CANCER INCIDENCE IN DAKOTA AND WASHINGTON COUNTIES

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Minnesota Cancer Surveillance System

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Executive Summary

The widely-publicized presence of perfluorochemicals (PFCs) in city drinking water supplies and private wells in a variety of eastern Metro area communities has raised many concerns among citizens, their elected officials, and public health officials. Among the health concerns raised among residents of Dakota County and Washington County is whether community cancer rates are unusually high in communities where PFCs have been detected. While the potential exposures and health risks of these chemicals continue to be evaluated by federal, state, academic, and industry scientists, it is important to address public concerns of increased cancer occurrence by examining cancer rates in these counties.

The major goal of this report is to address cancer concerns by providing detailed profiles of cancer rates among residents of Dakota and Washington Counties. County-wide cancer rates are presented for each county for all cancers combined and for each of about 25 of the most frequent types of cancer. Additional non-routine analyses were also conducted to examine incidence rates for selected cancers for specific communities within each county. In addition, this report describes some general information on cancer rates and cancer risks and the limitations of using cancer surveillance statistics to characterize health risks of low level environmental contamination in communities.

Cancer rates at the county and state-wide level are routinely available from two sources within the Minnesota Department of Health: *cancer death rates* are compiled and published annually by the Minnesota Center for Health Statistics and *cancer incidence rates* (newly-diagnosed cancers) are compiled and published biennially by the Minnesota Cancer Surveillance System (MCSS). The MCSS was established in 1988 and systematically collects demographic and diagnostic information on all Minnesota residents with newly diagnosed cancers. Cancer incidence rates provide a much more complete and accurate perspective on cancer occurrence and this report focuses only on cancer incidence rates.

Most cancer rates presented in this report are based on a comparison of the observed number of cancers in a population and the number of cancers that would be “expected” based on the population size, age, and gender. The expected numbers do not account for the many other factors that dramatically influence cancer rates (e.g., smoking).

As of the time of this report, routine county-level data (available for all Minnesota counties) were available for the 15-year period 1988-2002. Due to population growth, limitations on community census data, and other factors, cancer rates for specific communities (zip codes) within these counties were determined for the period 1996-2004. Cancer rates based on geographic location reflect the address at the time of diagnosis.

County-Wide Findings

A total of 8,660 new cancers were diagnosed among Washington County residents during the 15-year period 1988-2002. Among males, there were 4,397 cancers diagnosed compared to 4,549 expected, a small but statistically significant 3% deficit. Among females, there were 4,263 cancers diagnosed which was nearly identical to the 4,261 expected cancers. The number of childhood cancers was not significantly higher than the number expected for either

males or females. The overall cancer incidence in Washington County is comparable to or slightly lower than the statewide average.

A total of 15,062 new cancers were diagnosed among residents of Dakota County from 1988-2002. Among males, there were 7,479 cancers compared to 7,702 expected, a small but statistically significant 3% deficit. Among females, 7,583 cancers were diagnosed and 7,440 cancers were expected, an excess that was not statistically significant. The number of childhood cancers was not significantly higher than the number expected for males and females. The overall cancer incidence in Dakota County is comparable to or slightly lower than the statewide average.

Except for the most common types of cancer (prostate, breast, lung, colon and all cancers combined), the rates for specific types of cancer in these counties are based on very small numbers and have a high degree of statistical uncertainty. Among males, there were statistically significant deficits in lung cancers, 9% in Washington County and 6% in Dakota County, a 21% deficit in cancers of the larynx in Dakota County, and a 3% deficit in all cancers combined in both Washington and Dakota Counties. Among females in Washington County, there was a 35% deficit in Hodgkin's lymphoma, and a 24% deficit of all leukemias. Among females in Dakota County, there was a 47% excess of liver cancer and a 5% excess of breast cancer. The breast cancer rate, however, was identical to other Metro counties.

While an excess of liver cancer was found in Dakota females (44 cases vs. 30 expected), no excess of liver cancer was found in Dakota males (55 cases vs. 64 expected) or in Washington County males or females. Most of the elevation in female liver cancer in Dakota County occurred during 1988-1993; rates for the period 1994-2002 were very close to the statewide average. For a statewide perspective, liver cancer rates were examined for all Minnesota counties. This analysis showed that county male liver cancer rates ranged from one third to double the state average and female liver cancer rates range from one half to three times the state average.

Community (Zip Code) Findings

The determination of cancer rates at the community level is problematic due to limitations in the detailed census data needed for calculating rates, address errors, and the large statistical uncertainty of cancer rates in smaller populations. These data must be interpreted very cautiously and are provided here to address community concerns. For eight communities where PFCs have raised health concerns (Cottage Grove, Hastings, Lake Elmo, Newport, Oakdale, South St. Paul, St. Paul Park, and Woodbury), 16 cancers types were compared to Metro area rates. For additional perspective, bladder and liver cancer rates were compared to Metro rates for all communities (zip codes) in each county.

As with the county-wide data, the distribution of cancer types among the eight communities was similar to the statewide distribution. Prostate cancer in males and breast cancer in females are the most common cancers, while lung and colorectal cancers were the next most common cancers. Distributions of the less common cancers showed greater variability due primarily to the small number of cases at the community level.

For the most part, the observed and expected numbers for these eight communities are very similar. Of the 256 rate comparisons, there were seven rates that were statistically significantly elevated and four rates that were statistically significantly low. No pattern emerges from these elevated or decreased rates. These differences vary according to gender, involve a number of different cancers (lung, oral, kidney, liver, breast and all cancers combined), and occur in a number of different communities. Variations in lung cancer most likely reflect the variations in past tobacco use from community to community.

The pattern of rates for male bladder cancer (the fourth most common cancer in Minnesota males) shows considerable variability. Liver cancer is much less common than bladder cancer, and there were many communities with no cases for one gender or another, demonstrating how unstable rates are at this level of analysis. The figures in this report show the high degree of uncertainty when examining rates of specific cancers in relatively small populations.

For all eight communities combined, overall cancer rates were virtually identical to Metro area rates. Of the 16 categories of cancer examined for each gender, a 13% deficit of colorectal cancer among females was the only statistically significant difference from Metro rates.

Usefulness and Limitations of Community Cancer Rates in Addressing Cancer Concerns

MCSS is a powerful tool in addressing cancer rates and trends in Minnesota and MCSS data are extremely useful in facilitating epidemiologic studies of specific cancers, quality of care studies, evaluating screening and prevention programs, and many other purposes. While community cancer rates have a high degree of statistical uncertainty and must be interpreted cautiously, such data are also very useful in addressing public concerns over cancer rates in a county or a community. However, for many reasons, analyses of community cancer rates are rarely useful in documenting potential cancer risks from low levels of environmental pollutants.

- Cancer is not a single disease but a group of more than 100 different diseases. Cancers differ in their rates of occurrence, risk factors, treatment, and survivorship. Unfortunately, cancer is not a rare disease, especially when considered in terms of lifetime risk. Not including the commonest forms of skin cancer, the average lifetime risk of developing some type of cancer is approximately 47%. On average then, almost one in two people will have a diagnosis of cancer during their lifetimes.

- The time period for the development of cancer (latency period) is typically several decades, such that many cancers diagnosed today are due to exposures and lifestyle experiences that began or occurred many years ago. Unfortunately, it is often not possible to know when newly-identified contaminants would have first entered the drinking water in a community. Furthermore, due to the high mobility of our population, many residents in a community did not reside there for more than five years prior to their diagnosis of cancer. Thus, community cancer rates are frequently comprised of individuals who differ in their residential histories in the community, as well as in their potential exposures to environmental contaminants.

- While we have no control over risk factors such as age, race, and family history, much of our cancer risk is related to factors that we can control. Such "lifestyle factors," include: cigarette smoking; heavy drinking; and eating foods that have excess calories, high fat, and low vegetable intake. It has been estimated that approximately 30% of total cancer deaths in the U.S. are related to smoking, while another 30% are related to diet and obesity. Other lifestyle factors that increase risk have to do with occupation, reproductive patterns, sexual behavior, and sunlight exposure. However, even when no modifiable risk factors are known that can reduce the risk of developing a cancer, screening and early diagnosis may prevent or reduce the risk of death.

- Each type of cancer is usually associated with a number of risk factors (see Appendix). For some cancers, these known risk factors account for a significant proportion of cancer occurrence (e.g., 80-90% of lung cancer is attributable to smoking; 95% of cervical cancer is due to HPV). Communities and counties can vary widely in terms of known risk factors for cancer, contributing to the variability of cancer rates. While age and gender distributions in a community can be routinely be accounted for, lack of information about other known determinants of cancer incidence (such as smoking rates) in a given population makes it difficult to attribute any observed excess or deficit in cancer rates to a given cause.

- Well-designed epidemiological studies, in addition to toxicological research, are necessary to answer questions about the extent to which an environmental exposure may be contributing to the occurrence of cancers in human populations. Indeed, most known human carcinogens have been identified through epidemiologic studies of occupational groups. Cancer risks are more likely to be detected in occupational cohorts compared to community settings since occupational exposures are generally very much greater than community exposures and it is frequently possible to estimate past exposures in a workplace, using industrial hygiene data, job histories, and other data.

- State and federal regulatory standards and enforcement programs are intended to limit exposures to potential carcinogens to very low risks, for example, one additional cancer in 100,000 people with lifetime exposure. This level of cancer risk is many thousands of times lower than cancer risks that can be detected epidemiologically.

Conclusions

- Monitoring cancer rates and trends in Minnesota is one the important objectives of the MCSS. While detailed epidemiological studies and toxicological data from animal studies are usually required to assess cancer risks for establishing health standards, detailed profiles of cancer rates serve a critical role in informing the public as to the actual occurrence of cancers in their communities.

- Overall cancer rates in Washington and Dakota Counties are very similar to the rest of the state.

- Rates of specific types of cancer among county residents are comparable to the statewide average; the small number of deviations is consistent with random variability.

- Cancer rates in the profiled communities within Washington and Dakota Counties have more statistical uncertainty compared to county or Metro rates due to the small populations and these rates must be interpreted very cautiously; the few elevations and deficits for specific types of cancer are typical of cancer rates in other small populations in Minnesota. Overall cancer rates, as well as rates for specific cancers for all eight communities combined are virtually identical to Metro area rates.

Background and Purpose of This Report

The Minnesota Department of Health (MDH) receives over 100 inquiries each year from around the state expressing concerns about cancer rates or cancer risks in a community, school, or other population. These concerns often originate in one of two ways: (1) an unusual number of cancers are perceived or known to have occurred in some area or population and it is feared that some type of environmental exposure may be responsible; or (2) exposure to some environmental pollutant is known or suspected to have occurred and there is considerable concern about the risk of cancer from that exposure. Many of these concerns reflect common misunderstandings about the frequency and the causes of cancer, as well as how cancer risks are identified. Sometimes, these concerns are translated into the perception that there is an ongoing "cancer epidemic" in the community. The trepidation and anxiety created by this perception is a significant public health issue that often has long lasting consequences.

As with many other counties throughout the state, cancer concerns in Washington and Dakota Counties have involved a variety of communities, geographic regions, types of cancer, and environmental issues. Most recently, however, residents from a number of communities in Dakota and Washington County have voiced concerns about health risks from the widely-publicized presence of perfluorochemicals (PFCs) in drinking water supplies, people, fish, and soil.

In response to concerns about PFC contamination from several landfill sites located in these communities, the MDH and the Minnesota Pollution Control Agency (MPCA) conducted sampling of wells in several communities from 2004- present. PFCs were consistently detected in 6 of 8 municipal wells in Oakdale, with maximum concentrations of 1.2 ppb Perfluorooctanesulfonate (PFOS), 0.9 ppb Perflurooctanoic Acid (PFOA), and 1.8 ppb Perfluorobutanoic Acid (PFBA). A treatment plant is now in operation for two of the city wells. In the city of Lake Elmo, over 400 private wells were sampled and PFCs were detected in over 300 of these wells; approximately 60 private wells were found to have PFC concentrations exceeding MDH health-based values and required alternate water supplies. Further sampling in 2006 discovered widespread contamination of groundwater with Perfluorobutanoic acid (PFBA) in Cottage Grove, Woodbury and other communities in south Washington County. More information about perfluorochemicals in Minnesota and possible health risks can be found on the MDH website at http://www.health.state.mn.us/divs/eh/hazardous/topics/pfcshealth.html.

While the potential health risks of these chemicals continue to be evaluated from a variety of toxicological, epidemiological, and environmental perspectives by government, academic, and industry scientists, it is important to address community cancer concerns. This report attempts to address those concerns by providing detailed profiles of cancer incidence in the affected counties and communities and compare these cancer rates to rates elsewhere in the state or Metro region. At the same time, it is critically important to provide some general background on the nature of cancer, how cancer occurrence is monitored in Minnesota, and the limitations in interpreting community cancer rates.

Specifically, the purpose of this report is to do the following:

(1) Describe the sources of data on cancer occurrence in Minnesota and how cancer rates are expressed and compared;

(2) Describe the profile of cancer incidence rates for residents of Dakota and Washington Counties and how these rates compare to statewide rates;

(3) Describe the incidence of selected cancers for specific zip codes within Dakota and Washington Counties and how these rates compare to other Metro rates;

(4) Briefly summarize some important facts on the natural history of cancer; and

(5) Summarize the limitations of community-level cancer rates and epidemiologic studies in identifying cancer risks from environmental exposures.

Data Sources and Methods

Study Population

This report focuses on cancer rates among residents of Dakota County and Washington County. As shown in Figure 1, these two counties represent the eastern border of the Minneapolis-St. Paul Metro area. Both of these counties have experienced rapid population growth over the past couple of decades. Dakota County is the 3rd most populous county in the state with an estimated 2004 population of 379,058. At the time of the 2000 Census, Dakota County had a population of 355,904. Between 1990 and 2000, the Dakota County population increased by 29%.

Washington County is the 5th largest county in the state with an estimated 2004 population of 217,435. At the 2000 Census, it had a population of 185,760. Between 1990 and 2000, the Washington County population increased by 38%, placing it among the fastest growing counties in the state. Most of the growth was concentrated in the county's three largest cities: Oakdale, Cottage Grove, and Woodbury.

In addition to county-wide cancer rates, this report also includes limited data on cancer rates for eight communities (based on zip codes) within each of these two counties. Since the methods, time-periods, and limitations differ in a number of important respects from the county-wide and statewide analyses, the methods, findings, and interpretation of the zip code cancer data are discussed separately in this report.

Sources of Cancer Data

There are two sources of data on cancer rates in Minnesota: (1) cancer mortality (death) data and (2) cancer incidence (newly-diagnosed cases). Cancer mortality data come from information coded from death certificates and these data are published annually by the Minnesota Center for Health Statistics in the *Minnesota Health Statistics*. Cancer incidence data (newly-diagnosed cases) come from medical records and are collected and published biennially by Minnesota's statewide cancer registry, the Minnesota Cancer Surveillance System (MCSS). Cancer incidence (new occurrences) provides a much more complete and accurate picture of cancer occurrence than cancer mortality since it reflects all new occurrences of cancer, rather than just deaths from cancer. Over the five-year time period 1998-2002, for example, there were on average 22,500 new cancers diagnosed among Minnesota residents per year, while during the same time period approximately 9,000 Minnesotans died each year with cancer listed as the underlying cause of death on the death certificate. Therefore, this report will focus exclusively on rates of newly-diagnosed cancers.

The Minnesota Cancer Surveillance System was established in 1988 and is an ongoing program of the Minnesota Department of Health. The primary objectives of the MCSS are to:

- Monitor the occurrence of cancer in Minnesota and describe the risks of developing cancer;
- Inform health professionals and educate citizens regarding specific cancer risks;
- Answer the public's questions and concerns about cancer;
- Promote cancer research; and
- Guide decisions about how to target cancer control resources.

This system provides highly accurate and complete data on all pathology-confirmed cases of cancer among Minnesota residents. Rigorous quality control efforts are required to ensure complete and accurate reporting of cancer incidence data. External audits by the North American Association of Central Cancer Registries (NAACCR) confirm that MCSS includes over 99% of eligible cancers. Data accuracy is also exceptionally high with data judged to be 98.7% correct. The MCSS has achieved the highest NAACCR rating, Gold Standard, for its performance.

Data available for routine analyses in Minnesota and other states often lags by several years to assure that the reporting is complete, that missing information is obtained, and that conflicting information is reconciled. At the time of initiating this report, complete statewide and county-wide data were available for statistical analyses for the 15-year period 1988-2002 and these data are included in the statewide and county-level analyses. As described elsewhere in this report, for the non-routine community-level analyses, cancer rates for the nine-year period 1996-2004 were utilized.

Additional Minnesota cancer incidence and mortality rates for this time period, along with cancer trends, lifetime risks, a summary of cancer risk factors, and other data are included in 2005 MCSS biennial report "Cancer in Minnesota 1988-2002." This report is available online at: http://www.health.state.mn.us/divs/hpcd/cdee/mcss/camn2005index.html

Minnesota cancer rates through 2004 (statewide and by county) will be available in the next MCSS biennial report, due later this year. Cancer rates for 2003 can be found in Minnesota Cancer Facts and Figures 2006, available on the MCSS web page; and preliminary data for 2004 are also available on the MCSS web page. (See Appendix.)

County Population Data

Minnesota statewide and county population estimates were obtained from the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) Program web site at http://seer.cancer.gov/popdata. These modified county estimates are derived from the U.S.

Census Bureau's Population Estimates Program and they represent estimates for all years except the census years of 1990 and 2000. Population data for 18 age categories for each sex are used in determining cancer rates. As described later, community (zip code) population data are derived from the U.S. Census Bureau.

Methods of Presenting Cancer Rates: Rates and Ratios
Cancer rates can be expressed in several ways. Cancer rates are commonly expressed as the incidence rate (number of new cases) per 100,000 people per year. Cancer rates are usually given separately for males and females. The cancer rate can be given for specific age categories (such as 60-64, 65-69) or as an overall rate over all ages. If an overall rate is given, it is customary to age-adjust the rate to minimize differences in rates that would occur solely because of age differences from one population to another. Because cancer occurs more frequently with increasing age, a population with a larger proportion of elderly individuals will have more cancers occur than a younger population of the same size, even if cancer rates at any given age are exactly the same in the two groups. Age-adjustment produces a summary rate, the rate that would occur if the group had the age distribution of a given population. These age-adjusted rates are also commonly referred to as "standardized" or "age-standardized" rates. Standardized rates in this report (Tables 1 and 3) were directly age-adjusted (standardized) to the 2000 U.S. population, as is customary in presentations of cancer rates throughout the U.S. If the rate is given for a period of years such as 1988-2002, the rate is the average annual rate during that time period.

Because specific types of cancers are relatively rare in a given year, cancer rates in small populations, including most rural Minnesota counties or regions within a Metro county, show great variability and are statistically unreliable. A few cancers more or less, or a slight shifting of the age distribution of cases can dramatically change the apparent rate. For the rare cancers, even statewide rates are subject to this variability. One way to reduce this variability is to average rates over several years. Most county statewide rates in this report, except as noted, are averaged over the entire 15-year period 1988-2002.

Most of the rates presented in this report use another common approach for examining cancer occurrence, and the preferred approach when analyzing cancer rates in smaller populations. In this approach, the actual ("observed") number of cancers that occurred in a population is compared to the number of cancers statistically "expected" to occur based on the population size, age, and gender. For county-wide analyses, the expected number of cancers represents the number of cancers that would have occurred in the county if the county had experienced the same cancer rate as the statewide average. The expected number takes into account only the age and sex distribution of the population of interest and does not adjust for smoking rates, dietary patterns, or the many other significant risk factors for cancer. The actual (observed) number of cancers and the expected number of cancers are usually compared by simply dividing the observed number of cancers by the expected number of cancers. This comparison is commonly referred to as the Observed-to-Expected ratio, or more technically as the Standardized Incidence Ratio (SIR):

$$\mathrm{SIR} = \frac{\text{observed number of cancers}}{\text{"expected" number of cancers}}$$

Using data from Table 2 as an example, it was found that 32 cases of stomach cancer were diagnosed among Washington County females during the 15-year period 1988-2002. This number is less than the 39.8 cases that would have been expected based on the county population. The SIR or observed-to-expected ratio is then 32/39.8 = 0.80. A ratio less than 1.00 means that there are fewer cancers than expected. In this example a ratio of 0.80 means that the number of observed cancers was only 80% of the expected number based on statewide female stomach cancer rates (i.e., there was a 20% deficit of cancers). Correspondingly, a ratio greater than 1.00 means a greater than expected number of cancers. For example, the number of testicular cancers in Washington County was 101, while 88.4 would have been expected. The observed-to-expected ratio is 101/88.4 = 1.14, indicating a 1.14-fold (14%) excess (compared to statewide rates) of testicular cancer. A ratio of 1.00 means that the observed and expected numbers of cancer are exactly the same.

Because of inherent variability, especially when examining rare cancers or even common cancers in small populations, observed and expected values are rarely exactly the same. Furthermore, two ratios might be the same (say 2.00), but one ratio is based on very small numbers (e.g., 4 observed cases and 2 expected) and one based on large numbers (80 observed, 40 expected). Statistical tests are typically used as guides in judging whether the difference between the observed and expected number of cancers (as expressed by their ratio) is large enough and based on enough cases to exceed some level of random variability. In this report, a 95% confidence interval is shown graphically for each observed-to-expected ratio, and can be interpreted to mean that there is a 95% chance that the true ratio is within this range. This interval is similar to the "margin of error" –such as plus or minus 5%–that frequently accompanies results of public opinion polls. As will be seen in the figures, when the number of cancers is relatively small (such as for rare cancers or for cancers within a specific community), the "margin of error" or statistical uncertainly becomes much larger and the confidence interval becomes very wide. In contrast, the confidence interval for all cancers combined for a large population, such as Dakota County, is very narrow and can barely be distinguished on a graph. As shown in Figures 2 and 3, the 95% confidence intervals for the two examples given above for stomach and testicular cancers include the value of 1.00 and it is concluded that the rates for these two cancers do not differ statistically from the state average.

Unfortunately, although statistical tests provide some guidance when examining a single cancer rate, these tests are less useful when comparing many cancer rates, since one out of 20 comparisons will appear to exceed the usual measure of variability (i.e., a "statistically significant difference"). Indeed, thousands of "statistically significant" excesses or deficits of cancer can be found by comparing multiple types of cancer for each sex, year, and county throughout the state. Cancer rates are rarely constant in a community and the standard meaning of statistical significance of a cancer rate at the community level for a given time period is frequently misleading and must be interpreted cautiously.

Findings

<u>County-wide Cancer Rates</u>

Cancer incidence rates were obtained from the MCSS for the years 1988-2002. These data for various time periods are published in the MCSS biennial reports on cancer rates and trends in

Minnesota. Tables 1 and 2 and Figures 2 and 3 show cancer rates for Washington County, while Tables 3 and 4 and Figures 4 and 5 show rates for Dakota County. For specific types of cancer, there was considerable variability as expected in small populations. This is seen in the Figures which show graphically the Standardized Incidence Ratios (observed/expected ratio) along with error bars showing where the real ratio is most likely to occur (95% likelihood). The vertical line down the center of each of the Figures represents an SIR of 1.0, meaning the number of observed and expected cancers were the same. Points to the left of the line represent fewer than expected cancers, while points to the right of this line represent greater than expected cancers. An error bar (95% confidence interval) that crosses the center line (i.e. the interval includes the value of 1.0) indicates that the difference between actual and expected values is within normal random variation and is not a statistically meaningful difference.

Except for the most common types of cancer, such as lung, colon, prostate, breast, and all cancers combined, the SIRs have wide confidence intervals (margins of error), reflecting the small numbers and variability. If all cancer types were represented here, rather than just the two dozen or so most common types, much more variability and uncertainty would be evident.

<u>Washington County Rates</u>
Table 1 shows the average annual incidence rates (per 100,000 people) for the most common types of cancer and for all cancers combined for Washington County and for the state overall. These rates are shown separately for males and females. Table 2 presents cancer incidence data for Washington County by providing the number of actual (observed) and expected cancers along with the Standardized Incidence Ratio (observed-to-expected ratio) for the most common types of cancer and for all cancers combined. Except for the category of childhood cancers (ages 0-19 years), the data in tables 1 and 2 are for all ages. A total of 8,660 new cancers were diagnosed among Washington County residents during the 15-year period 1988-2002. There were 4,397 cancers diagnosed among males, compared to 4,549 expected, a small but statistically significant 3% deficit. Among females, there were 4,263 cancers diagnosed which was nearly identical to the 4,261 expected cancers. The number of childhood cancers was not significantly higher than the number expected for males (76 actual, 79 expected) and for females (56 observed, 66 expected). The overall cancer incidence in Washington County is therefore comparable to or slightly lower than the statewide average.

For Washington County males, Figure 2 shows that there are two types of cancer that do differ from their expectation based on conventional statistical criteria. Both were deficits. The two cancers that occurred less frequently than expected were lung (545 observed, 601 expected; SIR=0.91) and “all cancers” (4,397 observed, 4,549 expected; SIR=0.97).

For Washington County females, Figure 3 shows that there are two types of cancer that occurred less frequently than expected. The two cancers that occurred less frequently than expected were Hodgkin lymphoma (22 observed, 34 expected; SIR=0.65) and total leukemias (83 observed, 109 expected; SIR=0.76).

When comparing male and female findings in Washington County we can see that the 9% deficit for lung cancer in males was not observed in females. The 3% deficit in “all cancers” among males was also not observed in females. The significant deficit in Hodgkin lymphoma (35%) among women was not seen in males (8% non-significant excess). Also among women, the 24% significant deficit of total leukemias was not seen among males (2% non-significant excess).

Dakota County Rates

Table 3 shows the average annual incidence rates (per 100,000) for the most common types of cancer and for all cancers combined for Dakota County and for the state overall. These rates are shown for males and females. Table 4 presents cancer incidence data for Dakota County by providing the number of actual (observed) and expected cancers along with the Standardized Incidence Ratio (observed-to-expected ratio) for the most common types of cancer and for all cancers combined. Except for the category of childhood cancers (ages 0-19 years), the data in tables 3 and 4 are for all ages. During the fifteen-year period 1988-2002, a total of 15,062 cancers were diagnosed among the residents of Dakota County. Among males, there were 7,479 cancers compared to 7,702 expected, a small but statistically significant 3% deficit. Among females, 7,583 cancers were diagnosed and 7,440 cancers were expected. The number of childhood cancers was not significantly higher than the number expected for males (148 actual, 141 expected) and for females (131 actual, 118 expected). The overall cancer incidence in Dakota County is therefore comparable to or slightly lower than the statewide average.

For Dakota County males, Figure 4 shows that the observed numbers for two specific types of cancer, as well as for all cancers combined, do differ from their expectation based on conventional statistical criteria. All were deficits. The two cancers that occurred less frequently than expected were lung cancer (941 occurrences, 1,006 expected; SIR=0.94) and larynx cancer (80 observed, 102 expected, SIR=0.79). For "all cancers" combined, there was a small but significant 3% deficit (7,479 observed, 7,702 expected; SIR=0.97).

For Dakota County females, Figure 5 shows that there are two types of cancer that occurred more frequently than expected. The two cancers that occurred more frequently than expected were liver (44 observed, 30 expected; SIR=1.47) and breast (2,637 observed, 2,523 expected; SIR=1.05). The breast cancer rate, although marginally elevated when compared to the entire state, is virtually identical to breast cancer rates in the entire Metro area.

The 47% excess of liver cancer among females was not found among males (14% deficit). Figure 6 displays the variability for liver cancer incidence for five three-year intervals for Dakota County from 1988-2002. Among Dakota County males, rates were at the state average during 1988-1996 and slightly below average for the period 1997-2002. Although the overall rate of liver cancer from 1988 to 2002 for females is elevated, most of the elevation occurred during the period 1988-1993, with rates during 1994-2002 close to the state average. These rates are based on small numbers, each three-year period having fewer than 10 cancers. While the major known risk factors for liver cancer include hepatitis B and C infections and cirrhosis, it is not known whether this excess is related to these factors or to random variability.

Comparing the male and female findings can sometimes be useful in identifying consistent patterns. There were deficits for two cancers among males: lung cancer (6% deficit) and "all cancers" (3% deficit). Among females, there was a non-significant excess (5%) of lung cancer and a non-significant excess of "all cancers" (2%).

Statewide Variability for Selected Cancers

The pattern of cancer incidence in Dakota and Washington Counties is quite typical of that found in most of the Minnesota counties when multiple cancer rates are compared to the statewide average. Interpretation of a cancer rate in any region, especially the less common cancers requires statewide perspective. This is provided for two cancers that were chosen as examples, liver and bladder cancer.

Figures 7 through 10 demonstrate the great variability in cancer rates from one county to another. In Figure 7, male liver cancer rates range from one third to double the state average. In Figure 8, female liver cancer rates range from one half to three times the state average. In Figure 9, male bladder cancer rates range from just over one third to nearly double the state average. In Figure 10, female bladder cancer rates range from zero to 60 percent above the state average. Norman County, which has the highest female liver cancer rate among the counties, has the lowest male bladder cancer rate among the counties. However, these are based on small numbers (5 female liver cancers, 14 male bladder cancers). Indeed, much of this variability is a function of counties having small populations and one or two cancers in specific age groups can cause a large change in its rate.

In addition to geographic variation, cancer rates at the county level show considerable temporal variation (change over time within a county or community). Figure 11 illustrates this temporal variability by comparing liver cancer rates among males for two time periods for each Minnesota County (excluding 29 counties that had no cases for one or the other time period). Males were selected for this analysis as they had more non zero rates than females. Specifically, the liver cancer incidence rate for the most recent 5-year interval (1998-2002) was divided by the rate for the earliest 5-year interval (1988-1992). Although liver cancer incidence in males statewide during 1988-2002 increased by an average of 3.5% per year, Figure 11 illustrates that male liver cancers often increased or decreased significantly in the same county over the two time periods.

Discussion of Cancer Occurrence in Dakota and Washington Counties

Cancer rates in Dakota and Washington Counties are similar to rates in Minnesota. The geographic and temporal variability of these rates and the resulting patterns of cancer incidence for Dakota and Washington Counties are consistent with statewide data. The continuous movement up and down of cancer rates over time and regions generates an important perspective from which individual rates in a specific county and time period are assessed. From this perspective, cancer incidence in Dakota and Washington Counties is well within expected values.

Figure 12 shows the relative frequencies for various types of cancer for males and females for all of Minnesota, 1988-2002. The most common cancers diagnosed among men and women in Dakota and Washington Counties and in all of Minnesota are the same. Prostate cancer is the most commonly diagnosed cancer among men. It accounts for more cancers among men then the next three most common cancers combined. Breast cancer is the most commonly diagnosed cancer among women and accounts for more cancers among women than the next five cancers combined. Each of these cancers accounts for nearly one third of cancers diagnosed among men and women, respectively. Lung cancer and cancers of the colon and rectum are the next two most commonly diagnosed cancers, and together account for about one in four cancers diagnosed among men and women in Dakota and Washington Counties and in the state as a whole. Although prostate cancer and breast cancer are more common, lung cancer is the leading cause of cancer mortality for both males and females, and accounts for 25 percent of cancer deaths in the state.

The fourth most commonly diagnosed cancer in Dakota and Washington Counties and in Minnesota is urinary bladder cancer for men and uterine cancer in women. They account for about six percent of cancers among men and women, respectively. Non-Hodgkin lymphoma is the fifth most common cancer in males in Dakota and Washington Counties, accounting for nearly five percent of diagnosed cancers in the state and in Dakota and Washington Counties. Non-Hodgkin lymphoma is also the fifth most commonly diagnosed cancer in females in Washington County, and the sixth most commonly diagnosed cancer in females in Dakota County. Ovarian cancer is the fifth most commonly diagnosed cancer among women in Dakota County and the sixth most commonly diagnosed cancer among women in Washington County. Melanoma and leukemia are among the leading cancers, and together account for seven percent of cancers. Cancers of the brain and pancreas are relatively uncommon, but are among the ten leading causes of cancer death because survival is poor.

Cancer Incidence for Geographic Regions within Dakota and Washington Counties

Citizens often have questions about cancer rates in geographical areas much smaller than the county level, such as specific cities or even specific neighborhoods. These concerns are often due to the perception that there is a cancer “epidemic” or “too much” cancer in the community and this belief is itself an important public issue that data from the MCSS is able to address.

Due to a variety of methodological and statistical issues with ascertaining and interpreting rates in such small populations, these analyses are not routinely conducted by the MCSS. However, to provide additional information on cancer rates within these two counties, additional analyses were conducted to determine cancer incidence for specific Washington County and Dakota County communities (as defined by their zip codes) in which PFCs have been a source of health concerns. As previously noted, due to some important differences in how these rates are determined and interpreted, these methods and findings are discussed separately from the previous county-wide analyses.

Methods and Limitations for Analyzing Community Cancer Rates

In addition to information on specific cancer diagnoses, MCSS also collects addresses of cancer patients. This assists MCSS in identifying duplicate records and allows MCSS to determine cancer rates geographically. This address comes from the medical record and is the address at the time of cancer diagnosis. The use of this address information poses a number of problems in determining cancer rates for specific communities within a county. Some of these issues are described here.

In some cases, addresses in medical records contain the name of a larger, adjacent city rather than the actual city or township of residence. For example, residents in communities adjacent to St. Paul sometimes list St. Paul as part of their address. Cancer rates based on the "city" as recorded in the medical record could significantly undercount the number of cancers for these suburbs and overcount the number of cancers for the neighboring larger cities. To reduce this problem, the zip code of the address is used since it can be reasonably assumed that people give their correct zip code. As shown in Tables 5 and 6, zip codes may or may not approximate the boundaries of a city. For example, in the cases of Oakdale and Woodbury, these zip codes are fairly good approximations of the city limits. However, for places like Hastings and Stillwater, large portions of its zip code are rural. In fact, a portion of the Hastings zip code is not in Dakota County but rather in Washington County.

Even if it is assumed that a zip code in an address is less likely to be in error than a city, errors can and do occur in recording the correct zip code, though these are relatively few. Oddities can occur, for example, in certain zip codes where a sizable portion of a community uses P.O. boxes or rural routes. With some cancers MCSS receives conflicting addresses which must be adjudicated. This is done as well as possible, but at times it is an educated guess as to where someone's legal residence was at date of diagnosis of their cancer when two addresses are conflicting. While efforts are made to determine the address at the time of diagnosis, at times, the hospital record may reflect what is really a billing address rather than the home address of the patient.

Another – and perhaps much more significant – source of error in examining rates by zip codes is the difficulty in obtaining detailed population data which is necessary in calculating age-adjusted incidence rates and observed-to-expected ratios.

As previously noted, the preferred method of examining cancer rates in a small population (such as for a zip code), is by comparing the observed number of cancers and the expected number of cancers using a ratio (SIR). In this analysis, the expected number of cancers for a community is derived by applying the cancer rates from the Metro area to the population of the community. Any inaccuracy in the population estimate will result in an error in the expected number. While detailed population counts or estimates are readily available at the county level, that is not the case for zip codes. The zip code population is obtained from the Census Bureau which identifies census tracts that best correspond to the zip code. Since zip code boundaries and census tract boundaries are drawn for different purposes, their boundaries may not match and may cause errors in the estimation of the zip code population. These potential errors will have the greatest effect on the calculation of an expected number when they occur in the older age groups, such as 65 and older, which generally have higher cancer incidence rates.

Even if the estimation of the population size is entirely correct, it is correct only for a particular census year, in this case the year 2000. The Census Bureau does not provide zip code population estimates for intercensal years. In areas of rapidly changing population as in many communities of Washington and Dakota Counties, the population for a year such as 1996 or 2004 (the range of years examined here) may be considerably different than the population in 2000. The analyses presented here are for the years 1996 through 2004 (four years either side of the census year) on the assumption that the rate of population change has been constant before and after the census year (2000). This may or may not be the case in fact. For example, the city of Woodbury grew by 39.0% between 1996 and 2000 and then by 7.7% from 2000 to 2004 (state demographer estimation). In addition to population changes, the analyses assume that zip code boundaries have not changed between 1996 and 2004. Zip code 55129 (East and South Woodbury) was created in the late 1990s out of 55125, and these two Woodbury zip codes were combined as one unit for this analysis.

Findings and Discussion of Community (Zip Code) Cancer Rates

While zip codes vary tremendously in population (see Tables 5 and 6), these are generally very small populations. Furthermore, in order to reduce population estimate errors, rates are only calculated for the nine-year period 1996-2004 centered on a census year. Consequently, with the smaller populations and reduced time frame, the numbers of cancers are small and the cancer rates are statistically highly unstable.

As with county-level cancer rates, this is particularly true when examining specific types of cancers. This is clearly evident in Figures 12 through 19 which are displays of two cancer sites, bladder and liver, shown for each gender and for each zip code in Washington and Dakota Counties. As with the previous Washington and Dakota county-level graphs, observed-to-expected ratios and 95% confidence intervals are shown. Note that the scale of the zip code graphs had to be expanded (showing ratios from 0.1 to 10.0) compared to the county-level graphs (showing ratios from 0.2 to 5.0). Even with this greatly expanded range, the confidence intervals are dramatically wider than the intervals for the county graphs, reflecting the enormous uncertainty in these rates.

As can be seen, the pattern of rates for male bladder cancer (the fourth most common cancer in Minnesota males) shows considerable variability and intervals that are quite wide. Liver cancer is much less common than bladder cancer, and at the zip code level, there are a number of zip codes with no cases at all demonstrating how unstable rates are at this level of analysis. These graphs are intended to show the high degree of uncertainty when examining rates of specific cancers in relatively small populations.

Tables 7 through 14 show the observed and expected numbers as well as the SIRs for the eight communities (based on nine zip codes) in Washington and Dakota Counties where community concerns about the water contamination and health risks have been raised. It should be noted that the years of data for zip code level analysis (1996-2004) are different than the years used for county level analysis (1988-2002) and that the numbers for the year 2004 are preliminary and could vary slightly in the future.

For the most part, the observed and expected numbers of these nine zip codes are quite similar; in other words, the SIRs are close to a value of 1.00. When the ratios differ from 1.00 (for example > 1.5 or <0.75), it is usually because the numbers of observed or expected cancers is quite small (less than 10). There are seven SIRs that are statistically significantly elevated and four SIRs that are statistically significantly low. No pattern emerges from these elevated or decreased SIRs. These differences vary according to gender, involve a number of different cancers (lung, oral, kidney, liver, breast and all cancers combined), and occur in a number of different zip codes.

Using the customary criteria for statistical significance ($p < 0.05$ level), about 1 in 20 results will reach statistical significance by chance alone. In this community analysis, 256 statistical comparisons (16 types of cancer, two sexes, eight communities) were made and it would be expected (if these tests were independent of each other) that by chance alone there would be approximately 13 statistically significant results. In fact, 11 significant differences were identified, indicating overall conformity of Metro and community level cancer rates.

There are two communities that show a number of elevated SIRs and two communities with a number of decreased SIRs though in most cases the numbers are too small to reach statistical significance. South St. Paul (55075) has 20 SIRs greater than 1.00 and 7 SIRs less than 1.00. St. Paul Park (55071) has 15 SIRs greater than 1.00 and 8 SIRs less than 1.00. Woodbury (55125-55129) has 6 SIRs greater than 1.0 and 18 SIRs less than 1.00. Lake Elmo (55042) has 6 SIRs greater than 1.00 and 22 SIRs less than 1.00. While some of these differences are very likely due to random chance, the generalized pattern of excesses (or deficits) for different types of cancer in these communities suggests another contributing factor: that the population estimates (used in calculating the "expected" number of cancers) are in error. For example, if the population size of the community is underestimated (e.g., due to rapid population growth after the 2000 census), the number of expected cancers will also be underestimated. Thus it will appear that there is a generalized trend for the number of observed cancers to exceed the number of expected cancers for multiple types of cancer.

Woodbury (55125-55129) has had rapid growth since 1990 and it is more difficult to estimate the true number of people with situations of rapid population change. Lake Elmo (55042) has had some growth too, though not to the extent of the Woodbury. South St. Paul (55075) and St. Paul Park (55071) are both more stable communities in the sense that there has not been a marked increase or decline of population numbers during the period 1996-2004. St. Paul Park (55071), like Lake Elmo, is a very small zip code and if there were greater numbers, the observed and expected numbers might very well even out. For both South St. Paul (55075) and St. Paul Park (55071), the median household income is approximately 25% lower than the median for their respective counties. Often in lower income areas, cancer rates are higher than average for smoking-related cancers such as lung, oral, all sites combined and sometimes bladder and kidney cancers, while rates are often lower for prostate and female breast cancer.

Conversely in higher socioeconomic areas such as Woodbury (55125-55129) (median household income 40% higher than the county), lower than average rates of lung, oral, bladder and kidney cancers and all sites combined, but higher than average rates of prostate and breast cancers are found. This does not quite hold true for these zip codes which, therefore, calls into question the accuracy of the population estimates. Even with these "tendencies" it is notable that the SIRs for all cancer sites combined for the two genders of these eight communities are all reasonably close to 1.00, ranging from a 13 % deficit (males in Newport and Lake Elmo) to a 19 % elevation (males in St. Paul Park). These smaller zip codes will have greater variation.

The community (zip code) level of analysis shows results very similar to the entire state of Minnesota in terms of the most common types of cancer. In these communities, prostate cancer in males and breast cancer in females are the most common cancers with lung and colorectal cancers being the next most common. The next most common cancers in these communities are bladder (especially in males) cancer and lymphoma as is the case statewide.

Unlike several other major cancers, rates of lung cancer exhibit greater variability from community to community and from region to region in Minnesota. The highest rates in the state are in the seven county metro area and in Northeastern Minnesota while the lowest rates are in the Southwest and South Central counties of Minnesota. This is clearly attributable to past habits of tobacco use (smoking accounts for about 85% of lung cancer) which differ from one region to another according to behavioral risk factor surveys. Even in areas as small as these eight communities, considerable variation occurs in lung cancer in both genders and this most likely reflects the variation in past tobacco use by residents of these communities.

The effect of small population size on the stability of cancer rates can be further demonstrated by two cancers, lung and thyroid. Both lung and thyroid exhibit substantial variability at the community level. In several of the communities, male rates are higher and female rates lower than the Metro average. In other communities the reverse is true. As shown in Table 15, when the eight communities are pooled into one larger population, the number of observed and expected lung and thyroid cancers (as well as all the other cancers) closely approach the Metro average. For all eight communities taken as a whole, cancer rates were comparable to Metro wide rates for all cancers combined and each type of cancer, except for a 13% deficit of colorectal cancers among women. Cancer rates which appear to have a haphazard pattern of occurrence within very small populations often appear normal or near normal in larger populations.

Issues in Interpreting Community Rates to Address Environmental Concerns

As previously stated, the MCSS is frequently asked to address concerns about a known or perceived excess of cancer in a community, or to address concerns about cancer risks from a known or suspected environmental exposure. These concerns often reflect some common misunderstandings about the frequency and causes of cancer, as well as how cancer risks are identified. Some of these issues are briefly discussed below.

<u>Some Important Facts About Cancer</u>

- Cancer is not a single disease; it is a group of more than 100 different diseases. Different types of cancer have differing rates of occurrence, causes, and chances for survival. The development of cancer is a multi-step process, starting with genetic changes in cells, followed by cell division and growth over time. The time from genetic change to the development of cancer, known as the "latency period," is usually decades long, often 30 years or longer. This means that many cancers diagnosed today are due to exposures and genetic changes that occurred in cells a long time ago.

- Cancer occurs in individuals of all ages and the risk of cancer at any particular age varies greatly depending on the type of cancer. For example, the median age at diagnosis for thyroid cancer is the mid-40s for both males and female, while the median age for prostate cancer is 69. In general, however, overall cancer rates rise sharply with increasing age and approximately 60% of cancers occur in individuals 65 years of age and older. Because people are living longer, the risk of developing cancer is increasing.

- Cancer is much more common than many people realize. Cancer can be viewed as either a rare disease or a very common disease. If addressing the yearly rate of a specific cancer in a young adult, it would be considered a rare disease. For example, the annual rate of lung cancer among men aged 20-34 is less than one case per 100,000. However, the risk of developing any form of cancer over an entire lifetime gives quite a different perspective. Not including the most common forms of skin cancer, the current estimate of the average lifetime risk of developing some form of cancer is approximately 47 percent. In other words, on average, between four and five people out of ten will be diagnosed with some type of cancer during their lifetimes. Figure 21 shows the lifetime risks for specific cancers for males and for females. An individual's own personal risk of cancer can of course be much higher or much lower than these averages, depending on personal risk factors.

- Since cancer is not a single disease, it does not have a single cause. There are a variety of causes (better known as "risk factors"). These factors act over many years to increase an individual's chance of developing cancer. They can include such things as age, race, gender, occupational exposures, diet, obesity, radiation, smoking, and reproductive history. For many cancers, such as breast and colon cancer, genetics play a role. This means that a family history can be a risk factor for some types of cancers. It is not unusual for several cases to occur within a family.

- While we have no control over risk factors such as age, race, and family history, much of our cancer risk is related to factors that we can control. Such "lifestyle factors," include: cigarette smoking; heavy drinking; and eating foods that have excess calories, high fat, and low vegetable intake. It has been estimated that approximately 30% of total cancer deaths in the U.S. are related to smoking, while another 30% are related to diet and obesity. Other lifestyle factors that increase risk have to do with occupation, reproductive patterns, sexual behavior, and sunlight exposure. However, even when no modifiable risk factors are known that can reduce the risk of developing a cancer, screening and early diagnosis may prevent or reduce the risk of death.

- It is often stated that most cancers are "environmental" in origin and thus potentially avoidable. Environment in this context does not refer only to ambient environmental exposures such as air and water pollutants, but also means everything that is not genetically inherited. It includes all aspects of a person's life and behavior, such as diet, smoking, occupational history, exposure to sunlight, reproductive history, viruses, medical history, alcohol use, and exposure to pollutants. Genetic factors, personal behaviors, and life-style factors, as well as chemical and occupational exposures have been identified as affecting our risk of developing cancer. It is very likely that a combination of factors is important.

Limitations of Community Cancer Rates

Cancer risks are identified through epidemiologic studies of human populations or through laboratory animal studies. Epidemiologic studies can provide the only direct evidence of cancer risks in humans. However, with rare exceptions (such as mesothelioma in an asbestos exposed population), community-level cancer statistics are not a useful tool for either confirming or refuting the existence of a cancer risk from an environmental contaminant. A higher than expected rate does not mean that some environmental pollutant is the cause of this higher rate and a normal or lower than expected rate does not mean that there is no concern regarding any particular pollutant. Some of the reasons are discussed below.

Cancer Latency and the Residential Mobility of the Population

Community cancer rates are defined by place of residence *at the time of diagnosis*. As previously described, cancer is the end result of a long biological process in the body that takes decades to develop. In assessing cancer risks, exposures that are of greatest interest are those that occurred several decades prior to diagnosis of cancer. This leads to two problems. One issue is that in communities with contaminants in drinking water, for example, it is frequently not known when contamination first occurred. Thus, even for a life-long resident, it may not be possible to determine exposures prior to the time of detection of the contamination. Another issue is residential mobility. Due to the extreme mobility of our population, many members of a community have not resided in the same house (and possibly in the same community) five years ago. For example, based on 2000 census data for Washington County, over 40 percent of the population was living in a different house than they lived in 1995. In Oakdale, 56.8% of the residents over age 5 were living in the same house in both 1995 and 2000. For Woodbury only 44.1% lived in the same house 5 years ago and approximately 83% of the residents of Woodbury moved into their current (as of 2000) home between 1990 and 2000. Consequently, present cancer rates in a particular community represent a vast array of personal histories at various residences, many of which are outside their current community**.**

Occupational versus Community Settings

It was recognized over 200 years ago that workers in certain occupations experienced higher risks of some cancers. Since then, a variety of occupations and workplace exposures have been causally linked to certain cancers. Indeed, most known human carcinogens have been identified through epidemiologic studies of occupational groups. Cancer risks are more likely to be detected in occupational cohorts compared to community settings for at least three important reasons: (1) occupational exposures are generally very much greater than community exposures making it easier to detect a risk; (2) it is frequently possible to estimate past exposures in a workplace, using industrial hygiene data, job histories, and other data; and (3) it is frequently possible in a workplace setting to identify a population of past or present employees who were likely to have been exposed (or not exposed) to a particular agent.

Some of the specific chemicals known to increase the risk of cancer among exposed workers include asbestos (lung cancer, mesothelioma), benzene (leukemia), arsenic compounds (lung, skin cancer), aromatic amines (bladder cancer), bis[choloromethyl] ether (lung cancer), chromium compounds (lung cancer), nickel dusts (cancer of lung, nasal sinuses), and vinyl chloride (liver cancer). It has been estimated that past asbestos exposures account for about 5 percent of the lung cancer deaths in men in the U.S. A number of industrial processes are also linked to increased cancer risks. It has been estimated that occupational exposures overall account for about 5 percent of total cancer deaths.

Cancer Risks Detectable by Epidemiologic Studies vs. Regulatory Standards

Although epidemiologic studies of human populations provide the most direct evidence of cancer risks, such studies cannot be relied upon exclusively to identify these risks. Even with the best available methods, epidemiologic studies cannot usually identify excess cancer risks that are less than about 10 percent above background (although a number of extremely large multi-city studies of air pollution have been able to detect increases in adverse health effects of several percent). Good epidemiologic data are not even available for the vast majority of compounds, both man-made and naturally occurring.

Because many chemicals have been labeled and regulated as "carcinogens" based only on extrapolation from animal studies, it is important to recognize the probable magnitude of the risks from typical environmental exposures. Regulatory standards are commonly set at levels in which lifetime exposure (70 years) to some agent is expected to result in a cancer risk of no more than one in 100,000. Or in other words, there would be no more than one additional cancer in 100,000 lifetimes of exposure. Such a level of risk, if real, would be approximately 10,000 times too small to be observed or verified by epidemiologic studies. If the entire population of Minnesota had lifetime exposure to a chemical at the level of exposure equivalent to this regulatory target there would be an expected 42 additional cancers due to this exposure within the background of 1.9 million cancers occurring for other reasons. Another way of explaining this is that there would be, on average, less than one excess cancer per year, out of the approximately 23,000 cancers due to all causes in Minnesota. Because cancer ultimately affects so many people, almost everyone will have neighbors, friends, or relatives with cancer. Epidemiologic or public health surveillance data such as that from the MCSS cannot detect rates at these levels. Therefore, the finding of "normal" patterns of cancer occurrence in a community conveys little information about specific cancer risks to the community as defined by current regulatory standards.

Lack of Information on Other Known Cancer Risk Factors

When a situation occurs in which there is a confirmed cancer increase in a population, it is very difficult to control for, or rule out, other risk factors that may have been the primary reason for the cancer increase. For example, exposure to asbestos is a risk factor for lung cancer. However, 85-90% of lung cancer occurrence is due to smoking. Consequently, smoking would need to be accounted for in determining whether an elevated lung cancer rate is related to asbestos exposure. In order to find what may have been the cause of the increased cancers, an epidemiologic study is needed, involving detailed comparisons between hundreds of patients recently diagnosed with a specific type of cancer and an equal number of individuals who have worked in a particular occupation or industry (or who can otherwise be defined as have some shared characteristic or exposure) over some time period. Typically, thousands of workers are identified. The occurrence of various diseases over many years or decades in this group is then compared to the occurrence in the general population. Even in such large-scale studies, differences in exposure and other factors between the groups are often very modest, and it is difficult to rule out random variation and various study biases.

Consequently, no single epidemiologic study provides definitive answers; multiple studies in different populations with consistent findings are generally needed to establish causality.

Variability of Cancer Rates in Small Populations

Annual rates of specific cancers are generally low, and are subject to much variability. This is true at the county level and the variability is even more pronounced when analyses are attempted at the sub county (city or zip code) level. Interpretation of cancer incidence at the county and community levels must take into account the statistical unreliability of rates from year to year. An apparent excess during one period of time may be followed by an apparent deficit the next time period. Geographic variations are also likely to occur from one population (county or city) to another.

An example of this variability at the county-level is shown by the following analysis undertaken for a previous MCSS report. Using county lines as geographic boundaries, an analysis was conducted to identify excesses of cancer cases for each of 85 types of cancer, for either sex, for any year between 1988 and 1994 in any of the 87 Minnesota counties. This analysis creates more than 100,000 possibilities for identifying an unusual cancer rate. Nearly 10,000 of these rates exceeded the statewide average by at least twofold. Roughly 1,500 of these rates reached the usual criteria of statistical significance.

A typical cancer registry tracks 80 different kinds of cancer. Using these facts, statisticians at the California Department of Health services have calculated that there is a 98% chance that a given community will show a statistically significant but totally random elevation in the rate of at least one type of cancer. Thus, even when a statistical test shows there is a "statistically significant" difference between the observed and the expected number of cases, in many instances the significant difference is due to chance and not to a real hazard in the community. That is, unusual rates both high and low are to be expected when examining cancer rates between communities or over time. High rates, low rates, and nominal rates moving dynamically over time and region comprise the normal background of cancer incidence in our community. The variability of cancer incidence over time and region requires that great care be taken when attempting to conclude that any specific elevation or deficit is a result of a specific factor.

Conclusions

- Monitoring cancer rates and trends in Minnesota is one the important objectives of the MCSS. While detailed epidemiological studies and toxicological data from animal studies are usually required to assess cancer risks for establishing health standards, detailed profiles of cancer rates serve a critical role in informing the public as to the actual occurrence of cancers in their communities.

- Overall cancer rates in Washington and Dakota Counties are very similar to the rest of the state.

- Rates of specific types of cancer among county residents are comparable to the statewide average; the small number of deviations is most likely due to random variability.

- Cancer rates in the profiled communities within Washington and Dakota Counties have more statistical uncertainty compared to county or Metro rates due to the small populations and these rates must be interpreted very cautiously; the few elevations and deficits for specific types of cancer are typical of cancer rates in other small populations in Minnesota. Overall cancer rates, as well as rates for specific cancers for all eight communities combined are virtually identical to Metro area rates.

Table 1. Average Annual Cancer Incidence Rates[1] per 100,000 for Washington County and All Minnesota, 1988-2002.

	Washington County		*All Minnesota*	
Cancer	Males	Females	Males	Females
Oral Cavity	17.2	6.0	17.6	6.9
Esophagus	6.5	1.1	7.1	1.7
Stomach	7.7	3.3	10.3	4.1
Colon	43.9	35.9	46.1	36.3
Rectum	18.3	9.5	19.2	10.7
Liver	4.5	1.4	4.3	1.7
Pancreas	9.9	6.5	9.7	7.0
Larynx	5.7	1.0	6.9	1.3
Lung & Bronchus	69.1	43.3	74.0	41.8
Small Intestine	1.9	2.4	2.5	1.6
Soft Tissue	3.8	2.8	3.7	2.5
Melanomas of Skin	19.1	13.0	17.2	13.1
Breast	1.9	142.0	1.1	133.9
Cervix Uteri	-	8.4	-	8.1
Corpus Uteri	-	27.5	-	26.0
Ovary	-	15.7	-	16.7
Prostate	176.1	-	183.7	-
Testis	7.2	-	6.3	-
Urinary Bladder	35.4	9.9	37.6	9.6
Kidney & Renal Pelvis	17.5	7.5	16.5	7.9
Brain	8.7	5.0	7.8	5.3
Thyroid Gland	3.1	8.3	3.4	8.4
Hodgkin's Lymphoma	4.0	1.9	3.5	2.7
Non-Hodgkin's Lymphomas	22.2	18.1	24.4	16.9
Multiple Myeloma	6.8	4.6	6.6	4.0
Mesothelioma	2.7	0.3	2.2	0.4
Total Leukemias	18.3	7.9	18.3	10.3
Childhood Cancers (ages 0-19 yrs)	17.5	13.8	18.3	16.2
All Cancers	536.4	406.4	556.1	402.3

[1]Rates are age-adjusted to the 2000 US standard population; includes all races.

Table 2. Actual and Expected[1] New Cancers and Standardized Incidence Ratios for Residents of Washington County, 1988-2002.

	Males			*Females*		
Cancer	Actual Cases	Expected Cases	Ratio of Actual to Expected	Actual Cases	Expected Cases	Ratio of Actual to Expected
Oral Cavity	160	161.0	0.99	63	72.0	0.87
Esophagus	53	58.5	0.91	11	16.4	0.67
Stomach	63	77.6	0.81	32	39.8	0.80
Colon	333	344.5	0.97	333	342.2	0.97
Rectum	149	159.5	0.93	96	106.1	0.90
Liver	37	38.0	0.97	13	17.0	0.77
Pancreas	86	81.4	1.06	62	66.6	0.93
Larynx	50	61.5	0.81	10	13.6	0.74
Small Intestine	17	21.2	0.80	14	16.3	0.86
Soft Tissue	36	37.1	0.97	33	29.3	1.13
Lung & Bronchus	545	600.8	0.91*↓	416	414.3	1.00
Melanomas of Skin	186	174.6	1.07	155	161.5	0.96
Breast	15	8.6	1.75	1541	1461.6	1.05
Cervix Uteri	-	-	-	110	106.0	1.04
Corpus Uteri	-	-	-	286	273.9	1.04
Ovary	-	-	-	172	185.4	0.93
Prostate	1335	1368.5	0.98	-	-	-
Testis	101	88.4	1.14	-	-	-
Urinary Bladder	268	279.8	0.96	96	92.4	1.04
Kidney & Renal Pelvis	158	150.4	1.05	75	80.6	0.93
Brain	93	87.5	1.06	61	62.3	0.98
Thyroid Gland	37	40.0	0.93	105	109.9	0.96
Hodgkin Lymphoma	47	43.4	1.08	22	33.8	0.65*↓
Non-Hodgkin Lymphoma	195	216.8	0.90	187	171.2	1.09
Multiple Myeloma	47	51.1	0.92	45	38.9	1.16
Mesothelioma	22	17.3	1.27	3	4.5	0.66
Total Leukemias	160	157.1	1.02	83	108.6	0.76*↓
Childhood Cancers (0-19)	76	78.6	0.97	56	65.7	0.85
All Cancers	4397	4548.6	0.97*↓	4263	4261.4	1.00

[1]*The "expected" number of cancers represents the number of cancers that would have occurred assuming county rates were identical to the statewide average.*

**Ratio is significantly lower (↓) or higher (↑) than 1.00 (p<0.05); does not account for multiple comparisons.*

Table 3. Average Annual Cancer Incidence Rates[1] per 100,000 for Dakota County and All Minnesota, 1988-2002.

	Dakota County		*All Minnesota*	
Cancer	Males	Females	Males	Females
Oral Cavity	17.6	7.2	17.6	6.9
Esophagus	6.9	1.8	7.1	1.7
Stomach	9.3	4.1	10.3	4.1
Colon	45.6	34.0	46.1	36.3
Rectum	17.2	9.2	19.2	10.7
Liver	4.2	2.7	4.3	1.7
Pancreas	8.4	7.0	9.7	7.0
Larynx	5.9	1.6	6.9	1.3
Lung & Bronchus	69.7	44.7	74.0	41.8
Small Intestine	2.5	1.9	2.5	1.6
Soft Tissue	3.5	2.0	3.7	2.5
Melanomas of Skin	18.7	13.6	17.2	13.1
Breast	1.0	139.0	1.1	133.9
Cervix Uteri	-	7.0	-	8.1
Corpus Uteri	-	24.3	-	26.0
Ovary	-	17.9	-	16.7
Prostate	175.5	-	183.7	-
Testis	6.8	-	6.3	-
Urinary Bladder	37.2	9.0	37.6	9.6
Kidney & Renal Pelvis	15.3	8.7	16.5	7.9
Brain	7.8	5.3	7.8	5.3
Thyroid Gland	3.7	9.1	3.4	8.4
Hodgkin's Lymphoma	4.0	3.3	3.5	2.7
Non-Hodgkin's Lymphomas	24.3	17.7	24.4	16.9
Multiple Myeloma	7.3	4.3	6.6	4.0
Mesothelioma	2.9	0.4	2.2	0.4
Total Leukemias	18.5	10.3	18.3	10.3
Childhood Cancers (ages 0-19 yrs)	19.1	18.0	18.3	16.2
All Cancers	537.8	410.6	556.1	402.3

[1]*Rates are age-adjusted to the 2000 US standard population; includes all races.*

Table 4. Actual and Expected[1] New Cancers and Standardized Incidence Ratios for Residents of Dakota County, 1988-2002.

	Males			*Females*		
Cancer	Actual Cases	Expected Cases	Ratio of Actual to Expected	Actual Cases	Expected Cases	Ratio of Actual to Expected
Oral Cavity	268	268.6	1.00	131	125.7	1.04
Esophagus	94	97.8	0.96	29	28.6	1.01
Stomach	118	131.1	0.90	69	69.9	0.99
Colon	578	582.3	0.99	565	601.1	0.94
Rectum	243	267.0	0.91	160	184.7	0.87
Liver	55	63.9	0.86	44	29.9	1.47*↑
Pancreas	121	136.2	0.89	118	116.4	1.01
Larynx	80	101.8	0.79*↓	29	23.4	1.24
Small Intestine	36	35.6	1.01	34	28.3	1.20
Soft Tissue	63	64.6	0.98	44	52.4	0.84
Lung & Bronchus	941	1006.4	0.94*↓	750	717.6	1.05
Melanomas of Skin	315	296.7	1.06	297	289.2	1.03
Breast	14	14.5	0.97	2637	2523.4	1.05*↑
Cervix Uteri	-	-	-	166	190.9	0.87
Corpus Uteri	-	-	-	442	471.2	0.94
Ovary	-	-	-	342	323.0	1.06
Prostate	2244	2307.0	0.97	-	-	-
Testis	181	165.4	1.09	-	-	-
Urinary Bladder	475	473.1	1.00	150	161.7	0.93
Kidney & Renal Pelvis	235	251.8	0.93	158	140.7	1.12
Brain	146	151.5	0.96	111	110.8	1.00
Thyroid Gland	75	69.7	1.08	217	200.8	1.08
Hodgkin Lymphoma	85	78.5	1.08	74	63.8	1.16
Non-Hodgkin Lymphoma	365	368.6	0.99	314	300.5	1.04
Multiple Myeloma	95	86.1	1.10	70	67.8	1.03
Mesothelioma	35	29.2	1.20	7	7.9	0.88
Total Leukemias	274	271.0	1.01	188	192.3	0.98
Childhood Cancers (0-19)	148	141.4	1.05	131	117.7	1.11
All Cancers	7479	7702.4	0.97*↓	7583	7440.2	1.02

[1]*The "expected" number of cancers represents the number of cancers that would have occurred assuming county rates were identical to the statewide average.*

**Ratio is significantly lower (↓) or higher (↑) than 1.00 (p<0.05); does not account for multiple comparisons.*

Table 5. Washington County Population (2000) by Zip Code and City

Zip code	Zip City Name	County	City	Pop.	Proportion of Total Pop. In Zip code
55001	Afton	Washington	Afton city	2600	0.976
		Washington	(other)	64	0.024
55003	Bayport	Washington	Bayport city	3162	1.000
55016	Cottage Grove	Washington	Cottage Grove city	29729	0.986
		Washington	Newport city	43	0.001
		Washington	St. Paul Park city	314	0.010
		Washington	Woodbury city	55	0.002
55025	Forest Lake	Anoka	Blaine city	76	0.004
		Anoka	Ham Lake city	220	0.011
		Anoka	Lino Lakes city	258	0.013
		Anoka	(other)	3737	0.190
		Chisago	(other)	859	0.044
		Washington	Forest Lake city	6798	0.346
		Washington	Hugo city	62	0.003
		Washington	(other)	7645	0.389
55038	Hugo	Anoka	Centerville city	3202	0.300
		Anoka	Lino Lakes city	1794	0.168
		Anoka	(other)	18	0.002
		Washington	Grant city	134	0.013
		Washington	Hugo city	5173	0.484
		Washington	(other)	366	0.034
55042	Lake Elmo	Washington	Lake Elmo city	6833	0.901
		Washington	Oakdale city	102	0.013
		Washington	(other)	648	0.085
55043	Lakeland	Washington	Afton city	237	0.059
		Washington	Lakeland city	1914	0.475
		Washington	Lakeland Shores city	355	0.088
		Washington	Lake St. Croix Beach city	1140	0.283
		Washington	St. Marys Point city	344	0.085
		Washington	(other)	38	0.009
55047	Marine on Saint Croix	Washington	Marine on St. Croix city	602	0.229

		Washington	(other)	2022	0.771
55055	Newport	Washington	Newport city	3672	0.968
		Washington	Woodbury city	123	0.032
55071	Saint Paul Park	Washington	Cottage Grove city	122	0.024
		Washington	St. Paul Park city	4756	0.917
		Washington	(other)	307	0.059
55073	Scandia	Chisago	(other)	219	0.078
		Washington	(other)	2571	0.922
55082	Stillwater	Washington	Grant city	2591	0.085
		Washington	Lake Elmo city	17	0.001
		Washington	Oak Park Heights city	3957	0.131
		Washington	Stillwater city	15143	0.500
		Washington	(other)	8596	0.284
55115	Mahtomedi	Washington	Birchwood Village city	208	0.023
		Washington	Dellwood city	64	0.007
		Washington	Grant city	972	0.108
		Washington	Mahtomedi city	7142	0.792
		Washington	Pine Springs city	376	0.042
		Washington	White Bear Lake city	97	0.011
		Washington	Willernie city	159	0.018
55125	Woodbury	Washington	Woodbury city	40093	1.000
55129	Woodbury	Washington	Cottage Grove city	93	0.015
		Washington	Woodbury city	6192	0.985
55128	Oakdale	Washington	Lake Elmo city	13	0.000
		Washington	Landfall city	700	0.026
		Washington	Oakdale city	26551	0.972
		Washington	Pine Springs city	45	0.002

Table 6. Dakota County Population (2000) by Zip Code and City

Zip code	Zip City Name	County	City	Pop.	Proportion of Total Pop. In Zip code
55024	Farmington	Dakota	Farmington city	12353	0.585
		Dakota	Lakeville city	5425	0.257
		Dakota	(other)	3347	0.158
55031	Hampton	Dakota	Hampton city	434	0.242
		Dakota	New Trier city	116	0.065
		Dakota	(other)	1247	0.694
55033	Hastings	Dakota	Hastings city	18201	0.705
		Dakota	Miesville city	58	0.002
		Dakota	Rosemount city	55	0.002
		Dakota	Vermillion city	200	0.008
		Dakota	(other)	5318	0.206
		Goodhue	(other)	31	0.001
		Washington	Cottage Grove city	638	0.025
		Washington	(other)	1293	0.050
55044	Lakeville	Dakota	Burnsville city	223	0.006
		Dakota	Lakeville city	31679	0.903
		Dakota	(other)	854	0.024
		Scott	(other)	2317	0.066
55065	Randolph	Dakota	Randolph city	318	0.324
		Dakota	(other)	647	0.660
		Goodhue	(other)	15	0.015
55068	Rosemount	Dakota	Apple Valley city	496	0.024
		Dakota	Coates city	163	0.008
		Dakota	Eagan city	17	0.001
		Dakota	Lakeville city	5841	0.282
		Dakota	Rosemount city	14153	0.683
		Dakota	(other)	64	0.003
55075	South Saint Paul	Dakota	Inver Grove Heights city	231	0.011
		Dakota	South St. Paul city	19855	0.987
		Dakota	West St. Paul city	22	0.001
55076	Inver Grove Heights	Dakota	Inver Grove Heights city	18289	0.984

		Dakota	South St. Paul city	300	0.016
55077	Inver Grove Heights	Dakota	Inver Grove Heights city	10496	0.991
		Dakota	Rosemount city	35	0.003
		Dakota	Sunfish Lake city	54	0.005
55085	Vermillion	Dakota	Vermillion city	237	1.000
55118	West Saint Paul	Dakota	Inver Grove Heights city	15	0.001
		Dakota	Lilydale city	552	0.020
		Dakota	Mendota city	51	0.002
		Dakota	Mendota Heights city	6706	0.246
		Dakota	Sunfish Lake city	450	0.017
		Dakota	West St. Paul city	19383	0.711
		Ramsey	St. Paul city	101	0.004
55120	Mendota Heights	Dakota	Mendota Heights city	4722	1.000
55121	Eagan	Dakota	Eagan city	7618	0.988
		Dakota	Inver Grove Heights city	96	0.012
55122	Eagan	Dakota	Apple Valley city	133	0.005
		Dakota	Burnsville city	329	0.012
		Dakota	Eagan city	27557	0.984
55123	Eagan	Dakota	Apple Valley city	40	0.001
		Dakota	Eagan city	26516	0.966
		Dakota	Inver Grove Heights city	624	0.023
		Dakota	Rosemount city	268	0.010
55124	Apple Valley	Dakota	Apple Valley city	44858	0.966
		Dakota	Burnsville city	668	0.014
		Dakota	Eagan city	820	0.018
		Dakota	Rosemount city	108	0.002
55306	Burnsville	Dakota	Burnsville city	14850	0.988
		Dakota	Lakeville city	183	0.012
55337	Burnsville	Dakota	Burnsville city	44150	0.977
		Dakota	Eagan city	1024	0.023

Table 7. Observed/Expected Cancer Incidence, 1996-2004, Zip 55128 (Oakdale)

	Males			*Females*		
Cancer	Observed Cases	Expected Cases	Ratio	Observed Cases	Expected Cases	Ratio
All Sites	468	441	1.06	476	478	1.00
Oral Cancers	9	14	0.64	7	8	0.88
Colon and Rectum	56	42	1.33	34	44	0.77
Liver	8	5	1.60	1	2	0.50
Pancreas	6	8	0.75	7	8	0.88
Lung and Bronchus	59	56	1.05	73	55	1.33*↑
Breast	1	1	1.00	168	166	1.01
Corpus Uteri	-	-	-	28	29	0.97
Ovary	-	-	-	18	18	1.00
Prostate	132	137	0.96	-	-	-
Urinary Bladder	28	28	1.00	12	11	1.09
Kidney	20	15	1.33	5	9	0.56
Brain	9	8	1.13	6	6	1.00
Thyroid	5	4	1.25	16	13	1.23
Lymphomas	26	26	1.00	24	23	1.04
Leukemias	15	15	1.00	11	11	1.00

*Expected numbers based on Metro area cancer incidence rates. *Ratio is significantly lower (↓) or higher (↑) than 1.00 (p<0.05)*

Table 8. Observed/Expected Cancer Incidence, 1996-2004, Zip 55042 (Lake Elmo)

	Males			*Females*		
Cancer	Observed Cases	Expected Cases	Ratio	Observed Cases	Expected Cases	Ratio
All Sites	120	138	0.87	108	119	0.91
Oral Cancers	11	5	2.20*↑	1	2	0.50
Colon and Rectum	8	13	0.62	8	10	0.80
Liver	0	2	0.00	0	<1	0.00
Pancreas	2	3	0.67	3	2	1.50
Lung and Bronchus	15	17	0.88	7	13	0.54
Breast	0	<1	0.00	52	44	1.18
Corpus Uteri	-	-	-	3	8	0.38
Ovary	-	-	-	4	5	0.80
Prostate	43	44	0.98	-	-	-
Urinary Bladder	4	8	0.50	1	2	0.50
Kidney	3	5	0.60	3	2	1.50
Brain	3	2	1.50	1	2	0.50
Thyroid	0	1	0.00	1	3	0.33
Lymphomas	8	8	1.00	3	5	0.60
Leukemias	3	4	0.75	5	3	1.67

*Expected numbers based on Metro area cancer incidence rates. *Ratio is significantly lower (↓) or higher (↑) than 1.00 (p<0.05)*

Table 9. Observed/Expected Cancer Incidence, 1996-2004, Zip 55016 (Cottage Grove)

	Males			*Females*		
Cancer	Observed Cases	Expected Cases	Ratio	Observed Cases	Expected Cases	Ratio
All Sites	418	403	1.04	367	381	0.96
Oral Cancers	7	14	0.50	6	6	1.00
Colon and Rectum	37	37	1.00	26	30	0.87
Liver	5	5	1.00	1	2	0.50
Pancreas	12	8	1.50	4	6	0.67
Lung and Bronchus	63	49	1.29	46	39	1.18
Breast	1	1	1.00	132	140	0.94
Corpus Uteri	-	-	-	23	24	0.96
Ovary	-	-	-	9	16	0.56
Prostate	118	124	0.95	-	-	-
Urinary Bladder	31	23	1.35	8	7	1.14
Kidney	23	14	1.64*↑	8	7	1.14
Brain	9	8	1.13	10	6	1.67
Thyroid	4	5	0.80	15	13	1.15
Lymphomas	21	25	0.84	11	18	0.61
Leukemias	10	14	0.71	7	9	0.78

*Expected numbers based on Metro area cancer incidence rates. *Ratio is significantly lower (↓) or higher (↑) than 1.00 (p<0.05)*

Table 10. Observed/Expected Cancer Incidence, 1996-2004, Zip 55125-29 (Woodbury)

	Males			*Females*		
Cancer	Observed Cases	Expected Cases	Ratio	Observed Cases	Expected Cases	Ratio
All Sites	596	647	0.92*↓	616	674	0.91
Oral Cancers	13	21	0.62	11	11	1.00
Colon and Rectum	61	61	1.00	47	58	0.81
Liver	6	8	0.75	1	3	0.33
Pancreas	16	12	1.33	6	11	0.55
Lung and Bronchus	47	80	0.59*↓	58	70	0.83
Breast	2	2	1.00	217	241	0.90
Corpus Uteri	-	-	-	43	40	1.08
Ovary	-	-	-	19	27	0.70
Prostate	183	194	0.94	-	-	-
Urinary Bladder	45	39	1.15	17	14	1.21
Kidney	23	23	1.00	13	12	1.08
Brain	8	12	0.67	9	10	0.90
Thyroid	6	7	0.86	21	21	1.00
Lymphomas	37	40	0.92	32	33	0.97
Leukemias	31	23	1.35	10	16	0.62

*Expected numbers based on Metro area cancer incidence rates. *Ratio is significantly lower (↓) or higher (↑) than 1.00 (p<0.05)*

Table 11. Observed/Expected Cancer Incidence, 1996-2004, Zip 55055 (Newport)

	Males			*Females*		
Cancer	Observed Cases	Expected Cases	Ratio	Observed Cases	Expected Cases	Ratio
All Sites	59	68	0.87	68	72	0.94
Oral Cancers	2	2	1.00	0	1	0.00
Colon and Rectum	3	7	0.43	5	7	0.71
Liver	0	1	0.00	0	<1	0.00
Pancreas	2	1	2.00	1	1	1.00
Lung and Bronchus	7	9	0.78	9	8	1.13
Breast	0	<1	0.00	24	25	0.96
Corpus Uteri	-	-	-	2	4	0.50
Ovary	-	-	-	1	3	0.33
Prostate	19	21	0.90	-	-	-
Urinary Bladder	4	4	1.00	2	2	1.00
Kidney	1	2	0.50	2	1	2.00
Brain	1	1	1.00	1	1	1.00
Thyroid	0	1	0.00	2	2	1.00
Lymphomas	5	4	1.25	7	4	1.75
Leukemias	2	2	1.00	1	2	0.50

*Expected numbers based on Metro area cancer incidence rates. *Ratio is significantly lower (↓) or higher (↑) than 1.00 (p<0.05)*

Table 12. Observed/Expected Cancer Incidence, 1996-2004, Zip 55071 (St. Paul Park)

	Males			*Females*		
Cancer	Observed Cases	Expected Cases	Ratio	Observed Cases	Expected Cases	Ratio
All Sites	123	103	1.19	108	92	1.17
Oral Cancers	3	3	1.00	3	2	1.50
Colon and Rectum	8	10	0.80	9	9	1.00
Liver	1	1	1.00	3	<1	5.77*↑
Pancreas	5	2	2.50	2	2	1.00
Lung and Bronchus	17	14	1.21	16	11	1.45
Breast	0	<1	0.00	30	32	0.94
Corpus Uteri	-	-	-	6	6	1.00
Ovary	-	-	-	5	3	1.67
Prostate	39	33	1.18	-	-	-
Urinary Bladder	12	7	1.71	3	2	1.50
Kidney	2	3	0.67	1	2	0.50
Brain	0	2	0.00	3	1	3.00
Thyroid	0	1	0.00	3	2	1.50
Lymphomas	9	6	1.50	5	5	1.00
Leukemias	2	3	0.67	3	2	1.50

*Expected numbers based on Metro area cancer incidence rates. *Ratio is significantly lower (↓) or higher (↑) than 1.00 (p<0.05)*

Table 13. Observed/Expected Cancer Incidence, 1996-2004, Zip 55033 (Hastings)

	Males			*Females*		
Cancer	Observed Cases	Expected Cases	Ratio	Observed Cases	Expected Cases	Ratio
All Sites	512	514	1.00	437	480	0.91*↓
Oral Cancers	17	16	1.06	6	8	0.75
Colon and Rectum	61	50	1.22	50	47	1.06
Liver	4	6	0.67	1	2	0.50
Pancreas	8	10	0.80	4	9	0.44
Lung and Bronchus	61	67	0.91	47	56	0.84
Breast	0	1	0.00	132	165	0.80*↓
Corpus Uteri	-	-	-	25	29	0.86
Ovary	-	-	-	17	18	0.94
Prostate	153	163	0.94	-	-	-
Urinary Bladder	34	34	1.00	15	12	1.25
Kidney	17	17	1.00	12	9	1.33
Brain	11	8	1.38	5	6	0.83
Thyroid	2	4	0.50	13	11	1.18
Lymphomas	27	29	0.93	26	24	1.08
Leukemias	19	17	1.12	9	12	0.75

Expected numbers based on Metro area cancer incidence rates. **Ratio is significantly lower (↓) or higher (↑) than 1.00 ($p<0.05$)*

Table 14. Observed/Expected Cancer Incidence, 1996-2004, Zip 55075 (South St Paul)

	Males			*Females*		
Cancer	Observed Cases	Expected Cases	Ratio	Observed Cases	Expected Cases	Ratio
All Sites	450	418	1.08*↑	470	425	1.11
Oral Cancers	9	12	0.75	7	7	1.00
Colon and Rectum	42	41	1.02	38	44	0.86
Liver	4	4	1.00	3	2	1.50
Pancreas	9	8	1.13	9	8	1.13
Lung and Bronchus	71	55	1.29*↑	69	52	1.33*↑
Breast	0	1	0.00	147	141	1.04
Corpus Uteri	-	-	-	28	25	1.12
Ovary	-	-	-	13	15	0.87
Prostate	144	132	1.09	-	-	-
Urinary Bladder	25	29	0.86	12	11	1.09
Kidney	17	14	1.21	13	9	1.44
Brain	11	6	1.83	8	5	1.60
Thyroid	7	3	2.33	13	9	1.44
Lymphomas	30	24	1.25	19	21	0.90
Leukemias	16	14	1.14	9	10	0.90

Expected numbers based on Metro area cancer incidence rates. **Ratio is significantly lower (↓) or higher (↑) than 1.00 ($p<0.05$)*

Table 15. Observed/Expected Cancer Incidence, 1996-2004, Combined Zip Codes for Eight Communities**

	Males			*Females*		
Cancer	Observed Cases	Expected Cases	Ratio	Observed Cases	Expected Cases	Ratio
All Sites	2746	2731.7	1.01	2650	2721.4	0.97
Oral Cancers	71	86.9	0.82	41	44.6	0.92
Colon and Rectum	276	261.9	1.05	217	249.0	0.87*↓
Liver	28	30.9	0.91	10	11.8	0.85
Pancreas	60	51.3	1.17	36	45.5	0.79
Lung and Bronchus	338	346.7	0.97	325	303.8	1.07
Breast	3	7.2	0.41	899	954.2	0.94
Corpus Uteri	-	-	-	158	162.9	0.97
Ovary	-	-	-	86	105.0	0.82
Prostate	828	848.3	0.98	-	-	-
Urinary Bladder	183	172.7	1.06	70	61.1	1.15
Kidney	106	92.7	1.14	57	52.5	1.08
Brain	51	47.0	1.09	43	36.9	1.17
Thyroid	24	26.6	0.90	84	74.1	1.13
Lymphomas	163	161.6	1.01	127	132.8	0.96
Leukemias	98	91.7	1.07	54	64.1	0.84

Expected numbers based on Metro area cancer incidence rates.

**Ratio is significantly lower (↓) or higher (↑) than 1.00 ($p<0.05$)*

***Hastings and South St. Paul in Dakota Co.; Cottage Grove, Lake Elmo, Newport, Oakdale, St. Paul Park, and Woodbury in Washington Co.*

Figure 1. Location of Two Counties Included in Analysis of Cancer Incidence Rates.

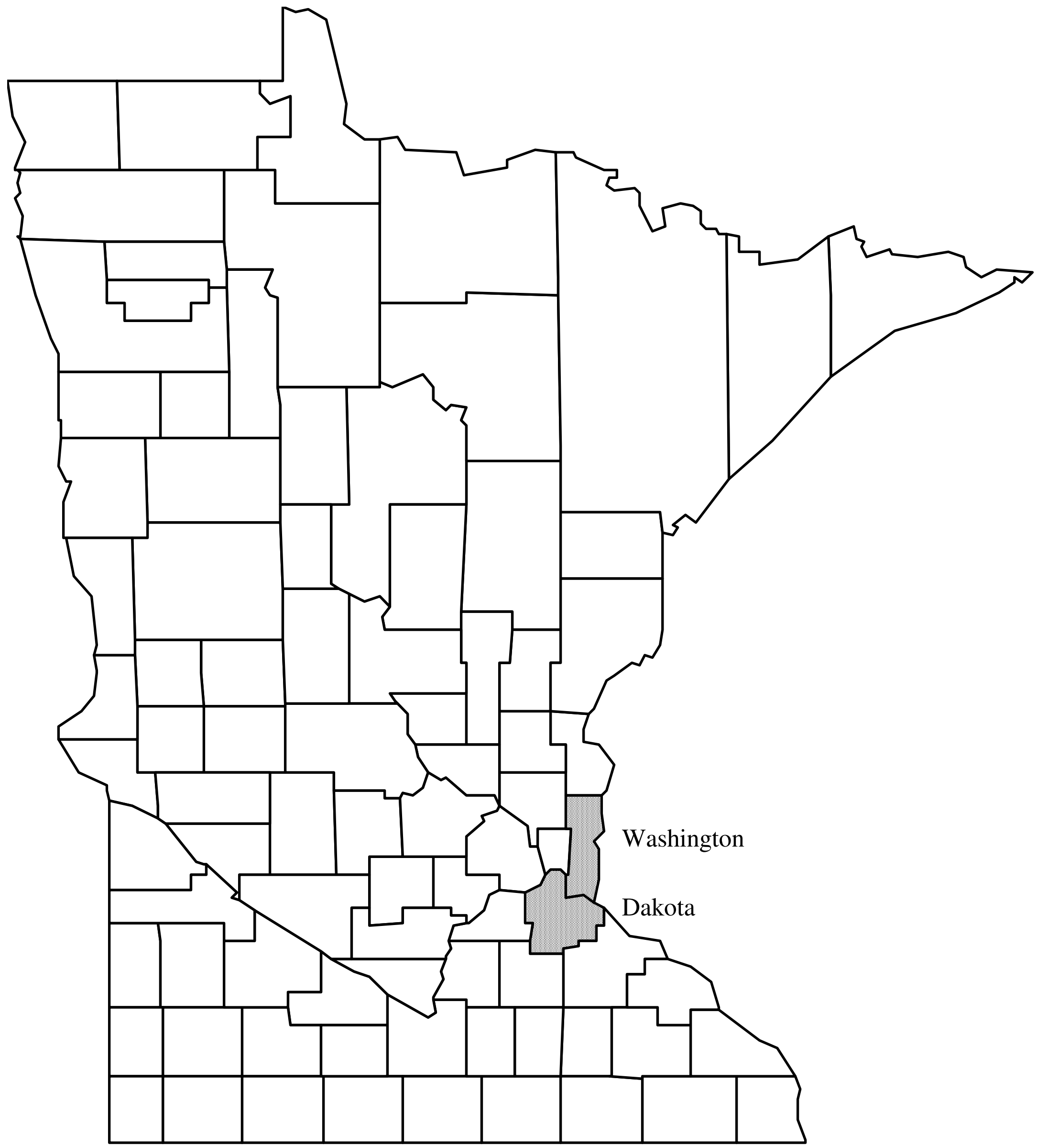
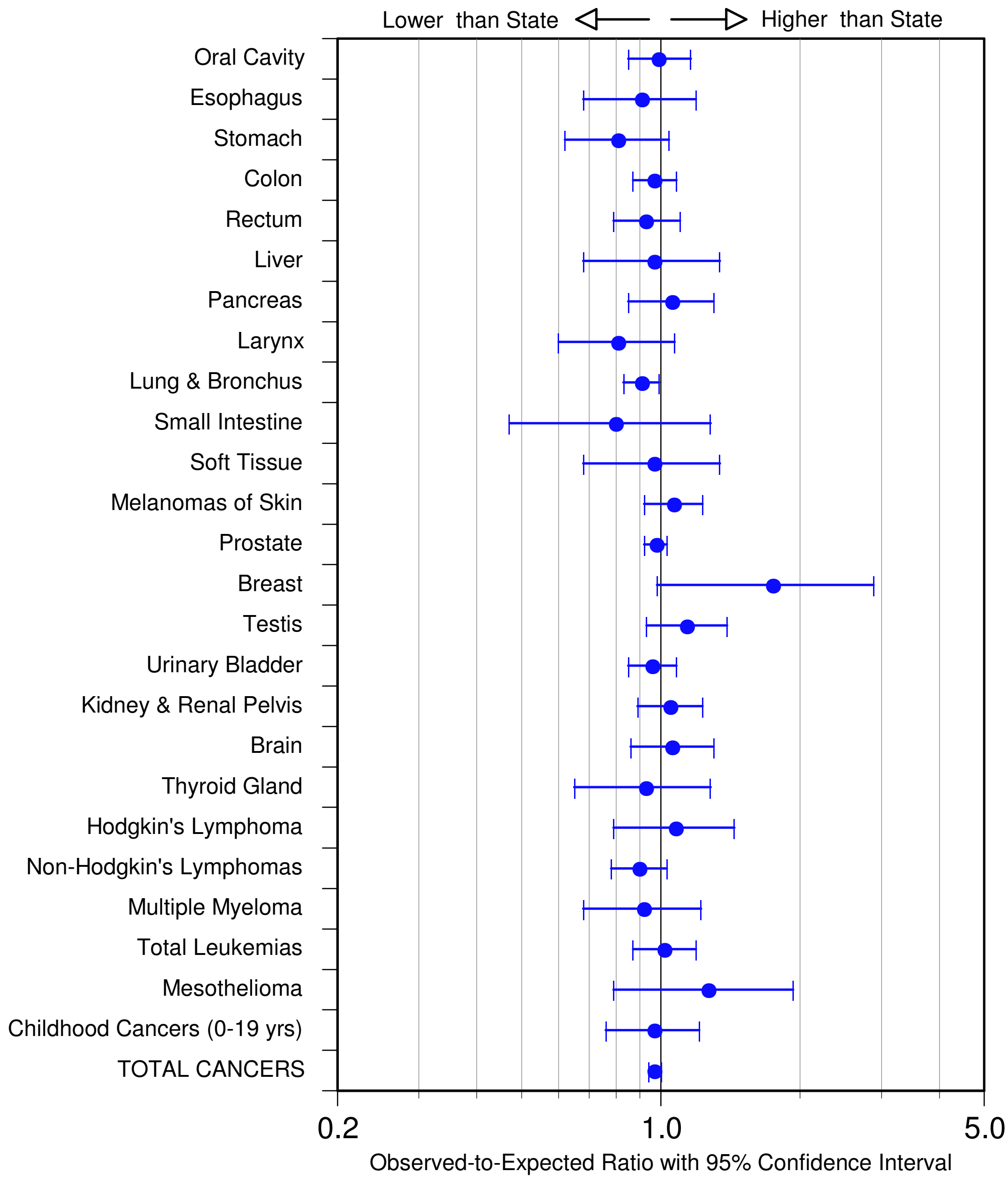
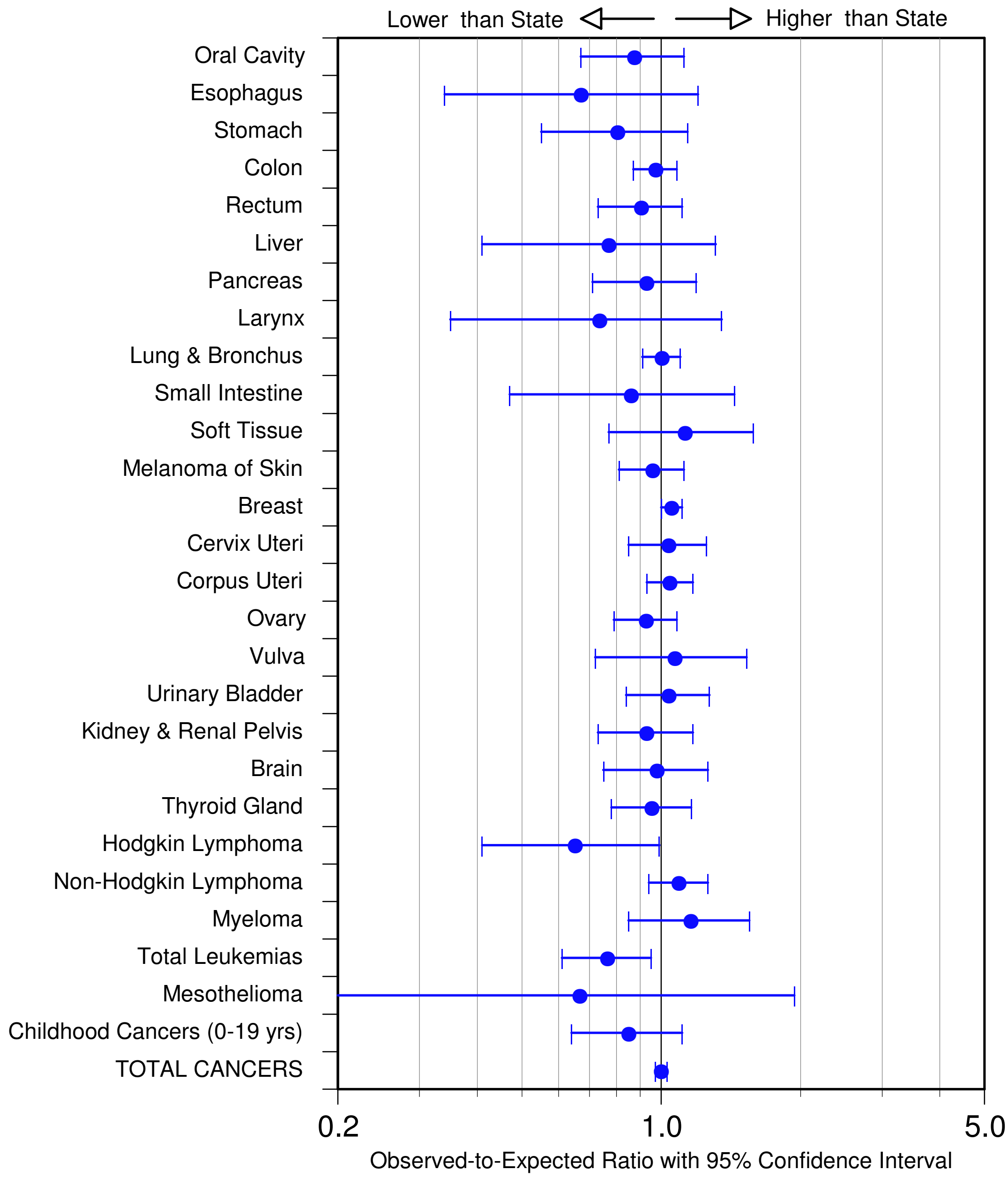


Figure 2. Cancer Incidence Rates for Washington County Males, 1988-2002



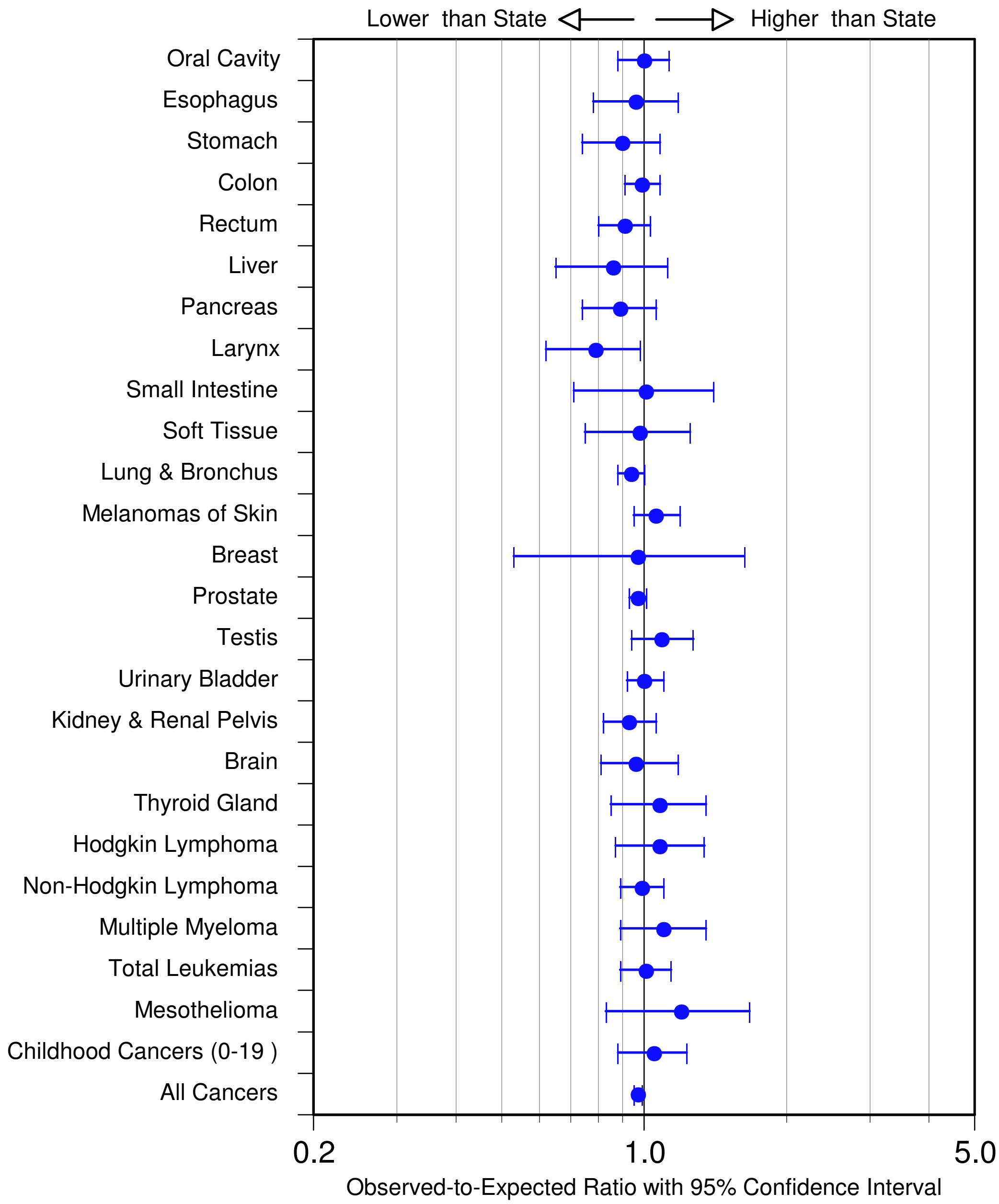
*Expected Cancers Based on County Population and Statewide Cancer Rates

Figure 3. Cancer Incidence Rates for Washington County Females, 1988-2002.



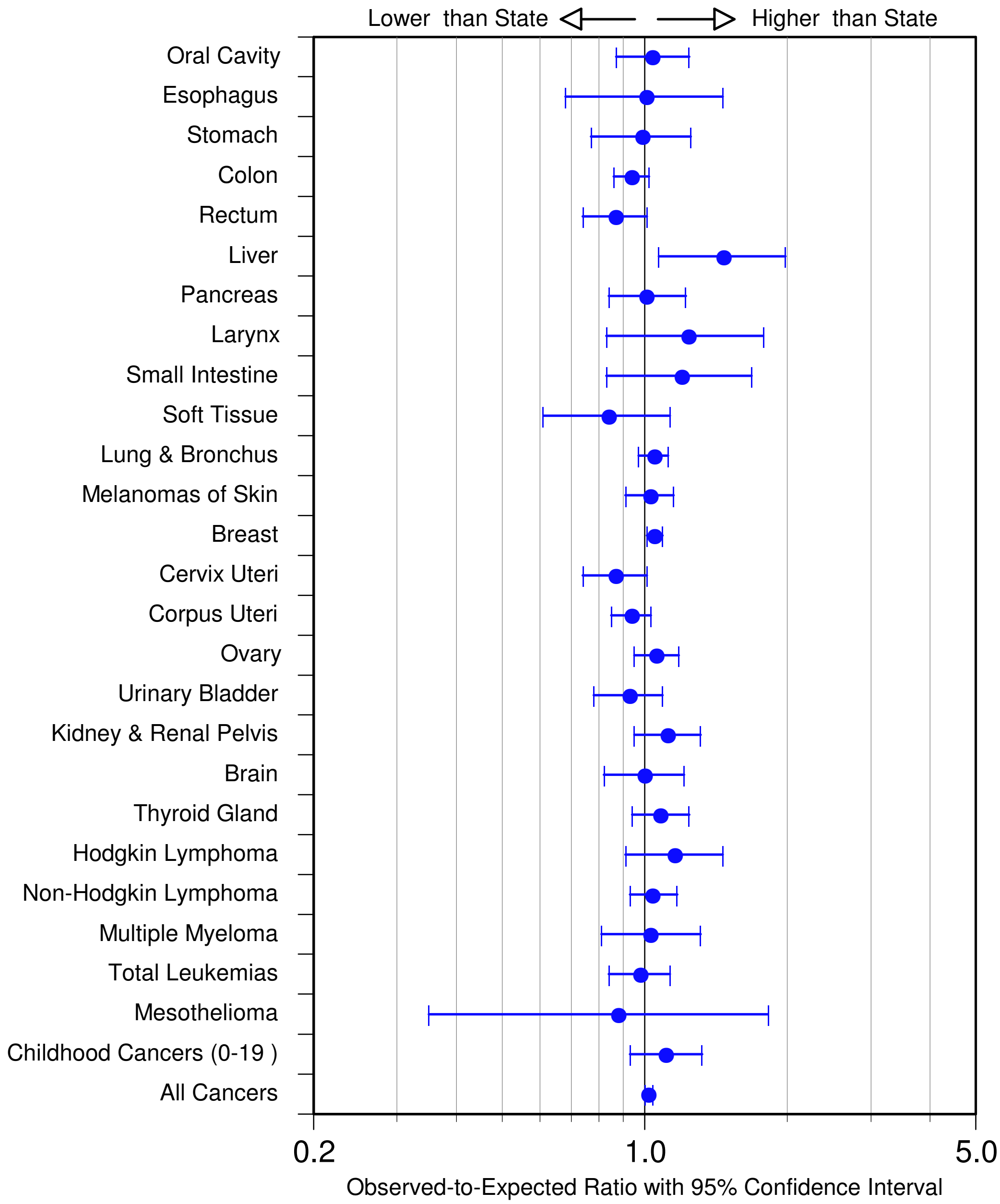
*Expected Cancers Based on County Population and Statewide Cancer Rates

Figure 4. Cancer Incidence Rates for Dakota County Males, 1988-2002



*Expected Cancers Based on County Population and Statewide Cancer Rates

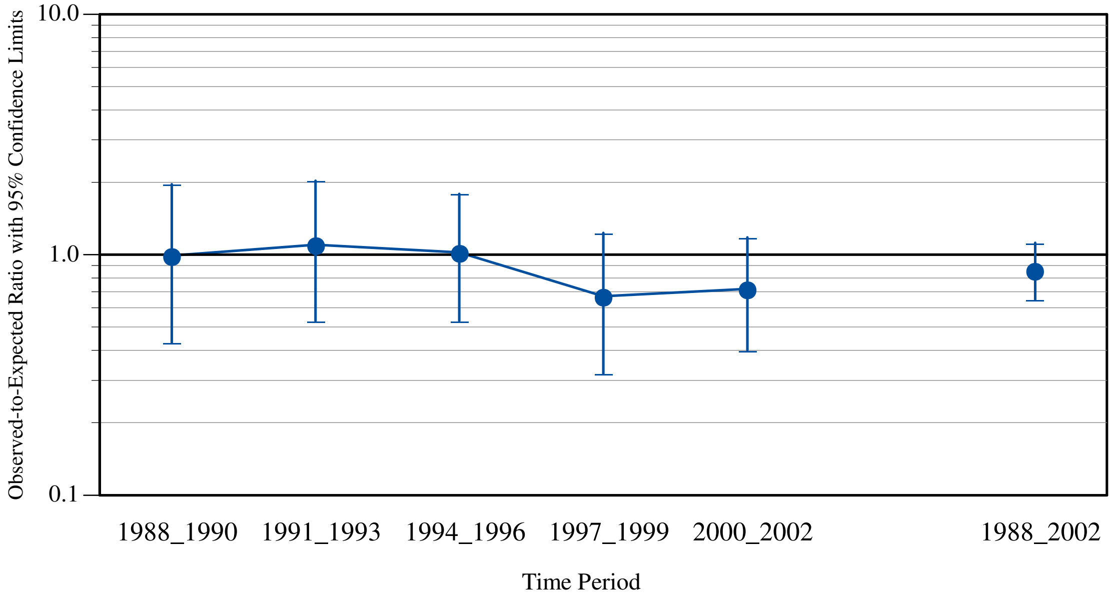
Figure 5. Cancer Incidence Rates for Dakota County Females, 1988-2002



*Expected Cancers Based on County Population and Statewide Cancer Rates

Figure 6. Liver Cancer Incidence Trends for Dakota County, Males and Females, 1988-2002

a. Males



b. Females

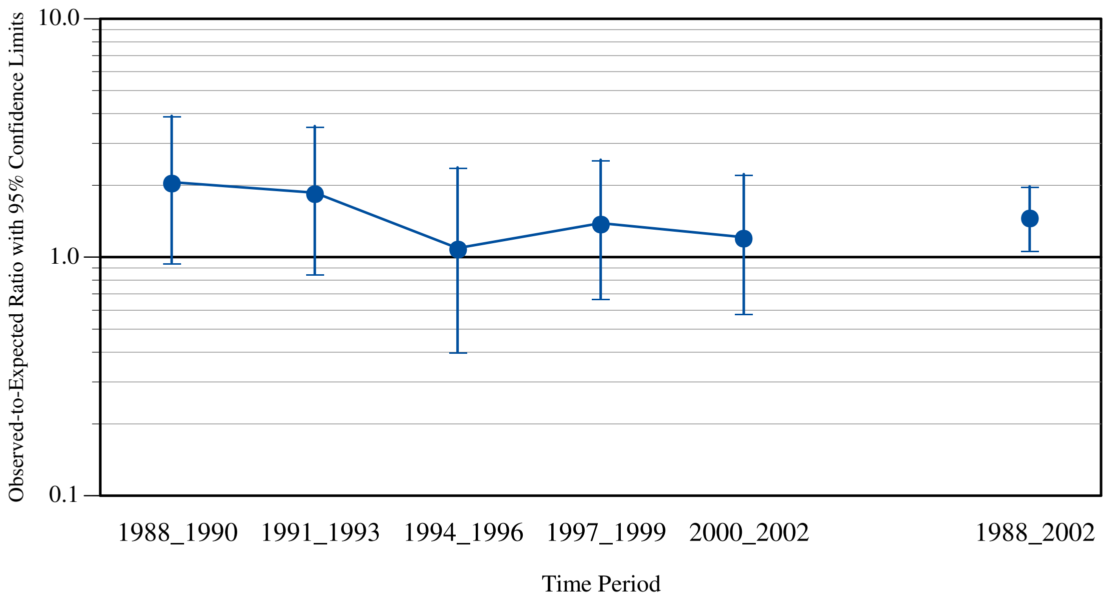


Figure 7. Male Liver Cancer Incidence Rates by County, 1988-2002

Excludes 5 counties with a total of 5 observed cases and 16.2 expected

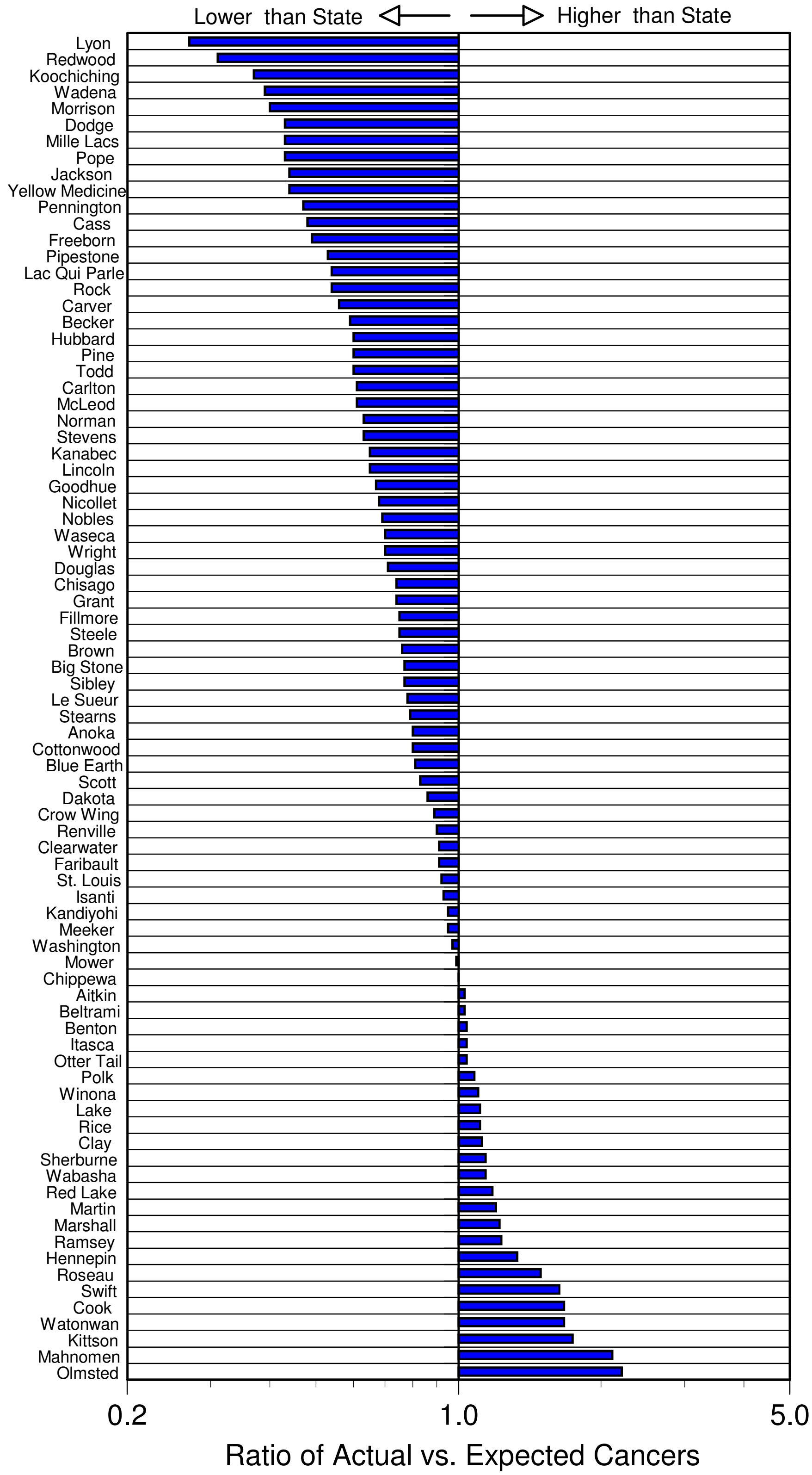


Figure 8. Female Liver Cancer Incidence Rates by County, 1988-2002

Excludes 20 counties with a total of 14 actual cases and 40 expected cases.

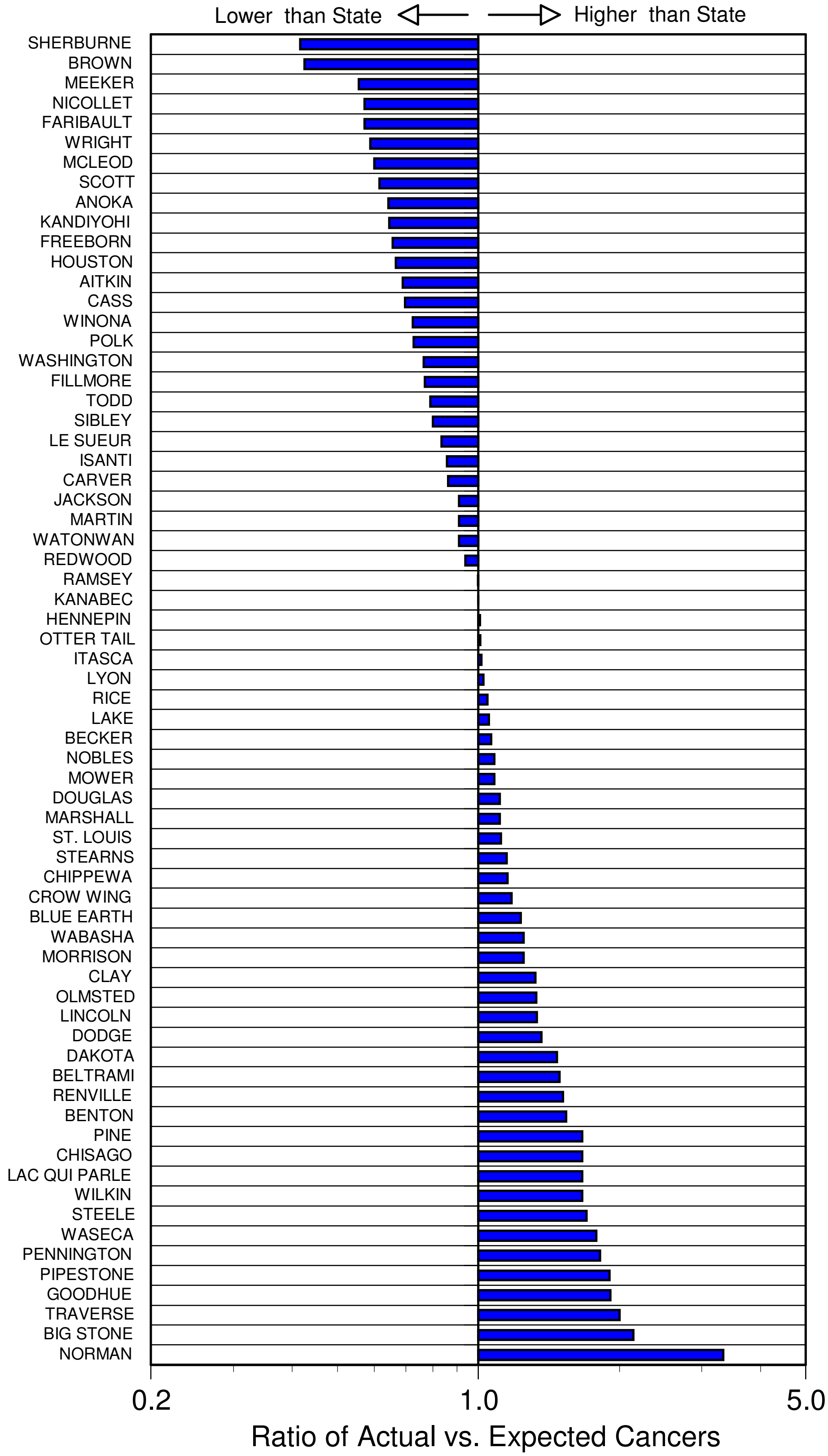


Figure 9. Male Bladder Cancer Incidence Rates by County, 1988-2002

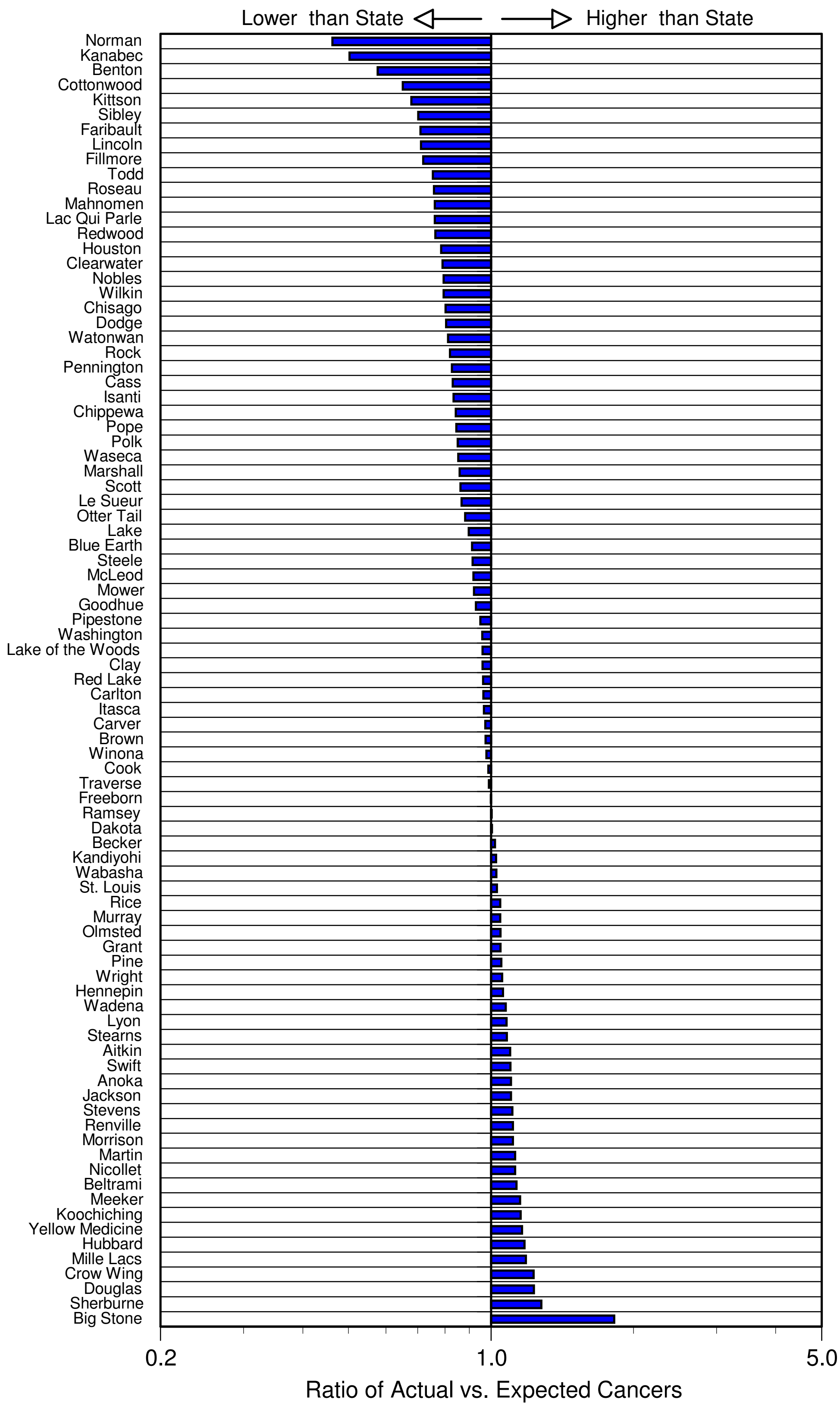


Figure 10. Female Bladder Cancer Incidence by County, 1988-2002.

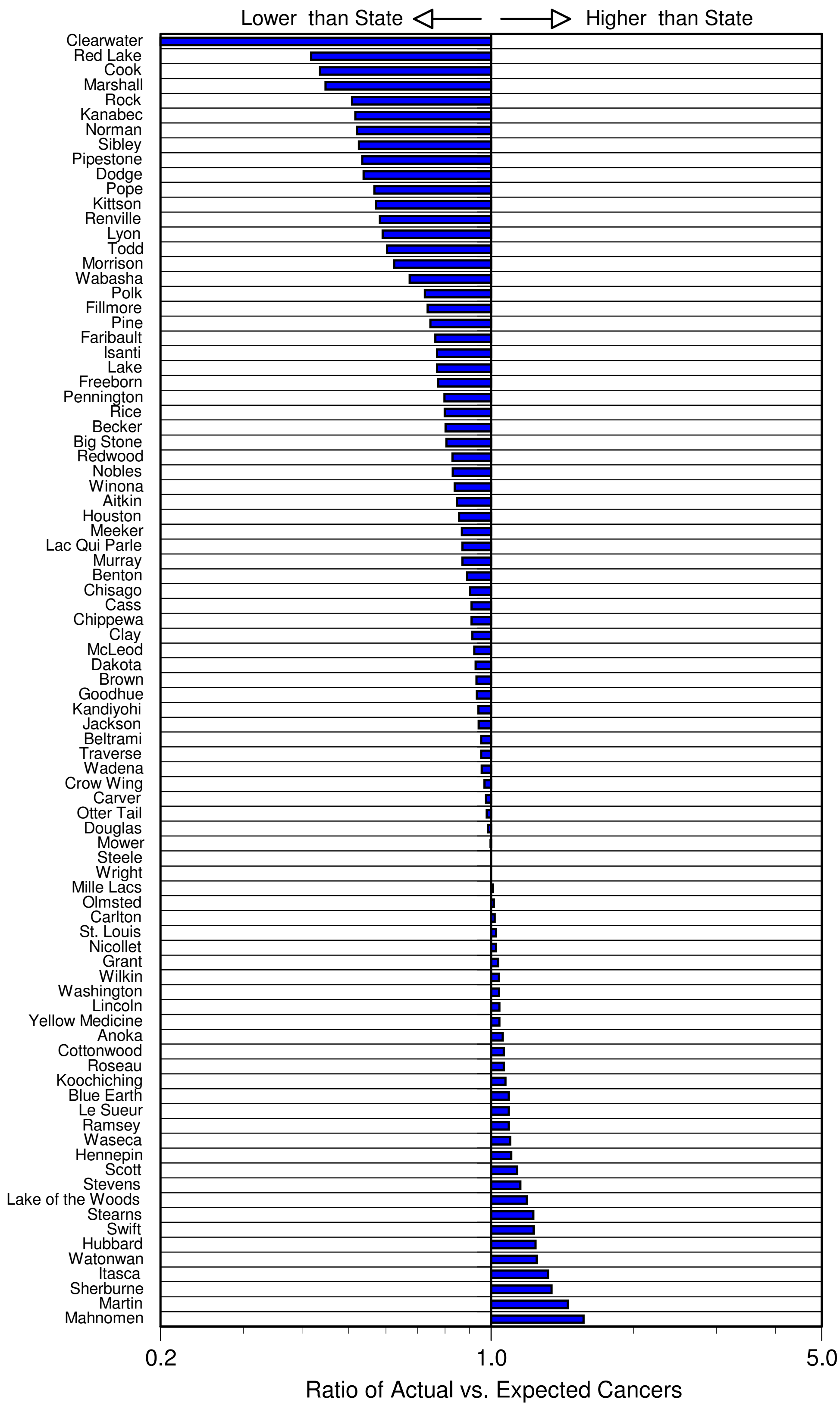
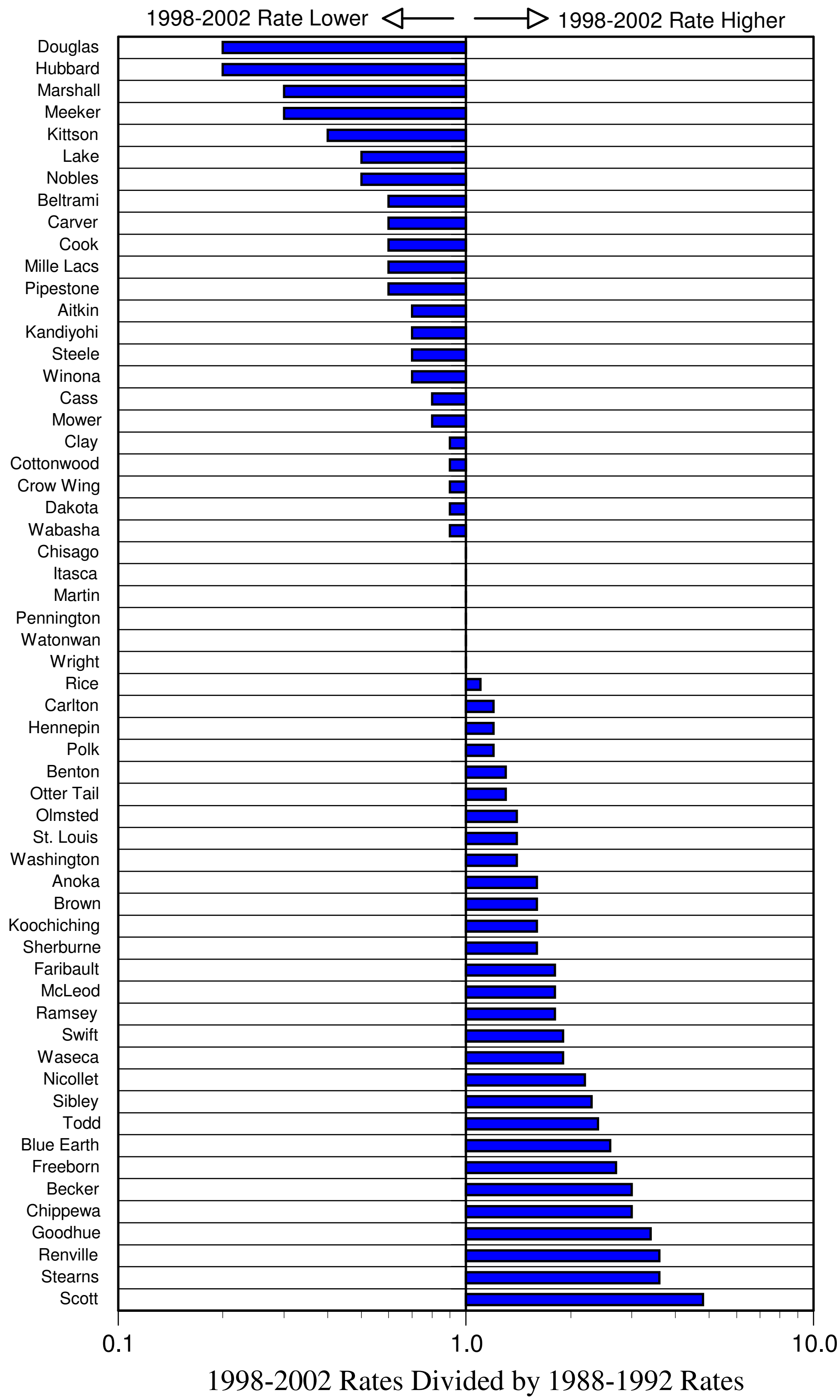


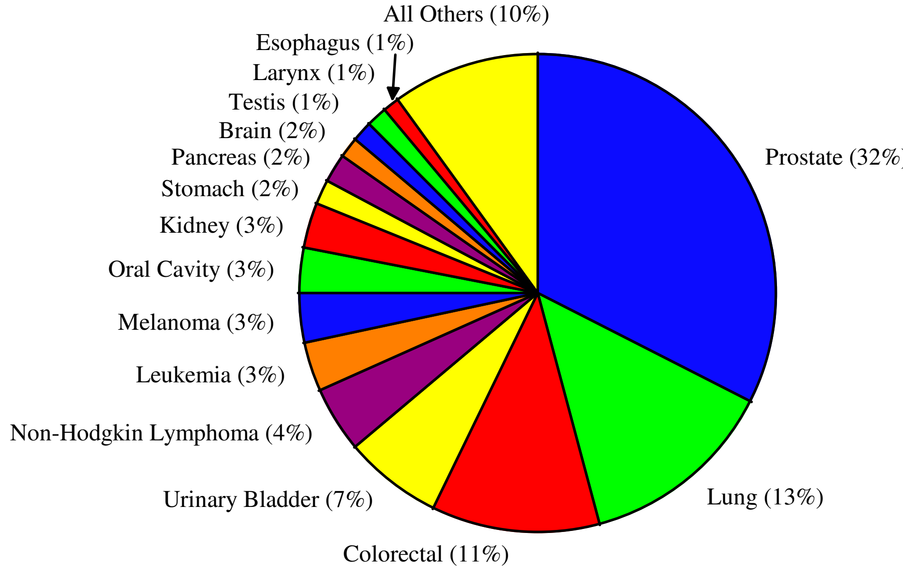
Figure 11. Male Liver Cancer Incidence Rates by County: Comparison of Two Time Periods, 1998-2002 Period vs. 1988-1992 Period.



Excludes 29 counties that had no cases for at least one time period.

Figure 12. Relative Frequencies of Cancer Types by Gender, Minnesota, 1988-2002.

A. Males (N=161,697)



B. Females (N=147,422)

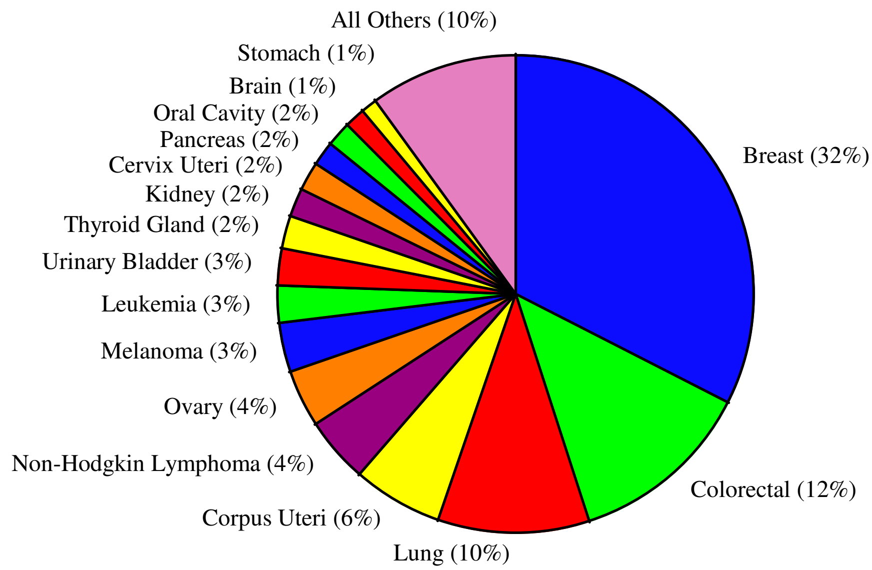


Figure 13. Bladder Cancer Incidence for Washington County Zip Codes Compared to Metro: Males, 1996-2004.

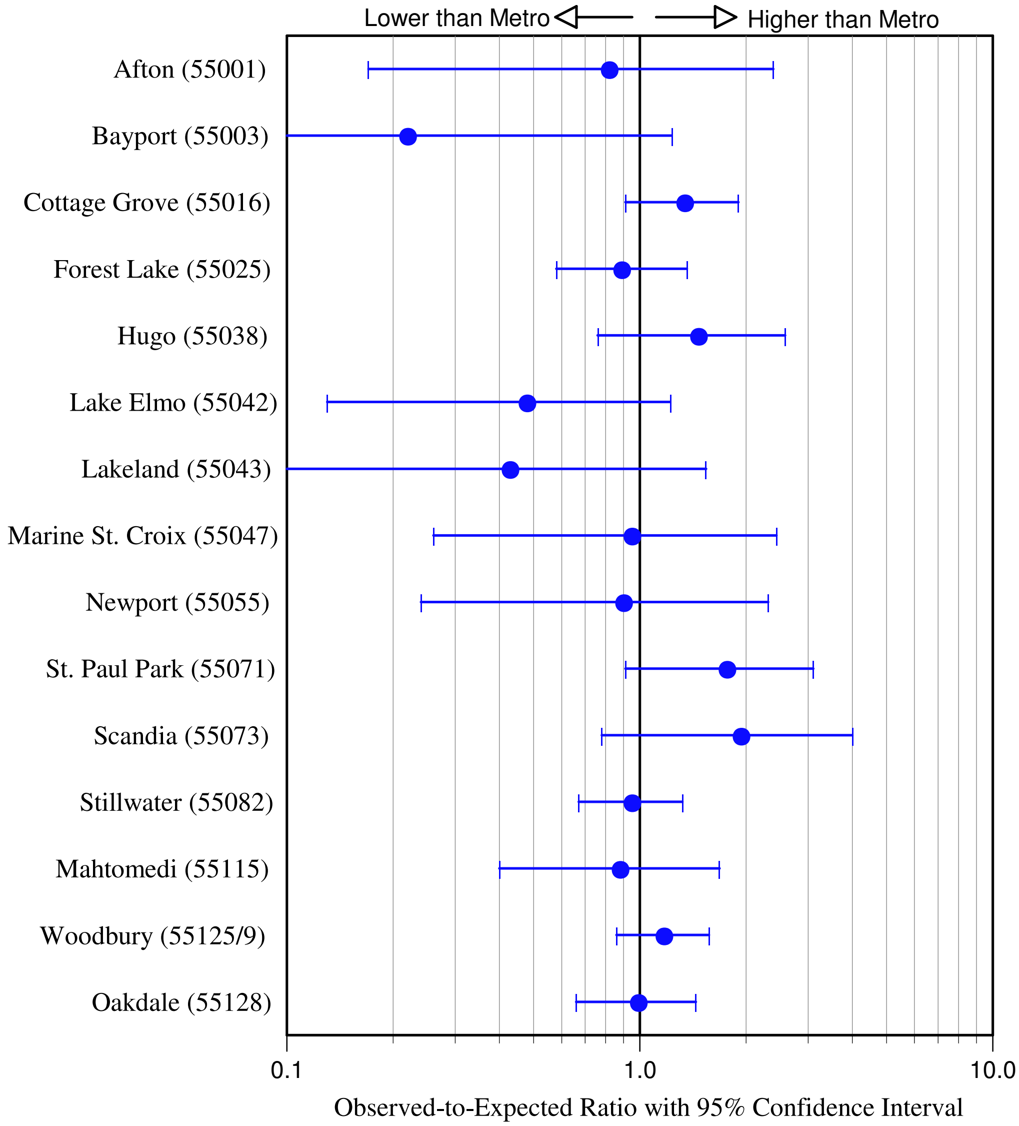


Figure 14. Bladder Cancer Incidence for Washington County Zip Codes Compared to Metro: Females, 1996-2004.

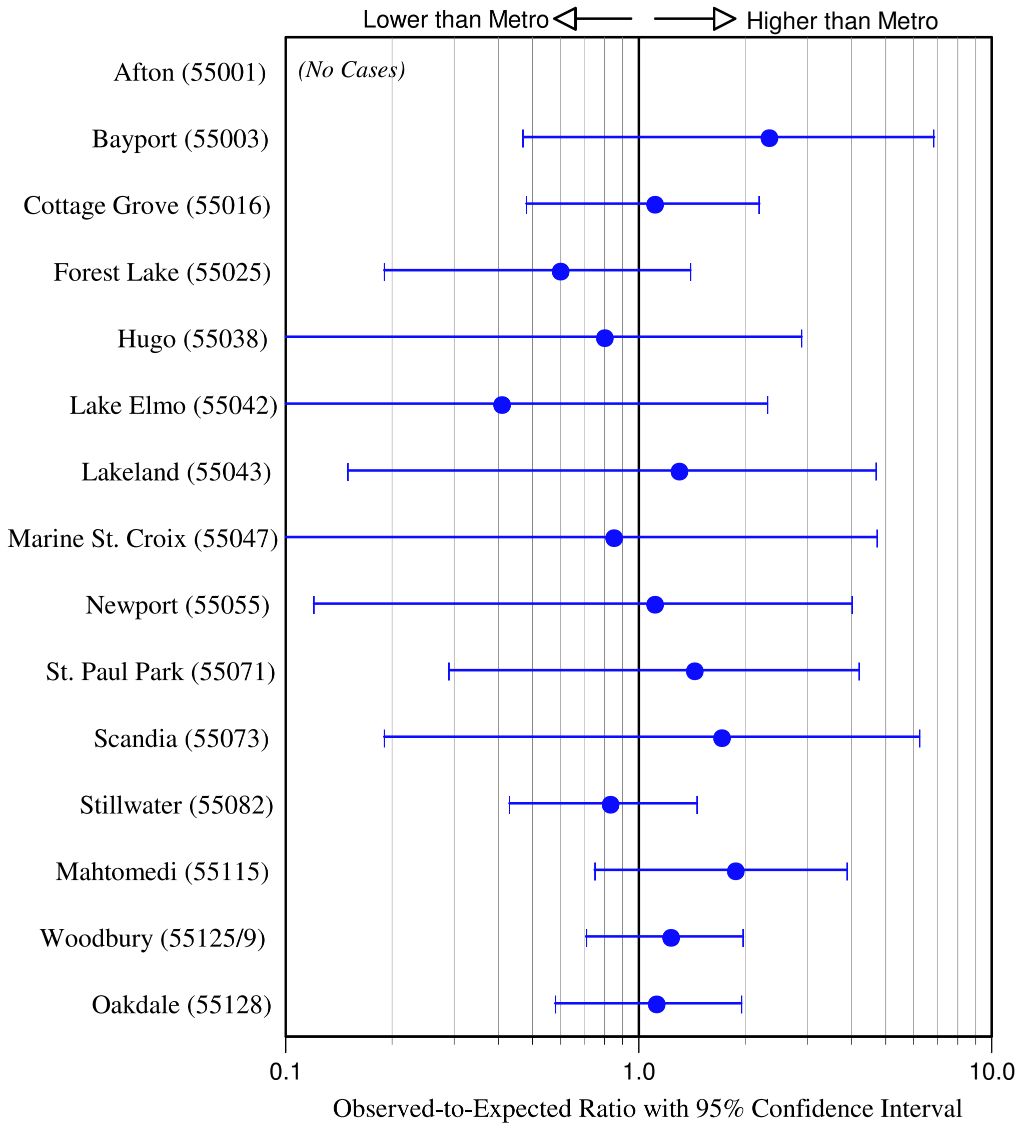


Figure 15. Bladder Cancer Incidence for Dakota County Zip Codes Compared to Metro: Males, 1996-2004.

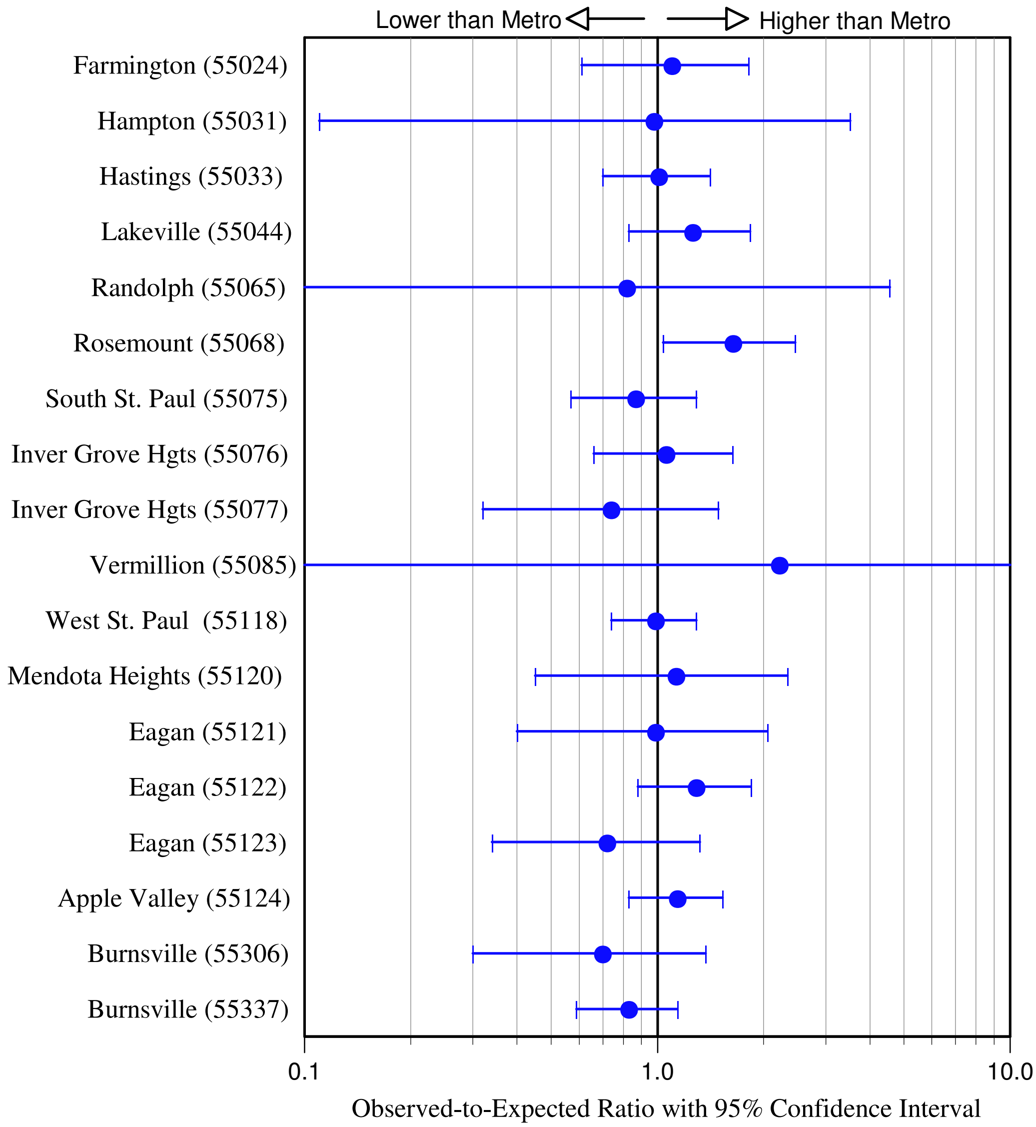
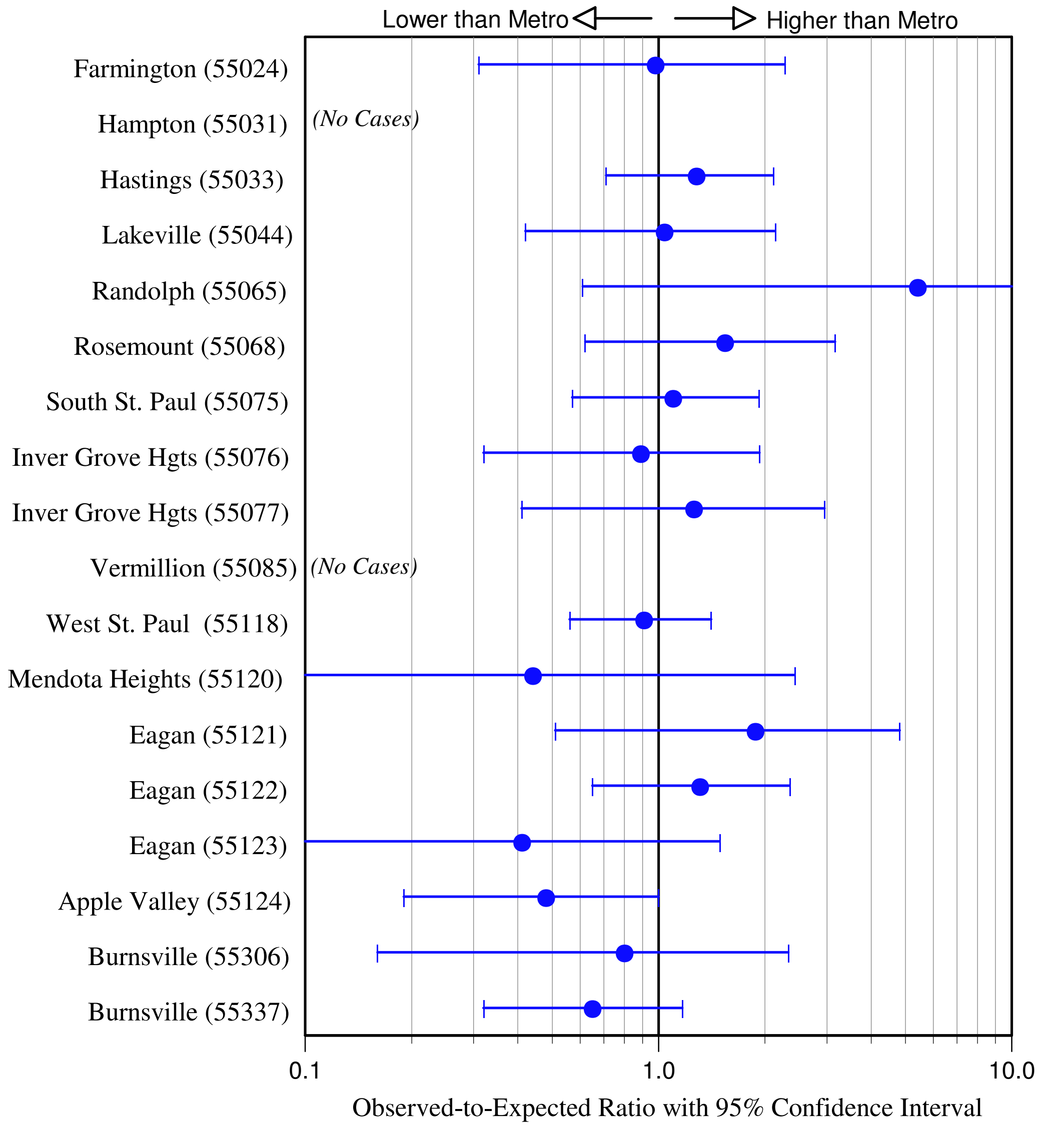
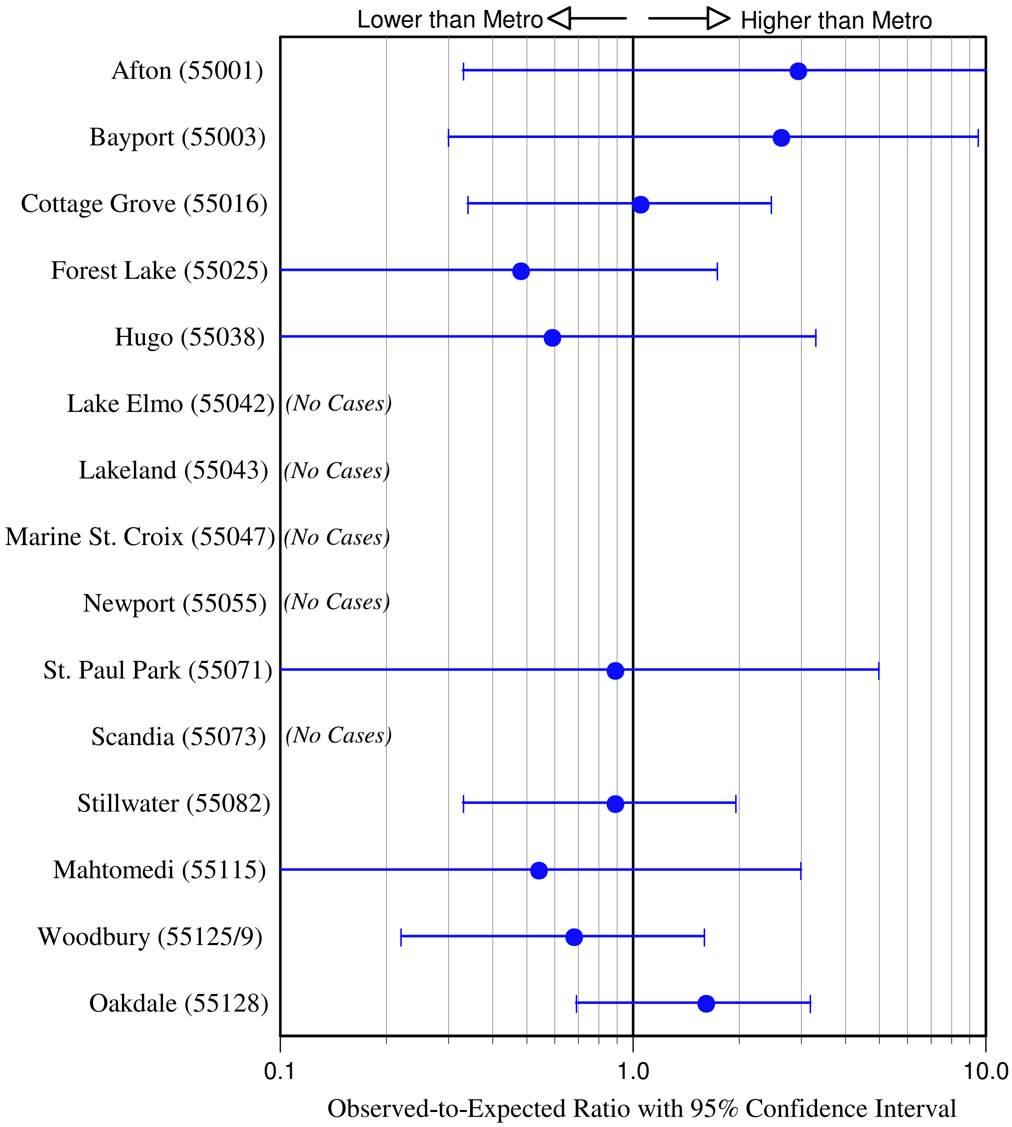


Figure 16. Bladder Cancer Incidence for Dakota County Zip Codes Compared to Metro: Females, 1996-2004.



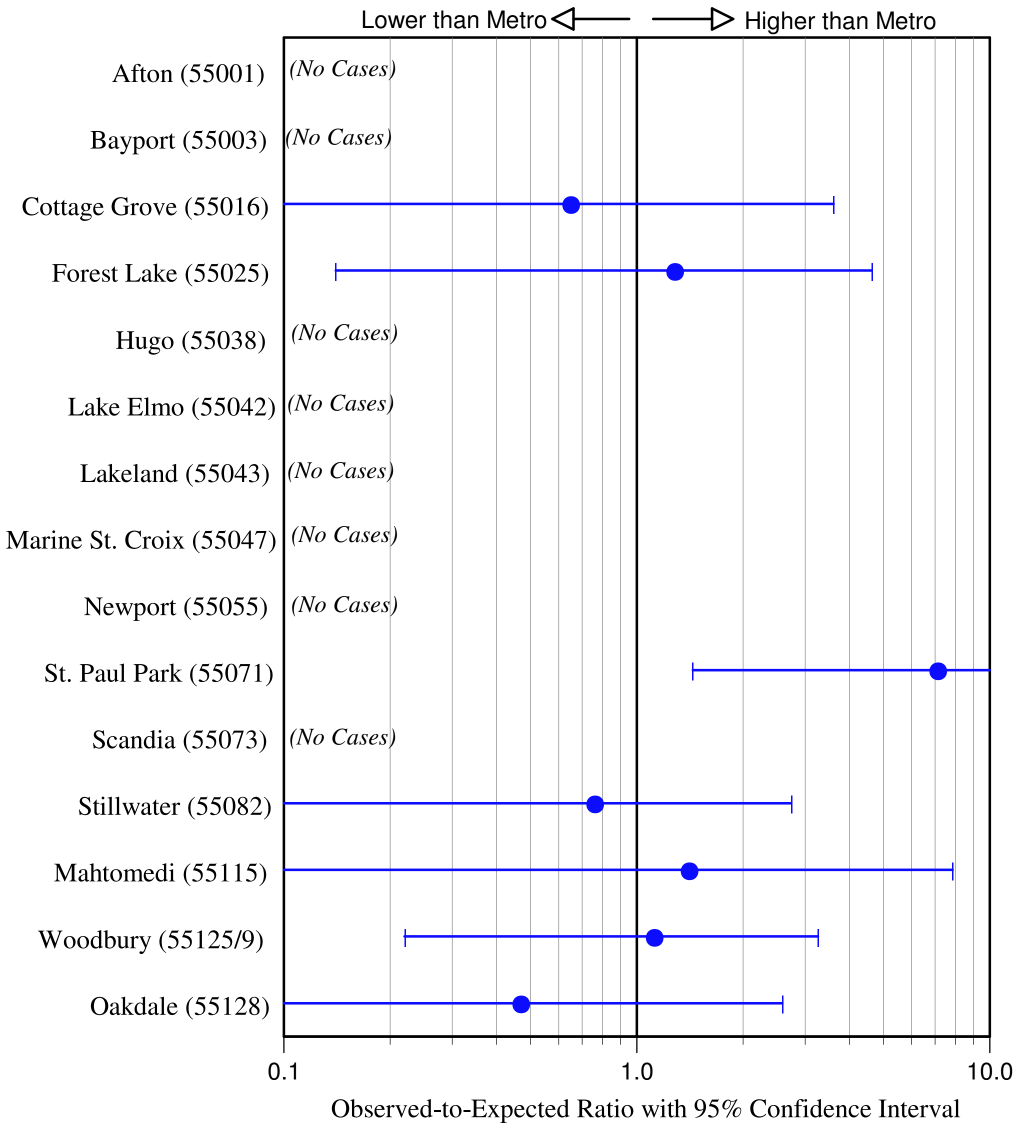
Rates not determined for two zip codes with a total of 0 cases and 0.70 expected cases

Figure 17. Liver Cancer Incidence for Washington County Zip Codes Compared to Metro: Males, 1996-2004.



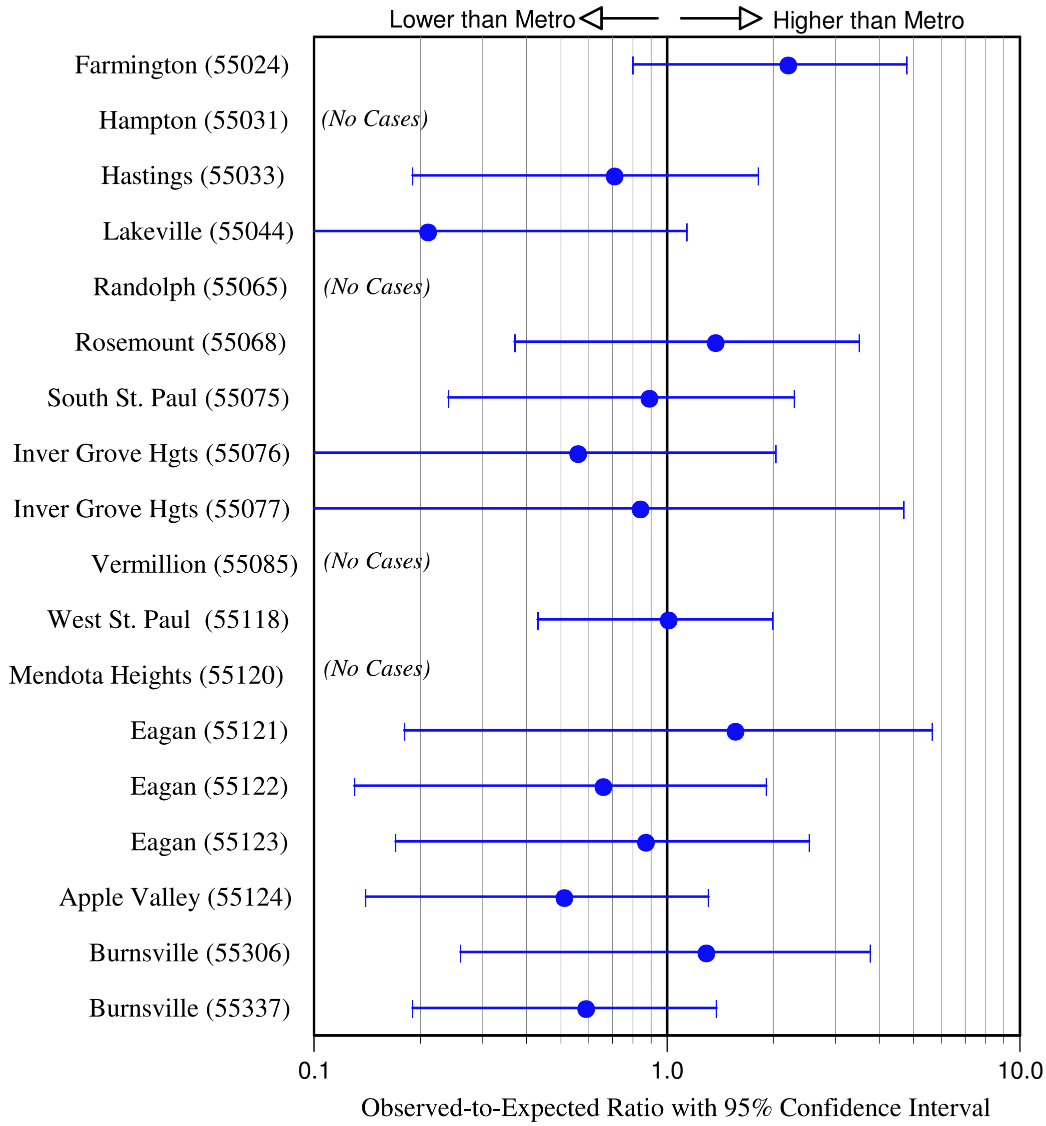
Rates not determined for five Zip Codes with a total of 0 cases and 4.63 expected cases

Figure 18. Liver Cancer Incidence for Washington County Zip Codes Compared to Metro: Females, 1996-2004.



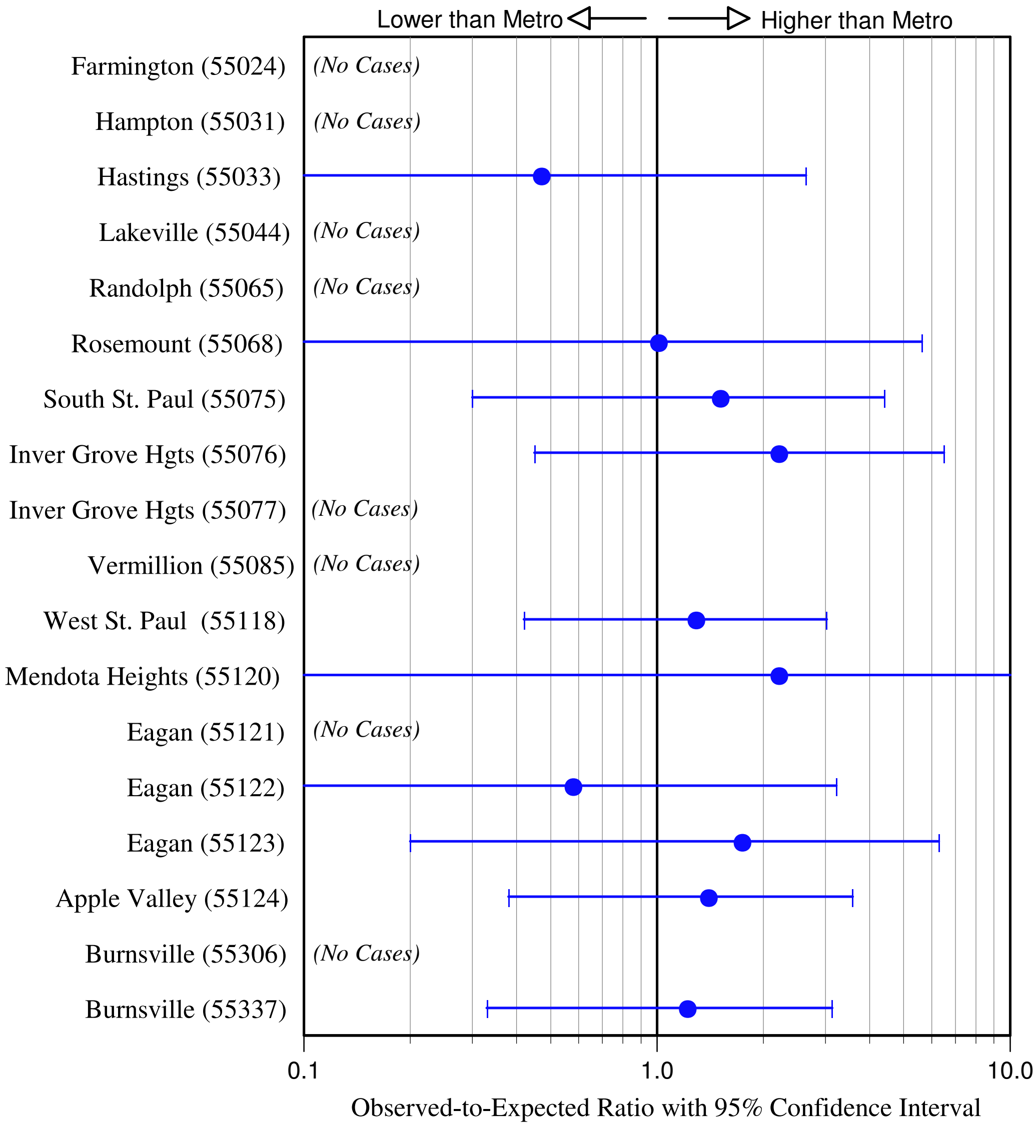
Rates not determined for eight zip codes with a total of 0 cases and 2.56 expected cases

Figure 19. Liver Cancer Incidence for Dakota County Zip Codes Compared to Metro: Males, 1996-2004.



Rates not determined for four zip codes with a total of 0 cases and 1.69 expected cases

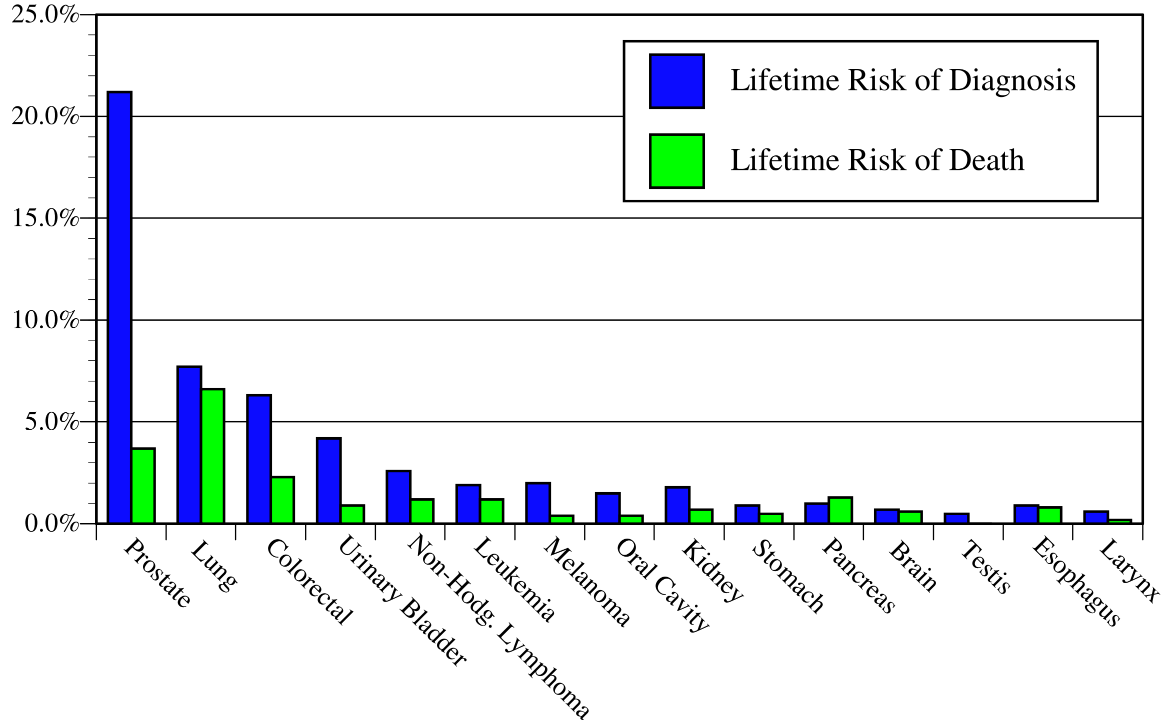
Figure 20. Liver Cancer Incidence for Dakota County Zip Codes Compared to Metro: Females, 1996-2004.



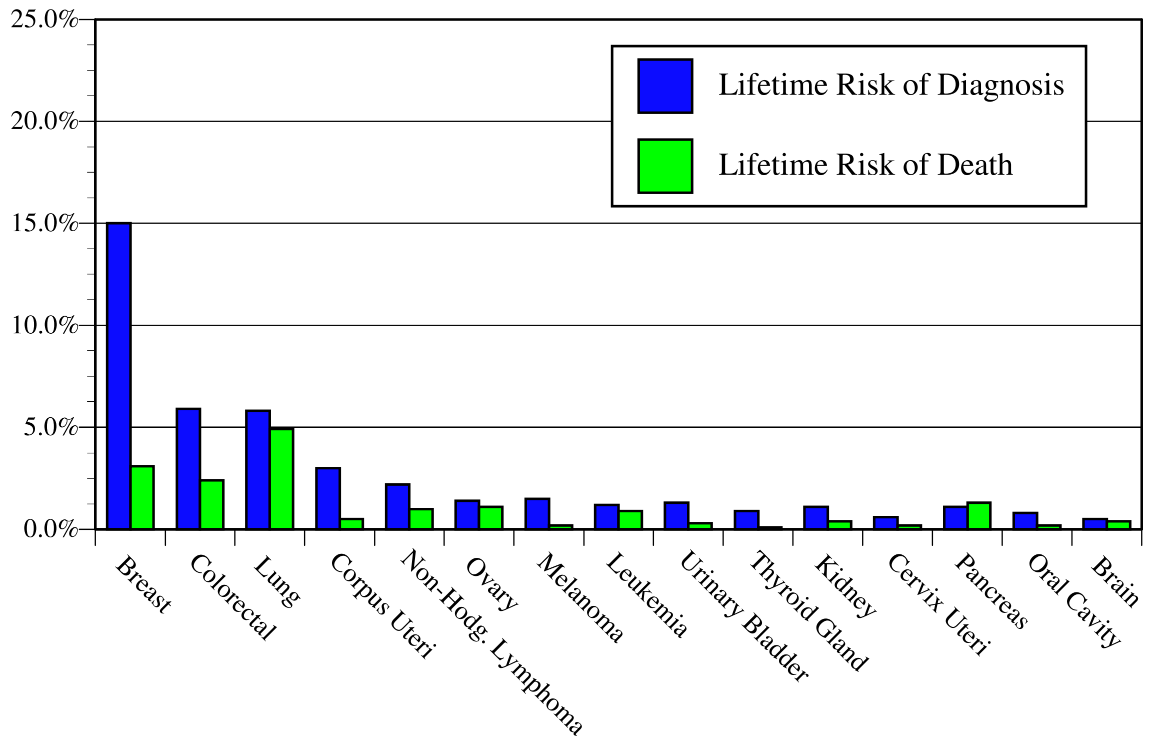
Rates not determined for eight zip codes with a total of 0 cases and 4.68 expected cases

Figure 21. Average Lifetime Risks (%) of Cancer Diagnosis or Cancer Death, by Gender, All Minnesota, 2000-2002*.

A. Males



B. Females



**Data taken from the 2005 MCSS report "Cancer in Minnesota 1988-2002."*

APPENDIX

Information Resources on the Rates, Causes, and Prevention of Cancer

Minnesota Department of Health

Chronic Disease and Environmental Epidemiology
Phone: 651-201-5900
http://www.health.state.mn.us/divs/hpcd/cdee/

Minnesota Cancer Surveillance System
Phone: 651-201-5900
Email: mcss@health.state.mn.us
http://www.health.state.mn.us/divs/hpcd/cdee/mcss/index.html

Cancer Control (information on SAGE breast and cervical cancer screening programs)
Phone: 651-201-5600
Email: cc@health.state.mn.us
http://www.health.state.mn.us/divs/hpcd/ccs/ccmain.htm

The National Cancer Institute
1-800-4-CANCER (1-800-422-6237)

Home Page
http://www.cancer.gov/

What You Need to Know About Cancer: An Overview
http://www.cancer.gov/cancerinfo/wyntk/overview

Cancer and the Environment: What You Need to Know, What You Can Do
https://cissecure.nci.nih.gov/ncipubs/details.asp?pid=1202

American Cancer Society
1-800-ACS-2345

Home Page
http://www.cancer.org

Cancer Prevention
http://www.cancer.org/docroot/PED/ped_1.asp?sitearea=PED&level=1

Cancer Clusters
http://www.cancer.org/docroot/PED/content/PED_1_3x_Cancer_Clusters.asp?sitearea=PED

U.S. Centers for Disease Control and Prevention (CDC)

Home Page
http://www.cdc.gov/

Environmental Health
http://www.cdc.gov/Environmental/

National Report on Human Exposure to Environmental Chemicals – Perfluorinated Compounds
http://www.cdc.gov/exposurereport/perfluorinated_compounds.htm

Cancer Clusters
http://www.cdc.gov/nceh/clusters/

Harvard School of Public Health – Harvard Center for Cancer Prevention

Cancer Risk Factors
http://www.hsph.harvard.edu/cancer/risk/index.htm

Harvard Reports on Cancer Prevention
http://www.hsph.harvard.edu/cancer/resources_materials/reports/index.htm