	Evaluation of Treatment Information in the Cancer Registry through Linkage	In Progress: MCSS linked a list of cancer patients diagnosed in 1995 with lists of enrollees in three sets of claims and encounter data. The goal is to compare completeness of treatment information between the two sources. Additional analyses of mammography and PSA utilization are being conducted with the linked data, including looking at the association between the tests and stage at diagnosis of breast and prostate cancer. (Minnesota Department of Health)
1998	Mesothelioma Incidence in the Mining Industry: A Case Study	In Progress: A list of 50,000 to 70,000 individuals who worked in the mining industry is being linked with the MCSS list of individuals who developed mesotheliomas. The goal is to identify specific job titles (if any) that are associated with asbestos exposures in the cohort. (Minnesota Department of Health)
1999	Minnesota/Wisconsin Men's Health Study	In Progress: MCSS is identifying individuals with prostate cancer diagnosed in 1999 and 2000. The study is looking for associations between genetic markers, exposure variables (pesticides, occupational, farming) and risk of prostate cancer. (University of Minnesota)

Table 1.3: Applications Requesting MCSS Data for Research as of May 2001

Year ^a	Nature of Study	Status (Institution)
1999	Pilot Test for Linking Population-Based Cancer Registries with CCG/POG Pediatric Registries	In Progress: The MCSS list of cancer patients age 0 - 19 was linked with the CCG/POG databases for Minnesota to describe the completeness of ascertainment for both databases. (Minnesota Department of Health)
2001	American Cancer Society CPS-II Nutrition Study	In Progress: MCSS will perform a linkage with 14,000 Minnesota cohorts, who completed nutritional surveys, to verify and update their cancer status. (American Cancer Society - National Home Office)
2001	Population-Based Study of the Quality of Life in Cancer Survivors	In Review: MCSS will begin identifying and recruiting cancer survivors in September, 2001 to participate in this study of psychosocial factors that affect quality of life. (American Cancer Society - National Home Office)
2001	Concord Study - Cancer Survival in Europe and North America	In Peer Review: MCSS would be one of many registries participating in this study that will compare survival rates between Europe and North America for breast, prostate, colorectal and lung cancer. MCSS would obtain date of death via linkage with the National Death Index and provide a limited data set to the Concord investigators. (London School of Hygiene and Tropical Medicine)

a. Year application submitted

Guiding decisions about how to target cancer control activities. Health care professionals, community and civic leaders, hospital administrators, and public health professionals use MCSS data to identify populations who would benefit from screening programs, write grant proposals to obtain funds for establishing screening programs for particular cancers, aid in deciding where satellite treatment facilities should be built and additional staff hired to serve patients who otherwise have to travel long distances to obtain treatment, and identify populations needing public education programs for cancer prevention.

C. Statistical Methods

The statistical methods and constructs used in this report conform to standards established by the National Cancer Institute and are described in Appendix D.

D. Protection of Individual Privacy

Privacy of information which could identify an individual (e.g. name, address) is strictly protected by Minnesota law. Personal identifying information may be released only by permission of the subject of the data. Furthermore, this information is considered privileged in that the Department of Health cannot be compelled by court order to release any personal data collected by the MCSS.

One of the most important uses of MCSS data is to promote research on the prevention and control of cancer. In Minnesota, approximately 90 percent of cancer patients and/or their families agree to participate in scientific/medical studies designed to learn more about reducing the impact of cancer on our society. The vast majority of people welcome the opportunity to translate their personal experience into knowledge that may help their families and others. Yet, even these important activities are voluntary. The subject or guardian must specifically agree to participate.

It is absolutely necessary that personal identifying information be collected by the MCSS. Multiple clinical reports are generated during the care of cancer patients. Personal identifying information is required to link this information in order to ensure completeness and accuracy of the resultant data. Federal guidelines require personal identifiers to be collected to prevent a significant over-counting of cancer, as well as to enable invitation of patients/families to participate in research. In Minnesota, a false “epidemic” from over counting of cancer would be quite significant. Without personal identifying information, cancer rates would appear 80 percent higher, greatly exaggerating differences between Minnesota and the rest of the United States. Thus, personal identifying information is both necessary for and strictly protected by the MCSS.

SECTION 2: Cancer Incidence 1997

A. Age-Standardized Incidence Rates

Table 2.1 provides a detailed profile of the statewide incidence of cancer in Minnesota for 1997, including the number of cancers diagnosed in Minnesota in 1997 and the corresponding age-standardized rate. Age-standardization adjusts for the distribution of the Minnesota population so that comparisons can be made to national age-standardized rates or to Minnesota rates of previous years. Table 2.1 compares the Minnesota rates for individual cancers in 1997 with Minnesota rates for 1992-1996 which were featured in the most recent Minnesota Cancer Surveillance System's Biennial Report to the Citizens of Minnesota published in August of 1999.

As seen in previous years, cancers of the prostate, lung, colon and rectum account for nearly 60 percent of the incident cancers for males. Breast, lung, colon and rectum cancers account for nearly 55 percent of the incident cancers for females.

Several conclusions can be drawn from Table 2.1. First, 1997 cancer rates in Minnesota are very similar to previous years' rates in Minnesota for most types of cancer. Abrupt changes are usually not seen from year to year in any of the major cancers, given the stability of larger numbers and the nature of the disease. Typically, there is more rate variation in cancers with smaller numbers; however, even here there are not great differences in most rates from year to year. In spite of this stability, to establish the beginning or end of a trend, more than one year of data is usually needed and so one should be very cautious about drawing any conclusion about the continuing, beginning or ending of trends based solely on the most recent year of data compared to previous years.

Ten years of MCSS data (1988-1997) are now available for examining time trends in cancer incidence (Table 2.2). Among males, cancers with significantly decreasing incidence rates were oral cavity and pharynx, stomach, colon and rectum, gallbladder, and lung. Among females, stomach and colon/rectum cancer also showed significantly decreasing incidence over the ten-year period.

Tobacco use is a major risk factor for cancers of the lung and oral cavity. The decreasing incidence of these two types of cancer among males is most likely the result of changes in smoking habits among men that took place 20 or more years previously.

Stomach cancer has been decreasing for quite a few years nationally, without any active intervention. The decrease is most likely related to improvements in food preservation and storage. Infection with the bacterium *Helicobacter coli*, which also causes gastrointestinal ulcers, is associated with a good proportion of stomach cancers.

The decrease in colon and colon/rectum cancer is thought to be the result of screening programs. Screening tests such as the fecal occult blood test (FOBT), sigmoidoscopy, and colonoscopy can detect precancerous polyps, which can then be removed before an invasive cancer develops.

Gallbladder cancer accounts for less than 0.5 percent of all incident cancers. Gallbladder cancer is approximately twice as common among women as among men. Between 1988 and 1997, gallbladder cancer incidence decreased by 6.8 percent per year among Minnesota males. Gallbladder cancer rates did not change significantly among Minnesota females over the 10-year period. It is unknown whether gallbladder cancer rates have been changing nationally. Risk factors for gallbladder cancer include obesity, a high fat / high calorie diet, and having gallstones. Some have speculated that the widespread use of laparoscopic surgical techniques may result in a decreased occurrence of gallbladder cancer.¹

Cancers with significantly increasing incidence between 1988 and 1997 were esophageal cancer, melanomas of the skin, and non-Hodgkin's lymphoma among males; and lung cancer, thyroid cancer, non-Hodgkin's lymphoma, and all cancers combined among females.

Melanomas of the skin are the most life-threatening form of skin cancer. Rates increased among females, as well, although the increase did not reach statistical significance. Sun exposure is the major risk factor for melanomas of the skin. Fair-skinned individuals are especially at risk.

The major known risk factors for esophageal cancer are tobacco and alcohol consumption, especially in combination. Given the fact that other tobacco-associated cancers have been decreasing in incidence among Minnesota males, the increase in esophageal cancer is probably related to some factor other than tobacco use. Esophageal cancer is sometimes diagnosed by x-ray, at a late stage when the cancer can no longer be resected; this has resulted in a not-infrequent decision to forego biopsy. It is possible that an increasing proportion of esophageal cancers in Minnesota are being biopsied and thus microscopically confirmed; this could account for at least some of the apparent increasing incidence. Esophageal cancer has been increasing among males nationally, but only at 1.8 percent per year², compared to the estimated 3.2 percent per year among Minnesota males. The increase in lung cancer among women is the result of increased smoking among women some 20 years previously.

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1. Lowenfels AB, Maisonneuve P, Boyle P, Zatonski WA. Epidemiology of gallbladder cancer. *Hepatogastroenterology* 1999 May-Jun;46(27):1529-32.
 2. Howe HL, Wingo PA, Thun MJ, Ries LA, Rosenberg HM, Feigal EG, Edwards BK. Annual report to the nation on the status of cancer (1973 through 1998), featuring cancers with recent increasing trends. *J Natl Cancer Inst* 2001 Jun 6;93(11):824-42.

The increase in thyroid cancer among females has also been observed nationally. Thyroid cancer, which is over twice as common in women as in men, is relatively rare and has high relative survival rates. Thyroid cancer risk is related to ionizing radiation. Other possible risk factors have also been identified, such as benign thyroid disease and thyroid stimulation that occurs during pregnancy and lactation. No cause for the recent national trend has been identified.³

Non-Hodgkin's lymphoma (NHL) incidence has also been increasing nationally, but no cause for the increase has been identified. The cause(s) of NHL are mostly unknown, but hypothesized risk factors are chronic antigenic stimulation of the immune system and immunosuppression, primary or acquired immunodeficiency diseases (such as AIDS), and immunosuppression following organ transplantation. Occupational exposure to certain chemicals and perhaps phenoxy herbicides may also increase risk of NHL.⁴

Notable changes over the 10-year period, 1988-1997, also occurred in prostate cancer incidence, but are not seen in Table 2.2 because the changes were not linear. Prostate cancer detection increased rapidly between 1988 and 1992, as the prostatic specific antigen (PSA) test was introduced and increasingly utilized. Prostate cancer incidence rates subsequently decreased through 1994, to a level between the 1988 and 1992 rates, and have been fairly stable since then.

The trend in incidence of all cancers combined for males was nonsignificant, but the trend in females increased by 0.44 percent per year. The increase was accounted for, at least in part, by the 2.44 percent annual increase in lung cancer incidence among women.

Childhood cancers (ages 0-14) have been stable over the ten years of data collection. 1997 rates for males (14.4 per 100,000 per year) are the lowest recorded so far (range is 14.4 to 18.6) in a modest but nonsignificant downward trend. 1997 rates for females (14.0 per 100,000 per year) are within the usual range of 11.3 to 15.4.

B. Age-Specific Cancer Incidence

Tables 2.3 and 2.4 contain cancer incidence rates for males and females for 18 separate age categories. These are referred to as age-specific rates. Although a few cancers, such as Hodgkin's disease, show relatively modest changes over broad age ranges, the rates of most cancers vary significantly with age, generally showing sharp increase with age.

3. Ibid.

4. Ibid.

Table 2.1: Number of Cancers and Cancer Incidence Rates for Selected Cancers, Minnesota Cancer Surveillance System, 1997

Cancer	Males			Females		
	Minnesota 1997		MN 92-96*	Minnesota 1997		MN 92-96*
	N †	Rate ‡	Rate ‡	N †	Rate ‡	Rate ‡
Oral Cavity	317	14.2	14.6	147	5.0	6.0
Esophagus	143	6.1	5.6	47	1.3	1.4
Stomach	185	7.4	8.5	105	3.3	3.2
Small Intestine	55	2.2	2.1	42	1.5	1.3
Colon	872	36.3	36.2	994	29.8	28.0
Rectum	368	15.4	15.9	256	8.2	8.9
Liver	79	3.3	3.3	45	1.6	1.4
Gallbladder	14	0.6	0.5	50	1.6	1.3
Pancreas	184	7.8	8.3	170	5.5	5.7
Larynx	159	7.0	6.0	31	1.1	1.3
Lung	1466	63.2	63.2	1035	38.0	36.5
Trachea and Pleura	41	1.8	1.9	15	0.5	0.4
Bones and Joints	18	0.8	1.1	19	0.8	0.8
Soft Tissues	76	3.1	3.1	68	2.5	2.0
Melanoma	387	15.7	14.1	344	12.2	9.9
Breast	18	0.8	0.8	3217	112.7	110.8
Cervix	-	-	-	174	6.1	6.9
Uterus	-	-	-	643	23.2	22.6
Ovary	-	-	-	415	14.6	16.1
Vulva	-	-	-	66	2.0	2.2
Prostate	3447	150.7	163.0	-	-	-
Testis	152	5.4	4.5	-	-	-
Bladder	726	30.6	29.3	228	7.0	7.9
Kidney	282	11.9	14.1	208	7.4	6.5
Eye	22	0.9	0.8	13	0.5	0.4
Brain	157	6.9	7.0	129	4.9	4.6
Thyroid	87	3.3	2.7	227	8.2	6.8
Hodgkin's Lymphoma	69	2.8	3.3	65	2.7	2.7
Non-Hodgkin's Lymphoma	499	20.5	20.3	445	14.8	13.8
Multiple Myeloma	114	4.9	5.2	125	5.3	3.2
Lymphocytic Leukemia	177	7.8	7.9	113	3.7	4.7
Myelocytic Leukemia	144	5.8	5.4	101	3.1	3.2
All Leukemias	355	14.8	15.1	246	7.6	8.6
All Cancers	10732	455.6	464.4	10043	344.1	334.9

* Data from Minnesota Cancer Surveillance System, 1992-1996.

† Number of newly-diagnosed cancers in Minnesota during 1997.

‡ Average annual rate per 100,000 people for all races combined, age-adjusted to the 1970 U.S. Population.

Table 2.2: Ten-Year Trends (Estimated Annual Percent Change [EAPC†]) in Cancer Incidence, Selected Cancer Types—Minnesota Cancer Surveillance System, 1988 - 1997

Cancer type	Males	Females
Oral Cavity and Pharynx	-2.49*	-1.40
Esophagus	3.15*	0.85
Stomach	-3.06*	-2.91*
Small Intestine	1.24	1.88
Colon and Rectum	-2.18*	-1.15*
Colon excl Rectum	-2.23*	-0.85
Rectum	-2.08*	-2.14
Liver and Intrahepatic Bile Duct	1.19	0.91
Gallbladder	-6.79*	-1.43
Pancreas	0.27	0.58
Larynx	-1.72	0.48
Lung and Bronchus	-0.86*	2.44*
Pleura	3.53	3.09
Bones and Joints	5.74	0.82
Soft Tissue including Heart	-1.49	0.38
Melanomas of the Skin	4.62*	1.88
Breast	2.79	0.28
Cervix	~	-2.11
Corpus and Uterus, NOS	~	0.44
Ovary	~	1.67
Prostate	1.49	~
Testis	0.90	~
Urinary Bladder	-0.20	-0.10
Kidney and Renal Pelvis	-0.12	1.89
Eye and Orbit	-5.19	-6.31
Brain	-0.73	-1.44
Thyroid	1.22	3.41*
Hodgkin's Disease	-1.14	0.12
Non-Hodgkin's Lymphomas	1.69*	1.63*
Multiple Myeloma	-2.20	1.50
Leukemias	0.29	-0.79
Lymphocytic Leukemia	0.89	-0.18
Myeloid Leukemia	0.74	-1.59
All Sites	0.13	0.44*

† EAPCs are based on annual age-adjusted rates (1970 U.S. standard) and were calculated using weighted least squares method.

~ Statistic could not be calculated.

* The EAPC is significantly different from zero ($p < 0.05$).

Table 2.3: MCSS 1997 Age-Specific Incidence Rates per 100,000 for Selected Cancers — Males, All Races

Cancer Site	Age																	
	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
Oral Cavity	0.0	0.0	0.0	0.5	0.0	1.3	2.7	5.6	9.7	15.2	30.4	30.3	59.3	63.6	62.2	55.1	89.6	67.6
Esophagus	0.0	0.0	0.0	0.0	0.0	0.1	0.5	0.9	0.5	3.7	10.1	8.1	22.2	41.5	33.5	51.0	30.9	36.1
Stomach	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	3.1	7.3	4.7	8.1	19.8	30.4	47.8	51.0	98.9	112.7
Small Intestine	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	2.0	3.0	0.8	0.0	1.2	12.4	17.5	28.6	9.3	27.1
Colon	0.0	0.0	0.0	0.5	0.7	1.3	2.2	4.2	5.1	14.6	35.1	67.8	114.9	138.2	248.8	326.4	358.5	378.8
Rectum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	4.6	8.5	20.3	26.3	49.4	87.1	84.5	116.3	126.7	157.8
Liver	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	2.0	4.9	6.2	10.1	3.7	12.4	19.1	28.6	15.5	22.5
Gallbladder	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	1.0	0.0	4.1	4.8	6.1	3.1	9.0
Pancreas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	2.0	6.1	14.1	20.2	28.4	29.0	51.0	67.3	37.1	36.1
Larynx	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	2.0	3.7	10.1	18.2	39.5	37.3	41.5	32.6	27.8	27.1
Lung	0.0	0.0	1.1	0.0	0.0	1.3	0.0	2.8	9.2	27.4	53.9	149.7	242.1	323.5	432.2	516.1	475.9	306.6
Trachea and Pleura	0.6	0.0	0.0	0.5	0.0	1.3	0.0	0.0	0.5	0.6	0.8	6.1	3.7	6.9	12.8	10.2	12.4	13.5
Bones and Joints	0.6	1.1	0.5	2.2	0.7	0.0	0.5	0.0	2.0	0.0	1.6	1.0	0.0	1.4	0.0	0.0	0.0	0.0
Soft Tissues	2.5	0.6	0.5	1.1	1.4	2.6	2.2	2.4	1.0	4.3	4.7	1.0	9.9	5.5	15.9	6.1	12.4	36.1
Melanoma	0.0	0.0	0.0	0.5	2.0	9.1	7.7	14.1	12.3	18.9	27.3	35.4	39.5	71.9	70.2	59.2	83.4	72.1
Breast	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.6	3.0	2.5	0.0	4.8	6.1	3.1	13.5
Prostate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	27.4	115.5	302.4	586.8	957.9	1252.0	1040.4	1029.1	698.9
Testis	1.2	0.0	0.0	1.6	9.5	17.5	23.0	14.6	9.2	4.9	1.6	1.0	0.0	1.4	4.8	0.0	0.0	0.0
Bladder	0.0	0.6	0.0	0.0	0.7	0.6	0.5	1.9	2.6	12.2	26.5	58.7	96.4	156.2	215.3	220.3	290.5	329.2
Kidney	0.6	1.1	0.0	0.0	0.0	1.9	0.0	2.8	8.2	11.0	14.8	22.2	42.0	60.8	79.7	65.3	58.7	72.1
Eye	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.0	0.6	2.3	3.0	2.5	2.8	6.4	4.1	3.1	0.0
Brain	2.5	3.4	2.7	2.2	4.1	4.5	4.9	4.2	4.6	7.9	7.0	19.2	22.2	22.1	25.5	8.2	6.2	4.5
Thyroid	0.0	0.0	0.0	0.0	2.0	2.6	3.8	9.4	2.0	3.0	6.2	4.0	7.4	15.2	8.0	14.3	9.3	0.0
Hodgkin's Lymphoma	0.0	0.6	1.6	2.2	6.1	6.5	3.3	2.8	3.1	4.9	1.6	2.0	1.2	4.1	4.8	4.1	9.3	0.0
Non-Hodgkin's Lymph.	0.6	1.1	1.6	1.1	2.0	3.9	11.5	8.0	8.7	22.6	28.9	42.5	45.7	99.5	89.3	151.0	157.6	94.7
Multiple Myeloma	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.0	4.9	9.4	10.1	7.4	20.7	22.3	46.9	49.4	27.1
Lymphocytic Leukemia	8.7	2.8	3.7	2.2	0.7	0.6	1.1	1.4	1.5	1.8	5.5	13.1	23.5	26.3	39.9	34.7	55.6	72.1
Myelocytic Leukemia	0.6	0.0	0.0	1.6	0.7	0.0	1.1	4.7	2.0	4.9	4.7	6.1	18.5	12.4	36.7	51.0	58.7	54.1
All Leukemias	9.3	2.8	3.7	3.8	1.4	0.6	2.2	8.0	4.1	7.3	11.7	21.2	44.5	40.1	89.3	95.9	123.6	148.8
All Cancers	20.5	11.9	11.7	16.9	33.9	59.1	72.7	93.1	108.6	240.2	466.0	913.2	1534.2	2309.9	3039.9	3115.1	3260.5	2912.9

Table 2.4: MCSS 1997 Age-Specific Incidence Rates per 100,000 for Selected Cancers — Females, All Races

Cancer Site	Age																	
	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
Oral Cavity	0.0	0.0	0.0	0.6	0.7	0/7	2/2	2.9	2.1	3.0	6.1	9.8	17.5	29.2	28.7	26.4	16.4	33.4
Esophagus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	3.0	3.5	6.1	6.5	16.1	10.9	21.1
Stomach	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.5	1.0	1.8	2.3	6.9	5.8	17.0	23.5	33.7	20.0	26.3
Small Intestine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.5	0.6	3.1	3.0	5.8	8.5	11.7	2.9	7.3	7.0
Colon	0.0	0.0	0.0	0.0	0.0	0.7	5.0	1.5	4.7	14.6	30.7	46.3	105.1	132.4	167.0	254.8	327.7	316.0
Rectum	0.0	0.0	0.0	0.6	0.0	0.7	0.0	1.9	4.2	8.5	12.3	15.8	32.7	21.9	53.5	54.2	69.2	59.7
Liver	0.6	0.0	0.0	0.0	1.4	0.0	0.6	0.0	0.5	1.8	2.3	1.0	3.5	8.5	13.0	11.7	1.8	7.0
Gallbladder	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.8	2.0	3.5	9.7	14.3	16.1	18.2	3.5
Pancreas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.6	3.0	6.9	15.8	15.2	25.5	27.4	57.1	38.2	36.9
Larynx	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.8	6.9	1.2	6.1	6.5	2.9	9.1	5.3
Lung	0.0	0.0	0.6	0.0	0.0	2.6	2.2	3.4	9.9	21.9	53.7	98.5	179.9	207.8	243.9	215.2	160.2	82.5
Trachea and Pleura	0.6	0.0	0.0	0.0	0.0	0.0	0.6	1.0	0.5	0.0	0.0	1.0	0.0	2.4	1.3	2.9	5.5	1.8
Bones and Joints	0.0	0.6	1.1	1.1	0.7	0.7	0.6	0.5	0.5	1.2	1.5	1.0	1.2	0.0	1.3	1.5	0.0	1.8
Soft Tissues	2.6	0.0	0.6	0.6	1.4	2.0	2.8	2.4	1.0	1.8	3.8	2.0	9.3	6.1	6.5	11.7	7.3	8.8
Melanoma	0.6	0.0	0.6	2.3	5.5	15.0	13.3	16.0	19.8	23.7	26.1	14.8	30.4	25.5	24.8	36.6	21.8	36.9
Breast	0.0	0.0	0.0	0.0	1.4	7.2	29.3	57.2	102.9	183.2	272.4	323.1	361.0	376.6	469.6	541.7	477.0	423.1
Cervix	0.0	0.0	0.0	0.0	0.7	7.2	11.6	15.0	13.1	15.2	6.9	15.8	10.5	9.7	9.1	10.2	7.3	0.0
Uterus	0.0	0.0	0.0	0.0	0.0	0.7	2.2	9.7	16.7	27.4	44.5	79.8	84.1	96.0	113.5	109.8	94.7	64.9
Ovary	0.0	0.0	0.6	1.1	2.8	5.9	4.4	14.6	15.7	18.9	33.0	37.4	39.7	49.8	63.9	46.9	63.7	49.2
Vulva	0.0	0.0	0.0	0.0	0.0	0.7	0.6	0.5	1.6	1.2	3.1	3.9	1.2	14.6	6.5	16.1	23.7	14.0
Bladder	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	2.6	3.7	6.9	12.8	24.5	32.8	45.7	51.2	67.4	68.5
Kidney	2.6	0.0	0.0	1.7	0.0	2.0	1.7	2.9	0.5	7.3	12.3	12.8	30.4	32.8	37.8	46.9	31.1	28.1
Eye	1.9	0.0	0.0	0.0	0.0	0.0	0.6	0.5	0.5	0.6	1.5	0.0	1.2	1.2	0.0	2.9	0.0	0.0
Brain	2.6	3.6	2.2	2.3	0.7	1.3	5.0	3.9	5.2	5.5	8.4	7.9	9.3	15.8	10.4	16.1	16.4	7.0
Thyroid	0.6	0.0	0.6	2.3	6.2	10.4	13.3	10.7	13.1	14.0	11.5	15.8	10.5	17.0	26.1	11.7	21.8	14.0
Hodgkin's Lymphoma	0.0	0.6	0.6	7.5	4.9	5.2	2.8	3.4	2.6	0.6	3.1	2.0	1.2	3.6	5.2	0.0	5.5	0.0
Non-Hodgkin's Lymph.	0.6	0.0	1.1	1.7	2.1	3.3	3.3	5.3	8.4	15.2	18.4	36.4	44.4	58.3	80.9	86.4	89.2	98.3
Multiple Myeloma	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	2.1	3.0	3.8	7.9	15.2	13.4	30.0	36.6	27.3	26.3
Lymphocytic Leukemia	3.2	2.4	1.1	0.0	0.0	1.3	0.0	0.0	0.5	0.6	3.8	4.9	11.7	15.8	14.3	20.5	32.8	38.6
Myelocytic Leukemia	0.0	1.2	0.6	1.1	0.0	0.0	1.7	1.5	3.1	1.8	1.5	5.9	4.7	14.6	13.0	20.5	25.5	33.4
All Leukemias	3.9	3.6	2.2	1.1	0.0	1.3	1.7	1.5	3.7	3.0	6.9	11.8	16.4	32.8	31.3	46.9	61.9	98.3
All Cancers	23.3	10.1	10.1	23.5	31.2	69.1	110.5	160.6	241.3	395.0	600.9	824.4	1106.3	1341.3	1626.7	1884.3	1795.2	1662.4

SECTION 3: Cancer Mortality

A. Introduction

Mortality data reflect how many people died of cancer during a given time period, while incidence data reflect how many people developed cancer during given time period. Mortality data are gathered from death certificates which are collected, coded, and computerized by the Minnesota Center for Health Statistics at the Minnesota Department of Health. A person who has a diagnosed cancer (e.g., prostate cancer) may die of another cause (e.g., heart attack). This person's prostate cancer would not be reflected in mortality statistics (since the cancer is not the underlying cause of death), but would be found in incidence statistics. For a given year, cancer incidence and cancer mortality usually do not reflect the experience of the same individuals. People who are diagnosed with cancer and eventually die from it, often do so a number of years after diagnosis.

For a variety of reasons, the picture of cancer occurrence developed from mortality data (deaths due to a cancer) will differ from the picture developed from incidence data (newly-diagnosed cancers). Specific reasons for this are:

1. Increasing numbers of people survive longer with their cancer. Incidence closely parallels mortality for the types of cancer with poor survival; for cancer with good survival, incidence is considerably higher than mortality. For example, lung cancer incidence and mortality are fairly similar, while breast and cervical cancer incidence rates are much higher than their corresponding mortality rates. As screening improves and becomes more widespread for specific cancers, the differences between incidence and mortality should widen for these cancers.
2. The differences in survival between the various types of cancer will also affect which types of cancer appear more common. Thus, in males prostate cancer is by far the most common type of cancer when new diagnoses (incidence data) are examined, but lung cancer is the most common cause of cancer death (mortality data). This is due to the much higher survival rates for those with prostate cancer than for those with lung cancer.
3. Cancer incidence data are more accurate than mortality data because of how the data are recorded. The physician filling out a death certificate may have little knowledge of the medical history of the deceased person. This can result in a nonspecific or even inaccurate cause of death being recorded on the death certificate. Incidence data collected by the MCSS, in contrast, are based on detailed information recorded at the time the diagnosis is made, are checked for accuracy, and are therefore a more accurate measure of cancer occurrence than are mortality data.

4. The data for incidence and mortality statistics may contain different definitions of “cancer.” Cancer incidence data for 1997 include only those cancers that were microscopically confirmed, that is where a tissue specimen was obtained and examined by a pathologist who determined the cells to be malignant. Death certificates also include cancers that were clinically diagnosed but not microscopically confirmed. A few types of cancer—notably pancreatic cancer—are frequently diagnosed without tissue confirmation, and so these cancers would not be included in incidence data but would be included in mortality data when and if the person dies of their cancer. Therefore, the number of pancreatic cancer deaths in 1997 was greater than the number of microscopically-confirmed cases during the same time period. The original quality control study¹ that established the methods for the MCSS documented that 98.6 percent of all microscopically-confirmed cancers were identified by the MCSS and that more than 95 percent of all cancers in Minnesota residents were diagnosed through tissue specimens. A recent independent assessment² demonstrated that MCSS case ascertainment was 99.6 percent complete for microscopically-confirmed diagnoses, and 99.1 percent complete for all (including nonmicroscopically-confirmed) diagnoses.

B. Age-Standardized Cancer Mortality

Table 3.1 provides a profile of the statewide, age-adjusted mortality rates for specific cancers for the year 1997 compared with 1992-1996. The number of cancer deaths (N) in Minnesota for 1997 is also given. Lung, prostate, and colon cancer for men and lung, breast, and colon cancer for women were the leading causes of cancer mortality in Minnesotans—accounting for nearly 50 percent of cancer deaths. Overall, males had a 47 percent higher cancer mortality rate than females. That gap, however, is closing as lung cancer incidence rates in women increase, while lung cancer incidence rates in men decrease. This change will be reflected in future mortality rates.

Table 3.2 shows the ten-year trends in cancer mortality for Minnesota. Among males, cancer mortality decreased for cancers of the stomach, colon and rectum, gallbladder, lung, pleura, and all cancers combined. Among females, cancer mortality decreased for cancers of the stomach, colon and rectum, breast, and ovary, as well as for melanomas of the skin.

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1. Final Report to the Bush Foundation. Feasibility and Implementation of a Pathology-Based, Statewide Cancer Surveillance System (July 1, 1983 - June 30, 1986). July 1986 Minnesota Department of Health Minneapolis, MN.
 2. Cancer Surveillance and Control Program. Case Completeness and Data Quality Audit: Minnesota Cancer Surveillance System 1994-1995. Addendum issued February 1997. (unpublished report available from the MCSS)

The decreasing mortality from stomach, colon/rectum, lung, and gallbladder cancer (lung and gallbladder cancer decreased only among males) is consistent with the previously-discussed (Section 2) decreasing incidence rates for these types of cancer.

The apparent decrease in mortality due to pleural cancer is most likely an artifact, since the incidence of pleural cancers did not decrease. Cancer of the pleura (the membrane that lines the chest cavity) consists primarily of mesotheliomas, for which the only known cause is asbestos exposure. Certification of mesotheliomas as the cause of death was problematic under the International Classification of Diseases, 9th Edition (ICD-9), the coding system in effect during the years covered by this report. When “mesothelioma” was recorded as the underlying cause of death, the death could be coded as due to cancer of the pleura, lung, or unknown primary site. Beginning with deaths that occurred in 1999, the International Classification of Diseases, 10th Edition (ICD-10) is being used; the ICD-10 has a code specifically for mesothelioma.

The decrease in mortality from all cancers combined among males (-0.65 percent per year in Minnesota) has also been observed nationally. It is probably explained primarily by the decreasing mortality rates of lung and colorectal cancer. No overall decrease in cancer mortality for females was observed. Any decreases in colorectal cancer mortality among females were offset by increasing mortality due to lung cancer.

Among males, cancer mortality increased for liver and intrahepatic bile duct (IBD) cancer and non-Hodgkin’s lymphoma. Among females, cancer mortality increased for lung cancer and thyroid cancer.

The increase in non-Hodgkin’s lymphoma mortality is consistent with the previously-discussed (Section 2) increasing incidence of that disease, as is the increasing mortality of lung and thyroid cancer among females.

Between 1988 and 1997, mortality due to liver and IBD cancer increased by 3.9 percent per year among Minnesota males. A smaller, non-significant increase (1.2 percent per year) in liver and IBD cancer incidence was observed among Minnesota males during the same time period. Increasing incidence and mortality from liver and IBD cancer has also been observed nationally. Liver and IBD cancer is the fifth most common cancer in the world, but is much less common in the United States. The major known cause of liver and IBD cancer is chronic infection with hepatitis B virus. Hepatitis C infection is also thought to cause liver and IBD cancer. Other risk factors for liver and IBD cancer are cirrhosis, chronic alcoholism, smoking, aflatoxin exposure, occupational exposure to vinyl chloride, and oral contraceptive use.³

C. Age-Specific Cancer Mortality

Tables 3.3 and 3.4 contain cancer mortality rates for males and females for 18 separate age groups. The strong effect of aging on cancer mortality is demonstrated with these data. Cancers of the prostate and colon are good examples of this relationship. Starting around age 40, mortality rates for these cancers generally increase from 50 to 100 percent every five years. Other cancer mortality rates such as those for brain and lung increase substantially through middle age and then level off and even decrease among the very elderly.

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3. Howe HL, Wingo PA, Thun MJ, Ries LA, Rosenberg HM, Feigal EG, Edwards BK. Annual report to the nation on the status of cancer (1973 through 1998), featuring cancers with recent increasing trends. *J Natl Cancer Inst* 2001 Jun 6;93(11):824-42.

Mortality Table 3.1: Number of Cancer Deaths and Cancer Death Rates for Selected Cancers, Minnesota, 1997

Cancer	Males			Females		
	N *	Rate 1997 [†]	Rate 92-96 [†]	N *	Rate 1997 [†]	Rate 92-96 [†]
Oral Cavity	77	3.3	2.9	50	1.6	1.3
Esophagus	145	6.1	5.6	46	1.2	1.2
Stomach	114	4.5	5.3	57	1.6	2.3
Small Intestine	9	0.4	0.4	11	0.3	0.4
Colon	391	16.0	16.4	405	10.8	11.7
Rectum	75	3.0	2.9	56	1.6	1.5
Liver	105	4.4	3.8	61	1.9	1.7
Gallbladder	13	0.5	0.3	41	1.2	1.0
Pancreas	230	9.6	9.8	247	6.9	7.1
Larynx	36	1.5	1.4	9	0.3	0.3
Lung	1259	53.4	54.5	859	29.2	29.0
Trachea and Pleura	8	0.3	0.3	3	0.1	0.1
Bones and Joints	7	0.3	0.4	7	0.3	0.3
Soft Tissues	32	1.3	1.3	35	1.2	1.2
Melanoma	69	2.8	2.7	43	1.3	1.3
Breast	11	0.5	0.2	678	21.5	24.4
Cervix	-	-	-	45	1.5	1.7
Uterus	-	-	-	59	1.7	1.9
Ovary	-	-	-	218	7.0	7.9
Vulva	-	-	-	22	0.5	0.3
Prostate	596	22.7	25.9	-	-	-
Testis	9	0.3	0.2	-	-	-
Bladder	136	5.3	5.3	84	1.9	1.4
Kidney	141	5.8	5.4	90	2.8	2.6
Eye	1	0.1	0.1	4	0.1	0.1
Brain	114	4.9	5.2	93	3.3	3.8
Thyroid	13	0.5	0.3	21	0.6	0.4
Hodgkin's Lymphoma	7	0.3	0.6	15	0.5	0.4
Non-Hodgkin's Lymphoma	234	9.6	9.2	218	6.2	6.6
Multiple Myeloma	107	4.4	4.2	77	2.2	2.7
Lymphocytic Leukemia	59	2.4	3.5	43	1.1	1.6
Myelocytic Leukemia	101	4.1	3.9	75	2.3	2.2
All Leukemias	211	8.5	9.6	166	4.7	5.0
All Cancers	4556	187.3	190.3	4178	127.2	132.1

* Number of cancer deaths in Minnesota for 1997.

[†] Average annual rate per 100,000 people for all races combined, age-adjusted to the 1970 U.S. Population.

Table 3.2: Ten-Year Trends (Estimated Annual Percentage Change [EAPC[†]]) in Cancer Mortality, Selected Cancer Types—Minnesota, 1988-1997

Cancer type	Males	Females
Oral Cavity and Pharynx	-1.56	-0.99
Esophagus	2.00	-1.81
Stomach	-2.83*	-4.63*
Small Intestine	-2.18	3.34
Colon and Rectum	-2.89*	-2.36*
Colon excl. Rectum	-2.89*	-2.64*
Rectum	-2.93	0.00
Liver and Intrahepatic Bile Duct	3.90*	2.69
Gallbladder	-7.01*	2.42
Pancreas	0.07	0.33
Larynx	-1.74	-0.77
Lung and Bronchus	-0.93*	2.64*
Pleura	-8.05*	~
Bones and Joints	-5.29	-3.67
Soft Tissue including Heart	0.81	3.56
Melanomas of the Skin	2.01	-4.24*
Breast	6.57	-2.43*
Cervix	~	0.95
Corpus and Uterus, NOS	~	-2.05
Ovary	~	-1.33*
Prostate	-1.12	~
Testis	-4.88	~
Urinary Bladder	0.24	-0.36
Kidney and Renal Pelvis	-0.69	0.81
Eye and Orbit	~	2.70
Brain	-1.16	-1.41
Thyroid	4.06	6.65*
Hodgkin's Disease	-6.74	-1.13
Non-Hodgkin's Lymphomas	2.20*	2.89
Multiple Myeloma	0.38	0.99
Leukemias	0.76	-0.78
Lymphocytic Leukemia	1.28	2.99
Myeloid Leukemia	0.84	-0.10
All Malignant Cancers	-0.65*	-0.18

† EAPCs are based on annual age-adjusted rates (1970 U.S. standard) and were calculated using weighted least squares method.

~ Statistic could not be calculated.

* The EAPC is significantly different from zero ($p < 0.05$).

Table 3.3: MCSS 1997 Age-Specific Mortality Rates per 100,000 for Selected Cancers — Males, All Races

Cancer Site	Age																	
	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
Oral Cavity	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5	1.5	3.7	4.7	6.1	16.1	19.4	17.5	8.2	24.7	18.0
Esophagus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	2.0	5.5	8.6	6.1	27.2	31.8	41.5	36.7	34.0	54.1
Stomach	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.0	1.2	3.9	6.1	9.9	8.3	27.1	36.7	86.5	90.2
Small Intestine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.8	1.0	0.0	2.8	0.0	2.0	9.3	0.0
Colon	0.0	0.0	0.0	0.0	0.0	0.6	0.5	1.9	1.5	2.4	13.3	27.3	37.1	69.1	97.3	163.2	154.5	284.1
Rectum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.6	5.5	6.1	8.6	8.3	17.5	20.4	37.1	49.6
Liver	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.5	4.9	4.7	8.1	2.5	31.8	30.3	34.7	27.8	36.1
Gallbladder	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	4.1	4.8	0.0	6.2	13.5
Pancreas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	2.0	6.1	10.9	15.2	28.4	45.6	78.2	59.2	83.4	103.7
Larynx	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.8	2.0	6.2	15.2	3.2	8.2	27.8	4.5
Lung	0.0	0.0	0.0	0.0	0.0	0.0	0.5	3.3	9.2	20.7	35.1	114.3	195.2	246.1	376.4	479.4	438.9	414.9
Trachea and Pleura	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	2.0	1.2	0.0	3.2	2.0	3.1	0.0
Bones and Joints	0.0	0.0	0.5	0.0	0.0	0.0	0.5	0.0	1.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	4.5
Soft Tissues	0.0	0.0	0.0	0.0	0.0	1.3	0.5	0.5	0.5	0.6	1.6	5.1	1.2	4.1	6.4	8.2	12.4	13.5
Melanoma	0.0	0.0	0.0	0.0	0.7	0.6	0.5	0.5	0.5	4.3	5.5	5.1	8.6	4.1	14.4	20.4	21.6	40.6
Breast	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.0	0.0	1.4	3.2	6.1	6.2	0.0
Prostate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	13.1	28.4	66.4	116.4	234.6	451.2	789.1
Testis	0.0	0.0	0.0	0.0	0.0	0.6	1.1	0.9	0.0	0.0	0.8	1.0	0.0	0.0	0.0	0.0	3.1	4.5
Bladder	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.5	0.6	0.8	7.1	6.2	16.6	33.5	49.0	77.3	166.8
Kidney	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.0	4.9	9.4	7.1	18.5	29.0	28.7	42.8	68.0	54.1
Eye	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0
Brain	0.6	0.0	0.0	1.6	0.0	0.6	2.7	1.9	2.0	2.4	7.8	16.2	19.8	22.1	23.9	28.6	9.3	9.0
Thyroid	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.5	0.0	0.0	0.0	2.0	0.0	2.8	3.2	8.2	3.1	0.0
Hodgkin's Lymphoma	0.0	0.0	0.0	0.0	0.7	0.6	0.0	0.0	0.5	0.6	0.8	0.0	0.0	0.0	0.0	4.1	0.0	0.0
Non-Hodgkin's Lymph.	0.0	0.0	0.0	0.0	0.7	0.0	0.5	0.9	1.5	4.9	7.8	16.2	22.2	42.9	65.4	75.5	129.8	108.2
Multiple Myeloma	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.8	5.1	9.9	18.0	39.9	42.8	40.2	72.2
Lymphocytic Leukemia	1.2	0.0	0.0	0.0	0.0	0.0	1.1	0.5	0.0	1.2	1.6	1.0	3.7	9.7	20.7	16.3	15.5	58.6
Myelocytic Leukemia	1.2	0.0	0.0	0.0	0.0	0.0	1.1	0.9	0.5	3.0	2.3	6.1	7.4	18.0	33.5	26.5	40.2	63.1
All Leukemias	2.5	1.1	0.5	0.0	0.0	0.6	3.3	1.9	0.5	4.3	5.5	7.1	14.8	30.4	67.0	73.4	80.4	148.8
All Cancers	4.3	2.8	1.6	1.6	4.1	7.1	13.1	21.6	31.3	81.1	144.4	313.5	508.9	807.3	1209.0	1558.6	1981.1	2719.2

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Mortality

Table 3.4: Minnesota 1997 Average, Annual, Age-Specific Mortality per 100,000 for Selected Cancers — Females, All Races

Cancer Site	Age																	
	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
Oral Cavity	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	3.1	2.0	8.2	7.3	13.0	8.8	7.3	15.8
Esophagus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	3.9	1.2	7.3	3.9	11.7	16.4	24.6
Stomach	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.5	0.5	0.6	0.8	3.0	5.8	8.5	9.1	11.7	10.9	28.1
Small Intestine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.2	0.0	2.6	1.5	5.5	5.3
Colon	0.0	0.0	0.0	0.6	0.0	0.0	1.1	1.9	2.6	4.9	9.2	19.7	28.0	41.3	52.2	80.5	136.6	219.4
Rectum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.2	3.8	2.0	4.7	7.3	6.5	10.2	12.7	29.8
Liver	0.0	0.0	0.0	0.0	0.7	0.7	1.1	0.0	1.0	0.6	2.3	3.0	5.8	7.3	11.7	10.2	20.0	17.6
Gallbladder	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.5	2.0	1.2	6.1	13.0	7.3	14.6	12.3
Pancreas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.0	3.0	5.4	9.8	15.2	34.0	47.0	57.1	87.4	101.8
Larynx	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.2	1.2	1.3	2.9	1.8	3.5
Lung	0.0	0.0	0.0	0.0	0.0	1.3	0.6	4.4	8.4	11.0	33.8	68.9	116.8	164.0	190.5	193.3	176.6	156.2
Trachea and Pleura	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	1.8	1.8
Bones and Joints	0.0	0.0	0.0	2.3	0.3	0.7	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	1.8	0.0
Soft Tissues	0.0	0.0	0.0	0.6	0.0	0.0	0.6	0.5	0.5	0.6	1.5	3.9	4.7	4.9	3.9	11.7	3.6	5.3
Melanoma	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.5	0.5	2.4	3.1	1.0	3.5	2.4	6.5	13.2	3.6	14.0
Breast	0.0	0.0	0.0	0.0	0.0	0.7	2.2	4.9	15.7	25.0	36.1	65.0	60.7	74.1	108.3	118.6	134.7	224.7
Cervix	0.0	0.0	0.0	0.0	0.0	0.7	0.0	1.0	2.6	1.8	3.1	5.9	3.5	3.6	5.2	2.9	10.9	10.5
Uterus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	1.5	2.0	3.5	12.1	9.1	13.2	20.0	24.6
Ovary	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.5	2.1	6.1	10.0	15.8	24.5	24.3	49.6	43.9	58.3	56.2
Vulva	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	1.0	0.0	2.4	1.3	5.9	3.6	15.8
Bladder	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.5	1.0	1.2	8.5	9.1	19.0	27.3	65.0
Kidney	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.0	1.2	4.6	3.9	11.7	14.6	10.4	16.1	31.0	29.8
Eye	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	1.3	1.5	0.0	1.8
Brain	0.6	1.2	0.0	0.6	0.0	0.7	1.1	1.9	2.1	4.3	6.9	4.9	9.3	15.8	15.7	8.8	21.8	10.5
Thyroid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	1.0	0.0	3.6	3.9	1.5	12.7	8.8
Hodgkin's Lymphoma	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	1.0	0.6	0.8	0.0	2.3	1.2	2.6	1.5	0.0	5.3
Non-Hodgkin's Lymph.	0.6	0.0	0.0	0.6	0.7	0.0	0.0	2.9	2.1	3.7	3.1	12.8	14.0	18.2	41.7	52.7	72.8	82.5
Multiple Myeloma	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5	1.8	1.5	3.9	5.8	4.9	15.7	27.8	23.7	22.8
Lymphocytic Leukemia	1.3	0.0	0.6	0.0	0.0	0.7	1.1	0.0	0.5	1.2	0.8	1.0	0.0	1.2	7.8	2.9	18.2	22.8
Myelocytic Leukemia	0.6	0.6	0.0	0.0	0.0	0.0	0.6	0.0	1.0	2.4	1.5	6.9	5.8	6.1	11.7	19.0	16.4	28.1
All Leukemias	1.9	1.2	1.1	0.0	0.0	0.7	2.2	1.0	1.6	3.7	3.1	9.8	7.0	10.9	23.5	32.2	56.4	75.5
All Cancers	4.5	2.4	1.1	5.2	2.8	5.9	11.1	25.2	48.6	82.8	149.7	274.8	378.5	530.9	735.8	874.1	1116.1	1462.3