**CANCER INCIDENCE STUDY**

# Red Butte Creek Oil Spill
# Five-Year Update Cancer Incidence Statistical Review
# Covering the Period from 1983 to 2012

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Prepared by the

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Division of Disease Control and Prevention
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## EXECUTIVE SUMMARY

Cancer is a dominating environmental public health concern. A function of the Utah Department of Health (UDOH) Environmental Epidemiology Program (EEP) is to investigate cancer incidence, starting with a statistical review of cancer cases. In 2010, the Salt Lake County Health Department (SLCoHD) requested that the EEP evaluate potential acute and chronic health effects from the crude oil spill in Red Butte Creek, including cancer. That report was released on September 28, 2011, and recommended a five-year update to that initial cancer incidence statistical review. Following that recommendation, SLCoHD requested the EEP carry out this five-year cancer incidence update.

This report presents a statistical review of cancer incidence among residents of the census block groups bordering Red Butte Creek in Salt Lake City, Utah. The EEP conducted this review by comparing the cancer incidence of six sequential five-year time periods (1983 to 2012) for 42 anatomical site-specific cancer categories to expected counts derived from the state age-adjusted cancer rate for the corresponding site and time period.

The EEP considers the incidence of cancer to be meaningfully elevated when two or more sequential time periods have statistically elevated cancer rates, or when the final analytical period has a statistically elevated cancer rate. Only ovarian cancer had a meaningfully elevated rate, as it was significantly elevated during the last (2008 – 2012) analytical period. Exposure to crude oil or its components is not a known risk factor for ovarian cancer. The epidemiology and known risk factors for ovarian cancer are discussed.

Early detection and intervention of cancer can dramatically improve the prognosis for recovery and quality of life. Because some cancer types have many year latency periods following a triggering environmental exposure, the EEP recommends that SLCoHD request another follow-up cancer statistical review after an additional five years of cancer data (2013 to 2017) becomes available. Further, the EEP recommends that SLCoHD work with the Utah Cancer Control Program for screening and health education services that are available to the study area communities.

# INTRODUCTION

**Cancer Incidence Statistical Reviews:** A core function of epidemiology is to track and evaluate disease patterns. This helps public health officials and policy makers identify and assess communities with public health challenges, define public health priorities, monitor and evaluate public health actions, and recognize public health concerns (Dicker, 2002; Stanbury et al., 2012; Thacker, 2000; Thacker et al., 2012). Cancer is a dominating environmental public health concern. Public fear of cancer resulting from environmental hazards is reinforced by U.S. environmental regulatory actions that use cancer as a mechanism for making regulatory decisions (Morrone, 2011). Public concerns about excess cancer risk often result in requests made to public health agencies to conduct investigations.

Public health agencies conduct investigations of cancer incidence using several different methods. The first is a cancer incidence statistical review. This approach focuses on determining if a particular community is experiencing more cancer than would be expected. A cancer statistical review is usually conducted by linking cancer registry data to population data and evaluating trends. From a public health perspective, a cancer incidence statistical review is most useful in identifying community needs about cancer-related health education, awareness building, public health screening services, and other public health interventions. For the community, these kinds of studies empower the residents to make improvements in governmental policymaking and health care services (Bell et al., 2006; Kingsley et al., 2007).

Another method available to public health practitioners is a cancer cluster investigation. This method focuses on characterizing the size and extent of a population with known cancer excess and determining potential causal factors. The cancer cluster methodology involves linking many causal variables, usually collected by medical record review and individual surveys or interviews. In situations like the one addressed in this report, an extensive exposure assessment would also be important. Data about individual risks are then processed through complex statistical analysis to identify variables that seem to explain the risk (Kingsley et al., 2007). However, cluster investigations rarely result in important discoveries of causality (Goodman et al., 2012; Kingsley et al., 2007).

**Site History:** On Saturday, June 12, 2010, a high-voltage electrical arc from an above ground power line followed a fence pole into the ground and to a Chevron crude oil transfer pipeline, creating a one-half inch diameter hole. An estimated 33,600 gallons of crude oil spilled into Red Butte Creek in Salt Lake City, Utah, before the leak was detected and the pipeline shut down on Saturday, June 12. The crude oil traveled down Red Butte Creek and collected in Liberty Park Pond, with some sheen escaping downstream into the Jordan River. Red Butte Creek travels through residential, business, and Veteran's Administration properties in Salt Lake City, many of which were impacted by the spill (see **Figure 1**) (UDOH, 2011).

Although remediation of the spilled oil and restoration of the creek has occurred, many area residents remained concerned about acute and chronic health effects resulting from exposure to crude oil. Their concerns include exposures to contaminants in the water as well as volatile organic compounds (VOCs) in the air during and after the spill. Residents voiced their concerns with the Salt Lake County Health Department (SLCoHD), who in turn requested that the

Environmental Epidemiology Program (EEP), within the Utah Department of Health (UDOH), evaluate potential acute and chronic health effects, including cancer. On September 28, 2011, the EEP released a public health assessment (PHA) addressing potential health effects from exposure to crude oil contaminants in water and air. As part of the assessment process, the EEP conducted a review of the cancer incidence of the area. The study examined only those cancer types that have been linked in the literature to exposure to components of crude oil (melanoma, pharyngeal cancer, laryngeal cancer, esophageal cancer, stomach cancer, lung cancer, multiple myeloma, Hodgkin lymphoma, non-Hodgkin lymphoma, and both acute and chronic lymphoblastic and myelogenous leukemias). The aim was to provide baseline cancer rates for comparison with future studies, and the PHA recommended that cancer incidence be reevaluated in five years as additional data becomes available. The five-year anniversary of the oil spill was on June 12, 2015, and SLCoHD contacted the EEP in May 2015 to inquire about this five-year update.

**Study Objectives:** This report presents a statistical review of cancer incidence among residents of the neighborhoods bordering Red Butte Creek in Salt Lake City, Utah. The EEP conducted this statistical review by analyzing periodic rates and trends in cancer incidence within the study area, compared to corresponding rates in the state of Utah. The objective of a statistical review is to identify significantly elevated cancer incidence rates. The statistical review methodology does not quantify the linkage of cancer rates to possible causal risk factors, and specific hazardous chemicals of concern and exposure risk are not addressed by this report.

## DATA AND METHODS

**Study Design:** This investigation is a retrospective (i.e., looking backwards in time) statistical review of cancer incidence among residents of the study area (defined below). Statistical reviews are not cancer cluster investigations, and lack the power to link cancer incidence to putative risk factors (Jekel et al., 1996; Kingsley et al., 2007; Mann, 2003). Statistical reviews are a tool used by the EEP to review the health status of a population and assess public health activities.

The incidence of cancer, quantified in sequential analytical periods for each cancer category among residents of the study area, are compared to corresponding expected cancer incidence counts derived from the rates for the state of Utah. The study's null hypothesis is that the incidence of cancer in the study area is not significantly different from the expected incidence of cancer as determined by the corresponding rates for the state of Utah.

**Study Population:** The study population was defined as all residents living in the 2010 U.S. census block groups 1014.001 - 003, 1030.001, 1035.001 - 003, 1036.001 - 002, 1041.001 – 002, and 1042.003 (see **Figure 1**). These census block groups include the residential neighborhoods adjacent to Red Butte Creek from Liberty Park in the west to the foothills of the Wasatch Mountains in the east; this area includes the site of the pipeline break. The 2013 estimated study area population was 16,349 persons (for comparison, the population count gathered from the 2010 census was 16,751) (USCB, 2013a).

**Cancer Data**: Cancer incidence data on people diagnosed with primary invasive cancer between 1983 and 2012 were obtained from the Utah Cancer Registry (UCR). The EEP receives cancer

data for all invasive cancers on an annual basis. The UCR completes a rigorous data review for completeness and quality before data are released to the EEP. The most recent years of data are not made available to the EEP until they have been finalized. The UCR data includes diagnostic information, patient demographics, and residential addresses of the cases, as well as information about the behavior of the cancer. The residential address information provided by the UCR includes the city and ZIP code (UCR, 2015). The EEP geocodes each cancer case's residential address data to obtain an x- and y-coordinate for that address. Using those coordinates, the EEP is able to geo-reference cancer case data to their respective U.S. 2010 census block groups (UEPHTN, 2015).

Individuals with multiple primary invasive cancers have multiple records in the data set in sequential order. These cancers are distinguished by unique cancer registry tracking numbers and a cancer sequence number. The sequence number allows discrimination between the first cancer diagnosis and subsequent diagnoses (UCR, 2015). Diagnostic coding of cancers includes the International Classification of Disease Oncology, 3rd Edition (ICD-O-3) codes for site, histology, and behavior (WHO, 2012). The UCR groups cancers into 42 major cancer types by site following the guidance provided by the National Cancer Institute's (NCI) Surveillance, Epidemiology, and End Results (SEER) Program (NCI, 2015a). These 42 UCR site codes are a convenient grouping for conducting surveillance analyses (UCR, 2015).

Certain kinds of medical treatment for cancer and other diseases, such as radiation therapy, increase an individual's risk for developing subsequent leukemia, particularly myeloid leukemia. This is also known as therapy-induced leukemia (Godley and Larson, 2008; Leone et al., 1999, 2011; Sill et al., 2011; Wilkins and Woodgate, 2008). Myeloid leukemia cases that were the first of any sequence of cancers for an individual were included for this investigation. Myeloid leukemia cases that were subsequent to a previous cancer and could be therapy-induced leukemia were excluded.

Thirty nine cancer cases located in the ZIP codes that cover the study area (84105, 84108, 84111, 84112, 84113, and 84132) were not geocodable to census block groups. An additional 2,284 cases were assigned to Salt Lake County but were not geocodable further, and nine cases had no location information aside from the State of Utah. While the precise geographic coordinates for these cases are unknown, a small portion of them likely occurred within the study area. Imputation was used to randomly assign a percentage of the unknown cases to the study area based on population weights. These weights were calculated by comparing the population of one of the above ZIP codes or Salt Lake County to the population of each study area census block group found within it. In total, 48 of the non-geocodable cases were assigned to the study area, while the remaining 2,284 were assigned to the comparison group (i.e., the rest of the state).

Statewide between 1983 and 2012, 189,827 invasive primary cancer incidence reports among 173,180 individuals were registered by UCR. Of those, 1,409 persons living in the study area experienced 1,527 incident cancers between 1983 and 2012 (this includes cases assigned to the study area by imputation).

**Population Data:** The 2010 U.S. census divides Utah into 1,690 census block groups with a median population of 1,445 people per block group (USCB, 2010). Commercially available U.S.

census population data for Utah for the 1970, 1980, 1990, 2000, and 2010 censuses (Geolytics, 2002a, 2002b, 2002c, 2012a, 2012b) were used to estimate annual age-group and sex population counts for each census block group in each intercensal year. These estimates were made by applying annual population growth rates derived from the previous and subsequent decennial data. This method follows national population estimation guidelines (USCB, 2013b).

**Analytical Periods:** Six five-year analytical time periods (1983-1987, 1988-1992, 1993-1997, 1998-2002, 2003-2007, and 2008-2012) were evaluated for trends in cancer incidence over time.

**Age Distribution Management**: Cancer cases and population data were aggregated into six age group strata: 0-19 years of age, 20-34 years of age, 35-49 years of age, 50-64 years of age, 65-74 years of age, and 75 years and older. For each study area census block group, the cancer incidences by cancer type and population count for each combination of age group, sex, and analytical period were calculated. These were added together to generate the age group, sex, and analytical period cancer incidence and population counts for the study population.

**Comparison Population**: The comparison population for this investigation was defined as the state population excluding the study population. Similar to the process of developing the study population, the cancer incidence by cancer type and population count for each age group, sex, and analytical period for all of the census block groups in the state not included in the study population were added together to generate the comparison population. The 2013 estimated population for the state was 2,813,673 (USCB, 2013a).

**Socioeconomic Assessment of the Study and Comparison Populations**: Social determinants of health are complex, integrated, and overlapping social structures and economic systems that are thought to profoundly affect disease morbidity and mortality (Merletti et al., 2011; Song et al., 2011; Ward et al., 2004). A prominent example is education level, where a better education leads to higher income and financial stability, which in turn leads to better health care access, leading to healthier lifestyles and to earlier detection and better treatment options for disease (Song et al. 2011). Of particular interest are the population age, race, and ethnicity distributions, as well as education level, employability, and financial stability (Merletti et al., 2011; Ward et al., 2004). Since 2000, the U.S. Census Bureau has used the American Community Survey (ACS) to sample a small percentage of the U.S. population each year to collect this kind of information. Data from the ACS 2009-2013 five-year estimates of population parameters were used to understand and compare selected demographic and economic characteristics that are important determinants of cancer-related health. These risk factors contribute to the burden of disease, but are not the risks of concern for this investigation (USCB, 2013a). Ideally, the social determinants of health for the study area should be similar to the comparison population. If the metrics between the two groups are disproportionate, they may confound the interpretation of the results. The characteristics of the study area were compared to those of Salt Lake County and the State of Utah (**Table 1**). For several important determinants, ACS data was not available at the census block group level; therefore, the ZIP codes that cover the study area (84105, 84108, 84111, 84112, and 84113) were used in these cases.

Compared to the rest of the state, more of the study area housing was built prior to 1960, which may indicate more risk associated with older homes and older home technologies. Reflecting its

**Table 1.** Social and economic determinants of health.

| Estimate | Study Area | Salt Lake County | State of Utah |
|---|---|---|---|
| 2013 estimated population | 16,349 | 1,048,314 | 2,813,673 |
| Percent of population that are children 0-19 years old | 29.5% | 31.5% | 34.3% |
| Percent of population that are adults 65 years or older | 9.0% | 9.0% | 9.2% |
| Percent of population that are of a minority race | 15.1% | 15.4% | 11.6% |
| Percent of population that are Hispanic or Latino | 5.6% | 17.2% | 13.1% |
| **Estimate** | **Study Area** | **Salt Lake County** | **State of Utah** |
| Percent of population born in Utah | 47.2% * | 60.2% | 62.2% |
| Percent of population born outside of the U.S. | 10.2% | 12.1% | 8.2% |
| Percent of population who are not U.S. citizens | 7.2% * | 7.9% | 5.4% |
| Percent of adults that completed high school | 95.0% | 89.0% | 90.9% |
| Percent of adults with a college degree (including 2-year) | 68.3% | 39.7% | 39.6% |
| Percent of population 16 years or older who are unemployed | 6.5% | 5.4% | 5.0% |
| Percent total population living in poverty | 16.3% * | 12.7% | 12.7% |
| Percent children 0-17 years old living in poverty | 15.7% * | 16.2% | 14.7% |
| Percent elderly adults 65 years or older living in poverty | 12.4% * | 7.2% | 6.5% |
| Percent of households moved in 2010 or later | 22.6% | 20.0% | 19.4% |
| Percent of households moved in 2000-2009 | 48.7% | 48.8% | 50.3% |
| Percent of households moved in 1999 or earlier | 28.7% | 31.1% | 30.3% |
| Percent of homes built before 1960 | 68.4% | 22.8% | 19.6% |
| Percent of homes that are single units | 64.1% | 71.9% | 74.8% |

* Data not available at the census block group level; the ZIP codes covering the study area were used (84105, 84108, 84111, 84112, and 84113)

more urban nature, more of the study area population was born outside of Utah, slightly fewer are U.S. citizens, and a substantially larger percentage has obtained a college degree compared to the remainder of the state. In general, the above health determinants may denote a variety of barriers to health care services and preventive health knowledge, including cultural, language, and legal obstacles. This statistical review does not control for these potential confounders.

**Behavioral Risk Factors**: Tobacco use, chronic alcohol use, and obesity are well-known risk factors for many types of cancer. The UDOH conducts annual telephone surveys in Utah known as the Behavioral Risk Factors Survey System (BRFSS). These data are made publicly available on the Indicator-Based Information System for Public Health (IBIS-PH) website tabulated using a small area geography known as a health statistical unit. The health statistical units are aggregations of one or more ZIP code areas based on specific criteria, including population size (at least 20,000 persons), political boundaries of cities and towns, and economic similarity. The study area is within two health statistical units: Foothill / University of Utah and Downtown Salt Lake City. The 2013 estimated population for these small areas was 75,767 persons. The BRFSS data were queried for these behavioral risks as well as access and utilization of health care. Except where indicated, data from 2009 through 2013 were used for the queries (UDOH, 2015).

Comparing the small areas covering the study population to the state as a whole, results are mixed when it comes to healthy behaviors (**Table 2**). The small areas population shows increased rates of smoking and chronic drinking. However, it is less likely to be overweight or obese, is more likely to get sufficient exercise, and is likely to have a better diet that includes enough fruits and vegetables. Access to health care appears to be similar between the two populations.

**Table 2**. Behavioral determinants of health.

| Estimate | Small Areas | State of Utah |
|---|---|---|
| Percent of population who smokes | 13.0% | 10.9% |
| Percent of population who are chronic drinkers of alcohol | 8.1% | 3.7% |
| Percent of population who are overweight or obese (BMI 25+) | 51.6% | 60.3% |
| Percent of population who do **not** participate in leisure time physical activities (sports, hobbies, etc.) | 13.3% | 19.5% |
| Percent of population who do **not** get the recommended level of aerobic physical activity (2011-2013) | 32.8% | 41.6% |
| Percent of population with insufficient fruit in diet (2011-2013) | 59.5% | 68.9% |
| Percent of population with insufficient vegetable in diet (2011-2013) | 75.7% | 82.5% |
| Percent of population who do not have health care insurance | 16.2% | 14.6% |
| Percent of population who have **not** had a medical checkup in the past 12 months | 44.2% | 42.1% |
| Percent of population who have **not** received dental care in the past 12 months (2010 & 2012) | 33.8% | 31.4% |
| Percent of population who are **not** able to get needed health care due to costs | 14.4% | 15.6% |

**Indirect Age-Standardized Incidence Rates**: The statistical analysis program SAS® version 9.3 was used to manage and analyze the data. The sex-specific and non-sex-specific indirect age-standardized incidence rate for each cancer type and analytical period was calculated using standard methods (Anderson and Rosenberg, 1998; Jekel et al., 1996; Selvin, 1996). This is the preferred method for analysis of disease with small case counts per analytical period. The expected incidence count and rate was computed by applying the comparison population incidence rate to the study area population for each analytical period using the indirect age-standardization method (see **Appendix D** for more information, including formulas).

**Standardized Incidence Ratio**: The standardized incidence count of cancer for the study area was evaluated against the expected incidence count in the form of standardized incidence ratio (SIR). An SIR greater than one (1.0) indicates that the incidence of cancer in the study area population is greater than the proportional cancer incidence in the comparison population for that period of analysis. Conversely, an SIR less than one indicates that the incidence of cancer in the study area population is less than expected based on the comparison population's rate. Statistical significance is determined by applying the Byar's 95% confidence interval for the SIR (Breslow

and Day, 1987; Rothman and Boice, 1979, 1982; Sahai and Khurshid, 1983, 1996). For statistical validity, SIRs and corresponding 95% confidence intervals were only calculated for time periods with three or more cases (Bender et al., 1990; Caldwell, 1990; Thun and Sinks, 2004). The EEP is required to protect confidential data from unlawful disclosure and therefore suppresses results for analytical time periods containing three or fewer cases (Langeberg et al., 2004).

An SIR for a specific cancer greater than one (1.0) and a confidence interval (expressed by the lower and upper limits) that does not include one (1.0) is considered to be statistically significant. Using a 95% confidence interval is a well-established standard for interpretation of an SIR with respect to statistical significance. Statistical significance focuses on minimizing false positive interpretations. A false positive occurs when the results appear to be elevated but in reality are simply due to random variation. It should be noted that an SIR may be statistically significant using this interpretation criteria, which may be a mathematical artifact and not biologically meaningful or relevant (Bender et al., 1990; Besag and Newell, 1991). When conducting multiple analyses using the 95% confidence interval to interpret data, one would expect approximately one in twenty (5%) of the analyses to have a statistically significant interpretation as a result of random chance. For this investigation, 660 independent analyses (34 cancer type categories x 3 sex groups x 6 analytical time periods and 8 sex-specific cancer types x 1 sex group x 6 analytical periods) were conducted. This means as many as 33 (660 x 5%) of the statistically significant analytical results could be due to chance.

The EEP uses interpretive rules to distinguish results that are meaningfully significant from those that are not. The EEP considers the results meaningful when there are two consecutive time periods with a statistically significant result, or if the last analytical period is statistically significant, as this could indicate an emerging cluster (Bender et al., 1990; Caldwell, 1990; Langeberg et al., 2004; Thun and Sinks, 2004).

**Analysis of Temporal Trend:** The Kendall Tau-b (or Kendall rank correlation coefficient) test for trend was used to test for temporal trends of increasing or decreasing cancer incidence rates (Kendall, 1938). The Kendal Tau-b statistic is an appropriate method to investigate trends when there are relatively few analytical periods. The Kendall Tau-b tests the correlation between the analytical period rate and the ordered numeric designation of the analytical periods (i.e., analytical period 1983 – 1987 is number 1, period 1988 – 1992 is number 2, etc.). The values of Tau-b range from -1 (a consistent decreasing trend) to +1 (a consistent increasing trend). Values near zero indicate no trend. Trend was indicated by statistically significant (p-value $\leq 0.05$) correlation coefficients (approximately equaled to $\pm 0.70$).

## FINDINGS

The analytical results for the study area for each of the 42 cancer types and analytical periods are presented in **Table 3**. Ten cancer types were found to be elevated during at least one analytical period: pancreatic cancer; laryngeal cancer; cutaneous melanoma skin cancer; other non-melanoma skin cancer; breast cancer; ovarian cancer; bladder cancer; Hodgkin lymphoma; myeloid leukemia; and other sites/types of cancer. The other sites/types category is a miscellaneous category for rare and ill-defined cancers that are not included in a different

category. The cancers included are mast cell tumors, histiocytes and accessory lymphoid cell tumors, immune-proliferative diseases, miscellaneous myeloproliferative and lympho-proliferative disorders, other cancers of the hematopoietic and reticuloendothelial systems, other cancers of the lymph nodes, cancers of unknown primary sites, and other and ill-defined sites (UCR, 2015).

**Statistically Significant Cancer Results:** Significantly elevated cancer incidence rates in the study area, as compared to the remainder of the state, are presented in **Table 3**. Comparisons for every cancer type / study period / sex combination are shown in **Appendix B, Table B1**; the significantly elevated rates found in **Table 3** are indicated with shading and bold text.

Among males, the rate of non-melanoma skin cancers was elevated during the 1988 – 1992 analytical period, the rate of laryngeal cancer was elevated during the 1998 – 2002 analytical period, and rates of both bladder cancer and myeloid leukemia were elevated during the 1993 – 1997 analytical period. These periods of elevated cancer incidence were all prior to the Red Butte Creek oil spill.

Among females, the first analytical period (1983 – 1987) showed an elevated rate of breast cancer, while the rates of pancreatic cancer, cutaneous melanoma, and other sites/types of cancer were elevated during the subsequent 1988 – 1992 analytical period. The myeloid leukemia rate was elevated in the middle of the study period (1998 – 2002), and ovarian cancer was elevated during the most recent analytical period (2008 – 2012). The analytical period with an elevated incidence of ovarian cancer is concurrent with the 2010 Red Butte Creek oil spill.

For both sexes combined, the rate of Hodgkin lymphoma was elevated in the 1983 – 1987 period, the rate of cutaneous melanoma was elevated during the next period (1988 – 1992), and the rates of bladder cancer and myeloid leukemia were elevated during the 1993 – 1997 analytical period. These periods were all prior to the oil spill.

**Meaningful Cancer Results**: Only ovarian cancer had an elevated incidence rate in the final analytical period (which covers when the oil spill occurred), which may represent an emerging cluster. None of the other 13 cancer type / analytical period / sex combinations described above had significantly elevated rates for two or more consecutive analytical periods or during the last analytical period, indicating that they are not likely to be temporal clusters.

**Trends:** Analysis of the changes in the rate of cancer incidence through time (i.e., a trend analysis) identified types of cancer with increasing or decreasing trends. Not all cancer types that are elevated during one or more analytical periods will present a significant trend. Not all cancer types with a significant trend will have significantly elevated cancer incidence rates. However, it is possible that cancer types with a significant trend of increasing incidence will eventually reach a time where the incidence is significantly elevated.

In this study, both significant increasing and decreasing trends in cancer incidence rates were found. Among males, significant decreasing trends were identified in the rates of cancers of the oral cavity and pharynx (Tau-b = -0.73; $p = 0.04$), stomach (Tau-b = -0.73; $p = 0.04$), and colon (Tau-b = -0.73; $p = 0.04$). The rate of cutaneous melanoma had a significant increasing trend

**Table 3:** Cancers with significantly elevated incidence rates in the study area between 1983 and 2012. *The total number of cases is 1,527. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.*

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 10 Pancreas | 1988-1992 | F | >3 | 14.54 | 2.63 | 1.06 - 5.43 |
| 12 Larynx | 1998-2002 | M | >3 | 10.81 | 4.85 | 1.31 - 12.43 |
| 17 Cutaneous melanoma | 1988-1992 | F | 12 | 26.19 | 2.29 | 1.18 - 3.99 |
| | | B | 18 | 20.68 | 1.73 | 1.02 - 2.73 |
| 18 Other non-melanoma skin cancers | 1988-1992 | M | >3 | 8.83 | 4.33 | 1.17 - 11.10 |
| 19 Breast | 1983-1987 | F | 52 | 110.18 | 1.50 | 1.12 - 1.96 |
| 22 Ovary | 2008-2012 | F | 9 | 23.08 | 2.31 | 1.06 - 4.39 |
| 27 Bladder | 1993-1997 | M | >3 | 31.20 | 3.14 | 1.62 - 5.49 |
| | | B | 13 | 16.53 | 2.53 | 1.34 - 4.32 |
| 35 Hodgkin lymphoma | 1983-1987 | B | 6 | 6.80 | 2.76 | 1.01 - 6.02 |
| 39 Myeloid leukemia | 1993-1997 | M | >3 | 17.62 | 4.35 | 1.74 - 8.97 |
| | | B | 7 | 8.53 | 2.57 | 1.03 - 5.30 |
| | 1998-2002 | F | >3 | 12.57 | 4.17 | 1.34 - 9.73 |
| 42 Other sites/types | 1988-1992 | F | >3 | 16.78 | 2.45 | 1.06 - 4.83 |

over the study period (Tau-b = 0.87; p = 0.02). In females, a significant increasing trend in the rate of thyroid cancer was identified (Tau-b = 0.87; p = 0.02). Thyroid cancer in Utah is known to have been increasing since 1996 (EEP, 2015 – in review). For both sexes combined, significant decreasing trends were found in the rates of stomach cancer (Tau-b = -0.87; p = 0.02) and cancer of the kidney and renal pelvis (Tau-b = -0.73; p = 0.04), while there were significant increasing trends in the rates of thyroid cancer (Tau-b = 0.87; p = 0.02) and cancer of the liver and interhepatic bile duct (Tau-b = 0.73; p = 0.04). None of the above cancer types with significant rate trends were found to be significantly elevated in the study area, although those with increasing trends may become so in the future.

# DISCUSSION

**Cancer:** There are a number of distinct cell types that make up the human body, including epithelial cells, connective tissue cells, muscle cells, nerve cells, and blood cells. Each of these types arises from stem cells or progenitor cells that divide and specialize (i.e., differentiate) to become different kinds of tissues, forming organs and organ systems. Rapid cellular division and differentiation occurs throughout fetal development and juvenile maturation. Once adulthood is achieved, cellular division and differentiation is essentially limited to replacement of damaged or dying cells. For example, the adult body replaces white blood cells every thirty days and red blood cells every four months. The process of cell division and differentiation is highly regulated, and when uncontrolled the process can lead to non-functional growths. These nonfunctional growths are called neoplasms, or more commonly cysts, polyps, or tumors. Most neoplasms are benign, meaning that they lack the ability to invade surrounding tissues or metastasize (spread to other parts of the body) and can usually be treated or removed. Neoplasms that are malignant, also known as cancers, have the ability to invade surrounding tissues or metastasize (King and Robins, 2006; Weinberg, 2006).

Cancer is a broad group of more than 100 diseases that involve uncontrollable cell replication and growth. Often these cells are undifferentiated, meaning they have lost their tissue-specific characteristics. As these cells grow to form tumor tissue, they invade nearby healthy tissue or spread through metastasis to other tissues. This disrupts the functions of the affected healthy tissues. Cancer cells may also produce metabolic products that can be transported to other parts of the body and result in adverse health effects (ACS, 2015a; Goodman and Samet, 2006). The American Cancer Society (ACS) estimates that nearly one in two men and over one in three women will develop cancer at some point in their life (ACS, 2014; NCI, 2014a). In the U.S., cancer is the second leading cause of death (CDC, 2015). Among all causes of death, approximately one in four men and one in five women will die of cancer (ACS, 2014; NCI, 2014b). On average, about one in nine people will develop two or more cancers in his or her lifetime (Wilkins and Woodgate, 2008).

Risk factors that contribute to the development of cancer include both inherent and external factors. Inherent factors include a variety of genetic susceptibilities. External factors include life choices and behaviors (e.g., tobacco use, alcohol use, poor diet, etc.), medical conditions and medications, oncogenic pathogens, and chemical or radiological environmental exposures. Cancer may often result from the interaction of several external factors coupled with an initiating triggering event (ACS, 2015; Goodman and Samet, 2006; NCI, 2015b).

**Cancer Sites:** The ACS and the NCI each post booklets on their websites specific to cancer by type or anatomical site (ACS, 2015a; NCI, 2015c). Links to the relevant websites are available in the References section of this document, and readers interested in more discussion are encouraged to explore these resources. This report will briefly describe what is known about risk factors for ovarian cancer, as this was the only type in the study area that had significant and meaningful results.

*Ovarian cancer:* Ovarian cancer is the leading cause of death from cancers of the female reproductive system, and is fifth overall in cancer deaths among women in the U.S. In 2015,

approximately 21, 290 women will receive a new diagnosis for ovarian cancer in the U.S., and about 14, 180 women will die from it (ACS, 2015b; NCI, 2015d; NCI, 2015e). The past 20 years have seen a slow decline in the rate of new ovarian cancer diagnoses (ACS, 2015b; NCI, 2015e). When diagnosed and treated while still localized, the five-year relative survival rate for ovarian cancer is 92.1%. Unfortunately, less than a third of cases are diagnosed this early, and the overall five-year survival rate is 45.6% (Hankinson and Danforth, 2006; NCI, 2015e).

Ovaries are made up of three main types of cells, each of which can develop into a different type of tumor. Epithelial cell tumors are the most common type of ovarian tumors and start from cells that cover the outer surface of the ovary. Germ cell tumors originate with the cells that produce the eggs. Stromal cell tumors start from cells of the structural and supporting tissue (the stroma) that hold the ovary together and produces the hormones estrogen and progesterone (ACS, 2015b).

Ovarian tumors are broadly classified as benign, of low malignant potential (also called borderline), or malignant. Borderline tumors are capable of metastasizing but do not invade the ovarian stroma. Approximately 85% to 90% of malignant ovarian tumors (or cancers) are epithelial in nature; these are more commonly known as epithelial ovarian carcinomas (ACS, 2015b). There are five main subtypes of epithelial ovarian carcinomas: serous (by far the most common), endometrioid, mucinous, clear cell, and undifferentiated (which is a miscellaneous category for cancers that don't look like the other subtypes) (ACS, 2015b; Hankinson and Danforth, 2006).

There are a number of risk factors that have been linked to ovarian cancer. Women who have inherited certain changes in cancer-associated genes, most prominently the BRCA1 and BRCA2 genes, have an increased risk of developing ovarian cancer. Relatedly, women with a personal history of breast cancer or a family history of ovarian cancer, breast cancer, or colorectal cancer may have a substantially increased risk (ACS, 2015b; Hankinson and Danforth, 2006; NCI, 2015d). Ovarian cancer risk is also increased in women with certain inherited syndromes, including familial site-specific ovarian cancer syndrome, familial breast/ovarian cancer syndrome, hereditary non-polyposis colorectal cancer (also known as Lynch syndrome), PTEN tumor hamartoma syndrome (also known as Cowden disease), Peutz-Jeghers syndrome, and MUTYH-associated polyposis (ACS, 2015b; NCI, 2015d). The use of estrogen-only hormone replacement therapy (HRT) after menopause has been linked to a slight increase in the risk ovarian cancer, which increases the longer a woman uses estrogen-only HRT. When the hormone therapy stops, the risk decreases over time. It is not clear if ovarian cancer risk increases with the use of HRT that has both estrogen and progesterone (ACS, 2015b; Hankinson and Danforth, 2006; NCI, 2015d). Obesity during the teenage years and gaining 40 or more pounds during adulthood is linked to an increased risk of ovarian cancer. As with most cancers, the risk of developing ovarian cancer increases with increasing age, and it is rare in women younger than 40 years (ACS, 2015b; Hankinson and Danforth, 2006; NCI, 2015d).

A number of factors have also proven to be protective for ovarian cancer. Oral contraceptives ("the pill") have been shown to lower the risk of ovarian cancer. The longer it is used, the lower the risk, and the decrease may last for many years even after use of the contraceptives is stopped (ACS, 2015b; Hankinson and Danforth, 2006; NCI, 2015d). Women who have had a full-term

pregnancy before age 26 have a lower risk of ovarian cancer, and the risk decreases with each full-term pregnancy. Breastfeeding has also been linked to a decreased risk of ovarian cancer, with the risk decreasing further the longer breastfeeding continues (ACS, 2015b; Hankinson and Danforth, 2006; NCI, 2015d). Tubal ligation (surgery to close both fallopian tubes) has been shown to decrease the risk of ovarian cancer, sometimes by up to two-thirds (ACS, 2015b; Hankinson and Danforth, 2006; NCI, 2015d).

It is not clear if the risk of ovarian cancer is affected by a number of factors, including some that have been definitively linked to other types of cancer. These include dietary factors (e.g., caffeine, antioxidants, fiber, etc.), smoking, alcohol, aspirin and other non-steroidal anti-inflammatory drugs (e.g., acetaminophen), use of talcum powder on the perineum, and infertility treatments (ACS, 2015b; Hankinson and Danforth, 2006; NCI, 2015d).

**Limitations:** The public often wants public health investigations to link cancer risk to a putative environmental concern. The methodology used in this investigation (i.e., calculation of indirectly standardized incidence ratios) does not have the capability to definitively link elevated cancer rates in the study population to any inherent or external risk factors, including environmental exposures (dos Santos Silva, 1999; Esteve et al., 1994; Jekel et al., 1996; Kingsley et al., 2007; Mann, 2003).

These kinds of cancer statistical reviews are based on annual incidence data reported to the Utah Cancer Registry. The incidence of cancer per year is dependent on the diagnoses of clinically manifested cancers, and there are a number of limitations that impede this linkage. There is seldom any knowledge about the frequency, duration, or intensity of exposure to potential environmental concerns in cancer victims. Cancer can also have a variable length latency period (period between exposure and the actual manifestation and diagnosis of cancer). Cancer can be present for a substantial amount of time before an individual seeks medical assistance that leads to diagnosis (Bray and Parkin, 2009; Izquierdo and Schoenbach, 2000; Parkin and Bray, 2009; Thoburn et al., 2007).

Cancer risk is thought to be the result of complex interactions between individual factors (e.g., genetics, behaviors, socio-economics, etc.) and environmental exposures (e.g., occupational exposures, domestic exposures, etc.). There is seldom sufficient information available to statistically control for the many non-environmental factors that contribute to cancer risk, or exposure to other potential environmental risks that are not the environmental concern in question (Chaix et al., 2010; Merlo et al., 2012; Peterson et al., 2006; Prentice and Thomas, 1993). For small populations, the incidence of cancer has a tendency to manifest in arbitrary clusters. This tendency is a common phenomenon encountered when investigating the rate of rare diseases in small populations. Often, a few types of cancer may be statistically elevated for disparate periods, but that conclusion may change if the analytical periods are changed (Greenland et al., 1986, 2000). Overcoming these limitations usually requires a comprehensive assessment of individual risk supported by a clear and consistent trend of elevated rates for a population.

This investigation used data from the UCR and U.S. Census. In Utah, the diagnosis of cancer for all site categories is reportable to the UCR. When a Utah resident seeks diagnosis, a report is

generated, and the UCR will follow-up to confirm information and collect additional factors about the case. This process occurs when cases are diagnosed in Utah, but may not occur if a case is diagnosed outside of Utah. The UCR may also contain records of incidence of cancer in persons who recently moved to the study area prior to their diagnosis. Alternatively, the UCR may lack records on individuals who lived for most of their life in the study area but moved elsewhere before seeking diagnosis and treatment. These situations create sampling biases. This investigation assumes that the sampling bias is non-systematic, meaning that the "move-in" and "move-out" situations balance each other. It is highly unlikely that this assumption is true in all cases, and can be a significant limitation when the study population is small.

The EEP uses U.S. Census data purchased from a commercial vendor, who has re-tabulated 1980, 1990, and 2010 data for the 2000 census block groups in Utah. Re-tabulation involves population distribution weighting based on census blocks that may not be consistent through time. The EEP estimates intercensal population counts using linear regression between the known census tabulations. This methodology does not account for short-term population growth dynamics (such as the zoning and development of a new subdivision), which can occur in just a few years.

This investigation used population-based summary data rather than individual-level data. An investigation of this type is termed an ecologic study. An interpretation error commonly associated with ecologic investigations is to apply population-level risk findings to individuals. This kind of interpretation error is called an "ecologic fallacy." For example, this study found the rate of ovarian cancer for the study population in the most recent analytical period to be 1.06 to 4.39 times higher than the rate for the rest of the state. This risk metric should not be applied to individuals, who may have no risk or a risk several times higher than the population risk based on the individual's genetic makeup, behaviors, exposure history, and susceptibility or resiliency to cancer (Greenland, 2001; Greenland and Robins, 1994; Izquierdo and Schoenbach, 2000; Morgenstern, 1982, 1995; Rockhill, 2005).

## CONCLUSIONS AND RECOMMENDATIONS

Ovarian cancer was the only cancer type with a significantly and meaningfully elevated incidence rate among the study population, with the rate during the final analytical period ranging from 1.06 to 4.39 times higher than expected, based on the rest of the state. It is also the only cancer type to be elevated during the analytical period that covers the Red Butte Creek oil spill, which occurred in 2010. The significantly elevated rate during the final period may indicate an emerging cluster. However, exposure to crude oil (and components thereof) is not one of the known risk factors for ovarian cancer, most of which are genetic or hormonal in nature.

Nine other cancer types (bladder cancer, breast cancer, cutaneous melanoma, Hodgkin lymphoma, laryngeal cancer, myeloid leukemia, non-melanoma skin cancer, pancreatic cancer, and other sites/types of cancer) were significantly elevated during at least one analytical period, but at a level that did not distinguish a cluster from random variation. Three cancer types (cutaneous melanoma, liver and interhepatic bile duct cancers, and thyroid cancers) had

significant, increasing trends in their incidence rates, indicating that the rates may become elevated in the future.

The EEP recommends that SLCoHD continue to request follow-up cancer statistical reviews in approximately five year periods as new cancer data becomes available. The next follow-up is recommended to include cancer data for the 2013 to 2017 time period. Because some cancer types have long latency periods after a triggering event, continued follow-up is warranted for several more iterations of this study. As with most cancers, early detection and early intervention can dramatically improve the prognosis for recovery and quality of life experience. The EEP recommends that SLCoHD work with the Utah Cancer Control Program for screening and health education services that could be made available to the study area communities. Residents are encouraged to be aware of cancer risk and to work with their health care provider for screening.

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## CERTIFICATION

This report titled "Red Butte Creek Oil Spill Five-Year Update Cancer Incidence Statistical Review Covering the Period from 1983 to 2012" was prepared by the Environmental Epidemiology Program, Utah Department of Health. This report covers an investigation of cancer incidence using standard and approved methodology and procedures existing at the time the investigation herein reported was begun. Editorial and technical review was completed by UDOH certifying reviewers and program partners.

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*Links for citations of online references may wrap onto multiple lines.*

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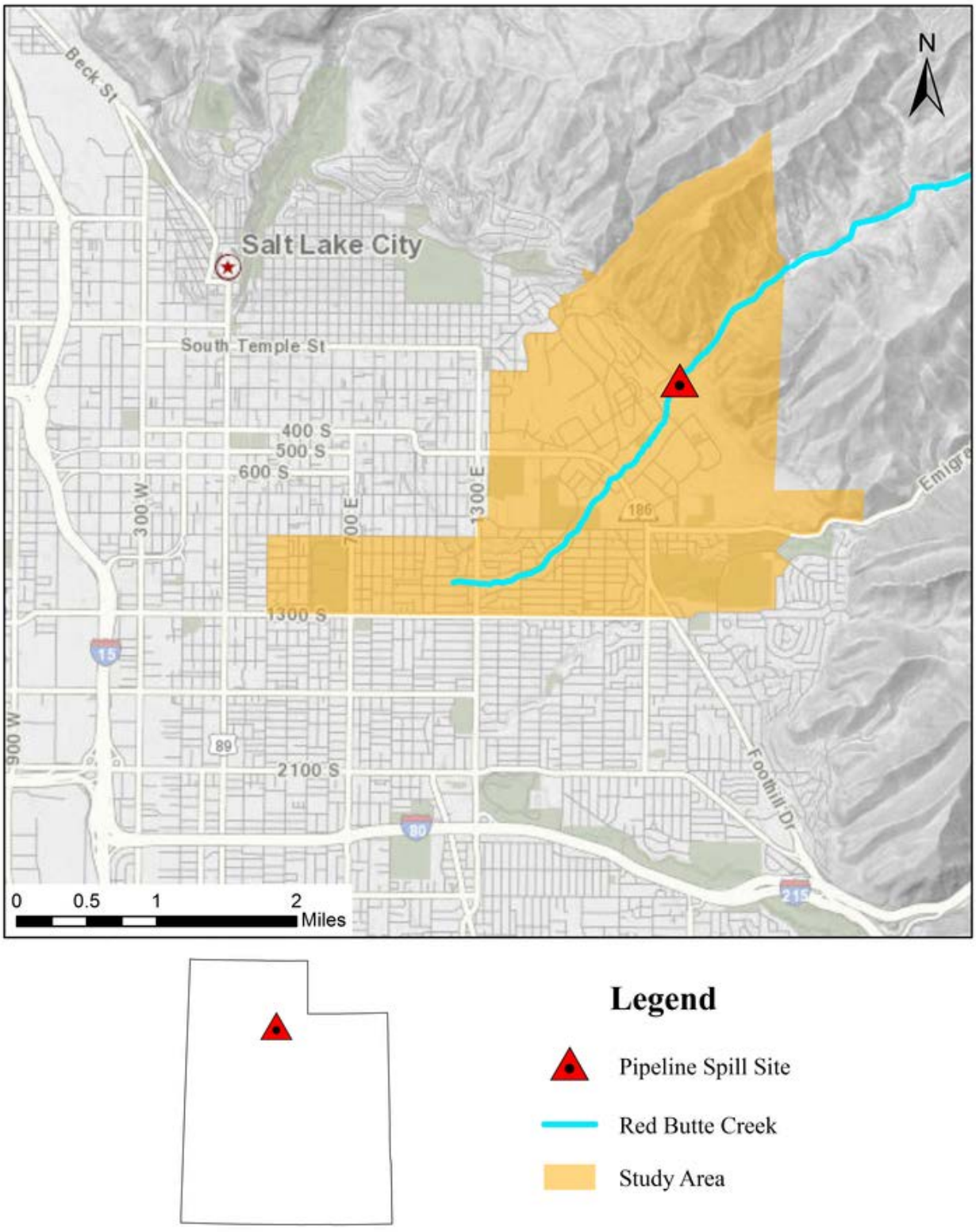
# APPENDICES

# APPENDIX A: FIGURES

**Figure 1:** Map of the study area for the cancer incidence investigation in Salt Lake City, Utah.




GIS data courtesy of the Utah Automated Geographic Reference Center (http://gis.utah.gov/)

# APPENDIX B: TABLES

**Table B1.** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 01 Oral cavity and pharynx | 1983-1987 | M | >3 | 16.40 | 1.33 | 0.53 - 2.74 |
| | | F | ≤3 | | | |
| | | B | 8 | 9.10 | 1.10 | 0.47 - 2.16 |
| | 1988-1992 | M | >3 | 12.86 | 1.40 | 0.45 - 3.27 |
| | | F | ≤3 | | | |
| | | B | 7 | 8.55 | 1.33 | 0.53 - 2.75 |
| | 1993-1997 | M | 4 | 10.22 | 1.10 | 0.30 - 2.83 |
| | | F | 5 | 11.84 | 2.96 | 0.95 - 6.90 |
| | | B | 9 | 11.22 | 1.69 | 0.77 - 3.22 |
| | 1998-2002 | M | >3 | 15.60 | 1.91 | 0.70 - 4.15 |
| | | F | ≤3 | | | |
| | | B | 7 | 9.02 | 1.44 | 0.58 - 2.96 |
| | 2003-2007 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | 5 | 6.41 | 1.04 | 0.34 - 2.43 |
| | 2008-2012 | M | ≤3 | | | |
| | | F | >3 | 10.41 | 2.41 | 0.65 - 6.16 |
| | | B | 7 | 8.74 | 1.29 | 0.52 - 2.65 |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | IRR | 95% CI |
|---|---|---|---|---|---|---|
| 02 Esophagus | 1983-1987 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1988-1992 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1993-1997 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1998-2002 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2003-2007 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2008-2012 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | IRR | 95% CI |
|---|---|---|---|---|---|---|
| 03 Stomach | 1983-1987 | M | >3 | 8.70 | 1.53 | 0.41 - 3.91 |
| | | F | ≤3 | | | |
| | | B | 7 | 7.24 | 1.58 | 0.63 - 3.25 |
| | 1988-1992 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | 5 | 5.83 | 1.34 | 0.43 - 3.13 |
| | 1993-1997 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | 4 | 4.97 | 1.33 | 0.36 - 3.41 |
| | 1998-2002 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2003-2007 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2008-2012 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | IRR | 95% CI |
|---|---|---|---|---|---|---|
| 04 Small intestine | 1983-1987 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1988-1992 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1993-1997 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1998-2002 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2003-2007 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2008-2012 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | IRR | 95% CI |
|---|---|---|---|---|---|---|
| 05 Colon | 1983-1987 | M | 14 | 29.85 | 1.44 | 0.79 - 2.41 |
| | | F | 12 | 22.66 | 1.13 | 0.58 - 1.98 |
| | | B | 26 | 26.06 | 1.28 | 0.83 - 1.87 |
| | 1988-1992 | M | 10 | 24.50 | 1.13 | 0.54 - 2.07 |
| | | F | 4 | 8.37 | 0.42 | 0.11 - 1.07 |
| | | B | 14 | 15.85 | 0.76 | 0.41 - 1.27 |
| | 1993-1997 | M | 8 | 20.84 | 1.03 | 0.44 - 2.02 |
| | | F | 10 | 23.39 | 1.21 | 0.58 - 2.22 |
| | | B | 18 | 22.21 | 1.12 | 0.66 - 1.77 |
| | 1998-2002 | M | 9 | 23.81 | 1.15 | 0.53 - 2.19 |
| | | F | 10 | 25.97 | 1.22 | 0.58 - 2.24 |
| | | B | 19 | 24.90 | 1.19 | 0.71 - 1.85 |
| | 2003-2007 | M | 8 | 20.96 | 0.97 | 0.42 - 1.90 |
| | | F | 10 | 27.19 | 1.37 | 0.66 - 2.52 |
| | | B | 18 | 24.00 | 1.16 | 0.68 - 1.83 |
| | 2008-2012 | M | 5 | 12.64 | 0.69 | 0.22 - 1.61 |
| | | F | 8 | 22.26 | 1.24 | 0.54 - 2.45 |
| | | B | 13 | 17.21 | 0.95 | 0.51 - 1.62 |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | IRR | 95% CI |
|---|---|---|---|---|---|---|
| 06 Rectum and recto-sigmoid junction | 1983-1987 | M | >3 | 11.37 | 1.16 | 0.37 - 2.70 |
| | | F | ≤3 | | | |
| | | B | 8 | 8.51 | 1.01 | 0.43 - 1.98 |
| | 1988-1992 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | >3 | 7.12 | 0.85 | 0.31 - 1.85 |
| | 1993-1997 | M | 5 | 13.19 | 1.55 | 0.50 - 3.62 |
| | | F | 4 | 9.43 | 1.27 | 0.34 - 3.25 |
| | | B | 9 | 11.25 | 1.41 | 0.64 - 2.68 |
| | 1998-2002 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2003-2007 | M | ≤3 | | | |
| | | F | >3 | 13.06 | 2.03 | 0.65 - 4.73 |
| | | B | 8 | 10.32 | 1.27 | 0.55 - 2.51 |
| | 2008-2012 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | 5 | 6.24 | 0.76 | 0.25 - 1.78 |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | IRR | 95% CI |
|---|---|---|---|---|---|---|
| 07 Anus, anal canal, and anorectum | 1983-1987 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1988-1992 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1993-1997 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1998-2002 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2003-2007 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2008-2012 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | IRR | 95% CI |
|---|---|---|---|---|---|---|
| 08 Liver and interhepatic bile duct | 1983-1987 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1988-1992 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1993-1997 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1998-2002 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2003-2007 | M | >3 | 10.17 | 2.55 | 0.68 - 6.52 |
| | | F | ≤3 | | | |
| | | B | >3 | 5.14 | 1.84 | 0.49 - 4.70 |
| | 2008-2012 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 09 Gallbladder and biliary bile ducts | 1983-1987 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1988-1992 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1993-1997 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1998-2002 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2003-2007 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2008-2012 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 10 Pancreas | 1983-1987 | M | >3 | 8.93 | 1.34 | 0.36 - 3.43 |
| | | F | ≤3 | | | |
| | | B | 7 | 7.15 | 1.22 | 0.49 - 2.52 |
| | 1988-1992 | M | ≤3 | | | |
| | | **F** | **>3** | **14.54** | **2.63** | **1.06 - 5.43** |
| | | B | 10 | 11.33 | 2.01 | 0.96 - 3.70 |
| | 1993-1997 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | 4 | 4.96 | 0.92 | 0.25 - 2.36 |
| | 1998-2002 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | >3 | 7.90 | 1.25 | 0.46 - 2.72 |
| | 2003-2007 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2008-2012 | M | >3 | 20.57 | 2.24 | 0.97 - 4.42 |
| | | F | ≤3 | | | |
| | | B | 9 | 12.02 | 1.40 | 0.64 - 2.66 |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 11 Other digestive system | 1983-1987 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1988-1992 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1993-1997 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1998-2002 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2003-2007 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2008-2012 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 12 Larynx | 1983-1987 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1988-1992 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1993-1997 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1998-2002 | **M** | **>3** | **10.81** | **4.85** | **1.31 - 12.43** |
| | | F | ≤3 | | | |
| | | B | >3 | 5.36 | 3.69 | 0.99 - 9.46 |
| | 2003-2007 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2008-2012 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 13 Lung and bronchus | 1983-1987 | M | 14 | 32.61 | 1.07 | 0.59 - 1.80 |
| | | F | 6 | 12.70 | 0.98 | 0.36 - 2.13 |
| | | B | 20 | 22.55 | 1.04 | 0.64 - 1.61 |
| | 1988-1992 | M | 10 | 26.03 | 0.93 | 0.45 - 1.71 |
| | | F | 8 | 18.50 | 1.35 | 0.58 - 2.66 |
| | | B | 18 | 22.46 | 1.08 | 0.64 - 1.71 |
| | 1993-1997 | M | 8 | 21.27 | 0.77 | 0.33 - 1.52 |
| | | F | 12 | 29.33 | 1.78 | 0.92 - 3.11 |
| | | B | 20 | 25.74 | 1.17 | 0.71 - 1.81 |
| | 1998-2002 | M | 12 | 32.59 | 1.21 | 0.62 - 2.11 |
| | | F | 5 | 13.21 | 0.79 | 0.25 - 1.85 |
| | | B | 17 | 22.85 | 1.05 | 0.61 - 1.68 |
| | 2003-2007 | M | 9 | 23.91 | 0.94 | 0.43 - 1.79 |
| | | F | 11 | 29.56 | 1.58 | 0.79 - 2.83 |
| | | B | 20 | 26.72 | 1.21 | 0.74 - 1.87 |
| | 2008-2012 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | >3 | 7.97 | 0.35 | 0.13 - 0.77 |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 14 Other respiratory system | 1983-1987 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1988-1992 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1993-1997 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1998-2002 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2003-2007 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2008-2012 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 15 Bones and joints | 1983-1987 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1988-1992 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1993-1997 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1998-2002 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2003-2007 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2008-2012 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 16 Soft tissue (including heart) | 1983-1987 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1988-1992 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1993-1997 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1998-2002 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2003-2007 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2008-2012 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 17 Cutaneous melanoma | 1983-1987 | M | 6 | 14.16 | 1.23 | 0.45 - 2.67 |
| | | F | 7 | 15.26 | 1.35 | 0.54 - 2.78 |
| | | B | 13 | 14.74 | 1.29 | 0.69 - 2.21 |
| | 1988-1992 | M | 6 | 14.49 | 1.16 | 0.42 - 2.52 |
| | | **F** | **12** | **26.19** | **2.29** | **1.18 - 3.99** |
| | | **B** | **18** | **20.68** | **1.73** | **1.02 - 2.73** |
| | 1993-1997 | M | 10 | 24.94 | 1.60 | 0.76 - 2.94 |
| | | F | 6 | 13.59 | 1.18 | 0.43 - 2.56 |
| | | B | 16 | 19.13 | 1.41 | 0.80 - 2.29 |
| | 1998-2002 | M | 6 | 15.03 | 0.82 | 0.30 - 1.80 |
| | | F | 7 | 16.68 | 1.14 | 0.46 - 2.34 |
| | | B | 13 | 15.92 | 0.97 | 0.51 - 1.65 |
| | 2003-2007 | M | 10 | 25.03 | 0.97 | 0.46 - 1.78 |
| | | F | 7 | 16.77 | 0.91 | 0.36 - 1.87 |
| | | B | 17 | 20.90 | 0.94 | 0.55 - 1.51 |
| | 2008-2012 | M | 16 | 39.45 | 1.20 | 0.68 - 1.95 |
| | | F | 6 | 14.74 | 0.69 | 0.25 - 1.49 |
| | | B | 22 | 27.11 | 1.00 | 0.62 - 1.51 |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 18 Other non-melanoma skin cancers | 1983-1987 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1988-1992 | **M** | **>3** | **8.83** | **4.33** | **1.17 - 11.1** |
| | | F | ≤3 | | | |
| | | B | >3 | 4.41 | 2.77 | 0.75 - 7.09 |
| | 1993-1997 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1998-2002 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2003-2007 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2008-2012 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 19 Breast | **1983-1987** | **F** | **52** | **110.18** | **1.50** | **1.12 - 1.96** |
| | 1988-1992 | F | 41 | 92.51 | 1.18 | 0.84 - 1.60 |
| | 1993-1997 | F | 41 | 98.45 | 1.16 | 0.84 - 1.58 |
| | 1998-2002 | F | 33 | 83.82 | 0.90 | 0.62 - 1.26 |
| | 2003-2007 | F | 41 | 105.66 | 1.18 | 0.85 - 1.60 |
| | 2008-2012 | F | 35 | 90.18 | 0.93 | 0.65 - 1.29 |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 20 Cervix | 1983-1987 | F | ≤3 | | | |
| | 1988-1992 | F | 4 | 8.67 | 1.14 | 0.31 - 2.93 |
| | 1993-1997 | F | ≤3 | | | |
| | 1998-2002 | F | ≤3 | | | |
| | 2003-2007 | F | ≤3 | | | |
| | 2008-2012 | F | ≤3 | | | |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 21 Uterus | 1983-1987 | F | 10 | 21.24 | 1.20 | 0.57 - 2.21 |
| | 1988-1992 | F | 9 | 21.37 | 1.15 | 0.52 - 2.18 |
| | 1993-1997 | F | 10 | 24.25 | 1.36 | 0.65 - 2.49 |
| | 1998-2002 | F | ≤3 | | | |
| | 2003-2007 | F | 8 | 20.57 | 1.12 | 0.48 - 2.21 |
| | 2008-2012 | F | 10 | 25.25 | 1.14 | 0.55 - 2.10 |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 22 Ovary | 1983-1987 | F | 6 | 12.97 | 1.14 | 0.42 - 2.49 |
| | 1988-1992 | F | 6 | 13.62 | 1.32 | 0.48 - 2.88 |
| | 1993-1997 | F | ≤3 | | | |
| | 1998-2002 | F | 5 | 12.67 | 1.16 | 0.37 - 2.71 |
| | 2003-2007 | F | 5 | 12.93 | 1.32 | 0.42 - 3.07 |
| | 2008-2012 | **F** | **9** | **23.08** | **2.31** | **1.06 - 4.39** |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 23 Other female genital | 1983-1987 | F | ≤3 | | | |
| | 1988-1992 | F | ≤3 | | | |
| | 1993-1997 | F | ≤3 | | | |
| | 1998-2002 | F | ≤3 | | | |
| | 2003-2007 | F | ≤3 | | | |
| | 2008-2012 | F | ≤3 | | | |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 24 Prostate | 1983-1987 | M | 43 | 90.71 | 1.21 | 0.88 - 1.63 |
| | 1988-1992 | M | 45 | 113.68 | 0.99 | 0.72 - 1.33 |
| | 1993-1997 | M | 54 | 147.16 | 1.30 | 0.98 - 1.70 |
| | 1998-2002 | M | 43 | 119.07 | 1.02 | 0.74 - 1.38 |
| | 2003-2007 | M | 54 | 143.95 | 1.13 | 0.85 - 1.48 |
| | 2008-2012 | M | 42 | 106.79 | 0.89 | 0.64 - 1.20 |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 25 Testis | 1983-1987 | M | 4 | 8.53 | 1.78 | 0.48 - 4.55 |
| | 1988-1992 | M | ≤3 | | | |
| | 1993-1997 | M | ≤3 | | | |
| | 1998-2002 | M | ≤3 | | | |
| | 2003-2007 | M | ≤3 | | | |
| | 2008-2012 | M | 4 | 8.58 | 1.23 | 0.33 - 3.14 |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 26 Other male genital | 1983-1987 | M | ≤3 | | | |
| | 1988-1992 | M | ≤3 | | | |
| | 1993-1997 | M | ≤3 | | | |
| | 1998-2002 | M | ≤3 | | | |
| | 2003-2007 | M | ≤3 | | | |
| | 2008-2012 | M | ≤3 | | | |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 27 Bladder | 1983-1987 | M | >3 | 11.16 | 0.94 | 0.30 - 2.20 |
| | | F | ≤3 | | | |
| | | B | 8 | 8.55 | 1.17 | 0.50 - 2.31 |
| | 1988-1992 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | >3 | 7.09 | 1.05 | 0.38 - 2.29 |
| | 1993-1997 | **M** | **>3** | **31.20** | **3.14** | **1.62 - 5.49** |
| | | F | ≤3 | | | |
| | | **B** | **13** | **16.53** | **2.53** | **1.34 - 4.32** |
| | 1998-2002 | M | >3 | 15.91 | 1.54 | 0.56 - 3.36 |
| | | F | ≤3 | | | |
| | | B | >3 | 7.94 | 1.17 | 0.43 - 2.55 |
| | 2003-2007 | M | >3 | 15.98 | 1.60 | 0.59 - 3.49 |
| | | F | ≤3 | | | |
| | | B | 7 | 9.46 | 1.52 | 0.61 - 3.14 |
| | 2008-2012 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | 4 | 5.49 | 0.82 | 0.22 - 2.10 |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 28 Kidney and renal pelvis | 1983-1987 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | 5 | 5.45 | 1.16 | 0.37 - 2.71 |
| | 1988-1992 | M | >3 | 15.49 | 2.22 | 0.81 - 4.83 |
| | | F | ≤3 | | | |
| | | B | >3 | 7.45 | 1.38 | 0.50 - 3.01 |
| | 1993-1997 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | 4 | 5.08 | 0.95 | 0.26 - 2.44 |
| | 1998-2002 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | 4 | 5.27 | 0.73 | 0.20 - 1.87 |
| | 2003-2007 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2008-2012 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 29 Other urinary | 1983-1987 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1988-1992 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1993-1997 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1998-2002 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2003-2007 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2008-2012 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 30 Eye and orbit | 1983-1987 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1988-1992 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1993-1997 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1998-2002 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2003-2007 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2008-2012 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 31 Brain | 1983-1987 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | 4 | 4.70 | 0.93 | 0.25 - 2.39 |
| | 1988-1992 | M | ≤3 | | | |
| | | F | >3 | 11.67 | 2.33 | 0.75 - 5.44 |
| | | B | 6 | 7.30 | 1.33 | 0.48 - 2.89 |
| | 1993-1997 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1998-2002 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2003-2007 | M | ≤3 | | | |
| | | F | >3 | 10.09 | 1.93 | 0.52 - 4.95 |
| | | B | 6 | 7.62 | 1.29 | 0.47 - 2.82 |
| | 2008-2012 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 32 Other central nervous system | 1983-1987 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1988-1992 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1993-1997 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1998-2002 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2003-2007 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2008-2012 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 33 Thyroid | 1983-1987 | M | ≤3 | | | |
| | | F | >3 | 8.72 | 1.28 | 0.35 - 3.28 |
| | | B | >3 | 5.53 | 1.25 | 0.40 - 2.91 |
| | 1988-1992 | M | ≤3 | | | |
| | | F | >3 | 13.14 | 1.71 | 0.63 - 3.73 |
| | | B | 6 | 6.65 | 1.28 | 0.47 - 2.78 |
| | 1993-1997 | M | ≤3 | | | |
| | | F | >3 | 11.16 | 1.29 | 0.42 - 3.01 |
| | | B | >3 | 5.71 | 0.98 | 0.31 - 2.28 |
| | 1998-2002 | M | ≤3 | | | |
| | | F | >3 | 13.45 | 1.08 | 0.39 - 2.35 |
| | | B | 6 | 6.85 | 0.85 | 0.31 - 1.85 |
| | 2003-2007 | M | ≤3 | | | |
| | | F | >3 | 18.33 | 1.03 | 0.44 - 2.03 |
| | | B | 9 | 10.37 | 0.90 | 0.41 - 1.70 |
| | 2008-2012 | M | 4 | 9.21 | 1.23 | 0.33 - 3.14 |
| | | F | 8 | 18.47 | 0.73 | 0.32 - 1.44 |
| | | B | 12 | 13.81 | 0.85 | 0.44 - 1.48 |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 34 Other endocrine | 1983-1987 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1988-1992 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1993-1997 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1998-2002 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2003-2007 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2008-2012 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 35 Hodgkin lymphoma | 1983-1987 | M | >3 | 9.33 | 3.33 | 0.90 - 8.53 |
| | | F | ≤3 | | | |
| | | B | 6 | 6.80 | 2.76 | 1.01 - 6.02 |
| | 1988-1992 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | 4 | 4.66 | 2.35 | 0.63 - 6.02 |
| | 1993-1997 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1998-2002 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2003-2007 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2008-2012 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | 4 | 4.69 | 1.82 | 0.49 - 4.66 |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 36 Non-Hodgkin lymphoma | 1983-1987 | M | ≤3 | | | |
| | | F | >3 | 11.93 | 1.48 | 0.54 - 3.23 |
| | | B | 9 | 9.60 | 1.06 | 0.48 - 2.01 |
| | 1988-1992 | M | 6 | 14.93 | 1.25 | 0.46 - 2.72 |
| | | F | 5 | 10.94 | 1.06 | 0.34 - 2.48 |
| | | B | 11 | 12.87 | 1.16 | 0.58 - 2.07 |
| | 1993-1997 | M | 9 | 22.85 | 1.61 | 0.73 - 3.05 |
| | | F | 6 | 14.31 | 1.31 | 0.48 - 2.85 |
| | | B | 15 | 18.52 | 1.47 | 0.82 - 2.43 |
| | 1998-2002 | M | 7 | 18.32 | 1.16 | 0.46 - 2.39 |
| | | F | 8 | 20.43 | 1.73 | 0.75 - 3.41 |
| | | B | 15 | 19.43 | 1.41 | 0.79 - 2.32 |
| | 2003-2007 | M | 4 | 10.24 | 0.60 | 0.16 - 1.55 |
| | | F | 5 | 13.20 | 0.97 | 0.31 - 2.28 |
| | | B | 9 | 11.68 | 0.77 | 0.35 - 1.45 |
| | 2008-2012 | M | >3 | 10.09 | 0.57 | 0.15 - 1.46 |
| | | F | ≤3 | | | |
| | | B | 7 | 9.09 | 0.59 | 0.24 - 1.22 |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 37 Multiple myeloma | 1983-1987 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1988-1992 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | >3 | 5.80 | 1.77 | 0.57 - 4.13 |
| | 1993-1997 | M | ≤3 | | | |
| | | F | >3 | 9.61 | 3.57 | 0.96 - 9.15 |
| | | B | >3 | 6.37 | 1.80 | 0.58 - 4.20 |
| | 1998-2002 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2003-2007 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2008-2012 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 38 Lymphocytic leukemia | 1983-1987 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | >3 | 7.00 | 1.52 | 0.56 - 3.31 |
| | 1988-1992 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | 4 | 4.97 | 1.13 | 0.30 - 2.90 |
| | 1993-1997 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1998-2002 | M | >3 | 10.95 | 1.84 | 0.49 - 4.70 |
| | | F | ≤3 | | | |
| | | B | 7 | 9.57 | 1.96 | 0.78 - 4.03 |
| | 2003-2007 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | >3 | 6.88 | 1.17 | 0.38 - 2.73 |
| | 2008-2012 | M | >3 | 13.18 | 1.89 | 0.61 - 4.40 |
| | | F | ≤3 | | | |
| | | B | 6 | 8.23 | 1.49 | 0.54 - 3.23 |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 39 Myeloid leukemia | 1983-1987 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1988-1992 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1993-1997 | **M** | **>3** | **17.62** | **4.35** | **1.74 - 8.97** |
| | | F | ≤3 | | | |
| | | **B** | **7** | **8.53** | **2.57** | **1.03 - 5.30** |
| | 1998-2002 | M | ≤3 | | | |
| | | **F** | **>3** | **12.57** | **4.17** | **1.34 - 9.73** |
| | | B | >3 | 6.32 | 1.78 | 0.57 - 4.15 |
| | 2003-2007 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2008-2012 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 40 Monocytic leukemia | 1983-1987 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1988-1992 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1993-1997 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1998-2002 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2003-2007 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2008-2012 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 41 Other leukemia | 1983-1987 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1988-1992 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1993-1997 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 1998-2002 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2003-2007 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2008-2012 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |

**Table B1 (continued).** Analysis of the incidence of primary cancer diagnoses among study area residents between 1983 and 2012 reported to the Utah Cancer Registry by site code. The total number of cases is 1,527. Case counts with '≤3' indicate a stratum with three or fewer cases, resulting in suppression of the results. Case counts with '>3' means the case count was large enough to evaluate, but was suppressed to protect confidential data. Rates are indirect age-standardized incidence rates per 100,000 person-years. The SIRs are the standardized incidence ratios (SIR) with Byar's 95% confidence intervals (CI). Statistical significance is indicated by shading and bold text. Sex codes are "M" for male, "F" for female, and "B" for both.

| Cancer Site | Analytical Period | Sex | Study Area Cases | Rate | SIR | 95% CI |
|---|---|---|---|---|---|---|
| 42 Other sites/types | 1983-1987 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | >3 | 4.96 | 0.80 | 0.26 - 1.86 |
| | 1988-1992 | M | ≤3 | | | |
| | | **F** | **>3** | **16.78** | **2.45** | **1.06 - 4.83** |
| | | B | 10 | 11.36 | 1.68 | 0.81 - 3.10 |
| | 1993-1997 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | >3 | 6.09 | 0.99 | 0.32 - 2.30 |
| | 1998-2002 | M | ≤3 | | | |
| | | F | ≤3 | | | |
| | | B | ≤3 | | | |
| | 2003-2007 | M | ≤3 | | | |
| | | F | >3 | 13.81 | 1.58 | 0.51 - 3.69 |
| | | B | 8 | 10.74 | 1.13 | 0.48 - 2.22 |
| | 2008-2012 | M | ≤3 | | | |
| | | F | >3 | 20.26 | 2.20 | 0.88 - 4.54 |
| | | B | 9 | 12.40 | 1.28 | 0.59 - 2.44 |

# APPENDIX C: DEFINITIONS

**ACS** American Cancer Society. The ACS, first established in 1913, is a nationwide voluntary health organization dedicated to eliminating cancer. The society, headquartered in Atlanta, Georgia, has over 900 offices throughout the United States. ACS funding is used for patient support services, research, prevention, detection and treatment and society operations. For more information, see: http://www.cancer.org.

**ACS** American Community Survey. The ACS is an ongoing survey that provides annual updates to population and demographic estimates derived from census data. The ACS is operated by the USCB. For more information, see: http://www.census.gov/acs/www/.

**AGRC** Automated Geographic Reference Center. An agency within the Utah Department of Information Technology responsible for maintaining a repository of geographic information system (GIS) data files and GIS functionality. For more information, see: http://gis.utah.gov/.

**ArcGIS** A complete desktop GIS software application for producing maps and conducting spatial analysis. This application is developed and distributed by ESRI. The EEP uses version 10.3. For more information, see: http://www.esri.com/software/arcgis.

**CDC** Centers for Disease Control and Prevention. A federal agency within the U.S. Department of Health and Human Services responsible for investigating disease trends and causalities, and promoting best disease prevention practices. For more information, see: http://www.cdc.gov/.

CI Confidence interval. Because there is some error in estimating a population parameter, and that error increases as the population size decreases, a confidence interval is used to indicate the degree of uncertainty associated with a parameter estimate. It is important to remember that a CI of a particular level (for example, a 95% confidence interval) does not refer to a specific calculated interval. Rather, the 95% probability relates to the reliability of the estimation procedure. Once a study is done and a CI calculated, the interval either covers the true parameter value or it does not (i.e., the probability is either 100% or 0%).

**CIS** Carcinoma in-situ is an early form of cancer that is defined by the absence of invasion of tumor cells into the surrounding tissue. Instead, the lesion is flat or follows the existing architecture of the organ. In this state, CIS seldom cause clinical systems sufficient to prompt the person with CIS to seek medical assistance and are generally undetected. CIS can progress to invasive tumors and are therefore considered a precursor or incipient form of cancer.

**EEP** Environmental Epidemiology Program. A program within the Bureau of Epidemiology, Division of Disease Control and Prevention, UDOH. The EEP was established in 1996 and is responsible for investigating diseases related to the

environment. The program has two sections. One section conducts surveillance and data management activities including managing the UEPHTN. The other section conducts health hazards risk assessment, including cancer investigations. The program is staffed by personnel with experience and expertise in environmental epidemiology, environmental sciences, toxicology, statistics, public health informatics and geomatics, and health education. For more information, see: http://health.utah.gov/enviroepi/.

**ESRI** ESRI is a leading developer and supplier of GIS software and geographically referenced data. ESRI is headquartered in Redlands, California. The EEP uses the ArcGIS software application developed by ESRI. For more information, see: http://www.esri.com.

**GeoLytics** GeoLytics is a commercial vendor of census and demographic data calibrated to the 2000 census boundaries. The EEP has purchased 1970, 1980, 1990, 2000 and 2010 census data from GeoLytics to be the basis for estimating intercensal population counts for each of the 1,481 census block group boundaries in Utah. Population counts are aggregated into five-year age groups for each sex. For more information, see: http://www.geolytics.com.

**GIS** Geographic Information Systems. A GIS includes computer software and geographically referenced data. The EEP uses ArcGIS as the computer software, and obtains data from ESRI or AGRC.

**ICD-O-3** International Classification of Disease - Oncology, 3rd Edition. The ICD-O-3 is one of a number of internationally established coding standards for coding site (topography) and histology (morphology) of neoplasms (cancers). For more information, see: http://www.who.int/classifications/icd/adaptations/oncology/en/.

**Imputation** The process of replacing missing data with substituted values, which can otherwise cause issues during data analysis.

**Incidence** The term incidence refers to new cases occurring in a period of time, usually annually. Cancer incidence is the number of new cases that occurred in a year. New cancer cases occur when a diagnosis is made. The 2009 national age-adjusted incidence rate is 4.64 cancer cases per 1,000 population per year. For more information, see: http://www.cancer.gov/statistics/glossary/incidence.

**NAACCR** North American Association of Central Cancer Registries. NAACCR was established in 1987 as a collaborative professional organization for cancer registries, governmental agencies and professional associations that work with cancer registries. All central cancer registries in the United States and Canada are members. The purpose of NAACCR is to promote standards and enhance the quality of cancer registry data. The NAACCR also promotes training, epidemiologic research, public health activities, and patient care improvement policies related to cancer. For more information, see: http://www.naaccr.org.

**NCI** National Cancer Institute. The NCI is one of the National Institutes of Health and part of the U.S. Department of Health and Human Services. The NCI was established under the National Cancer Act of 1937 and is primarily responsible for conducting surveillance and research about cancer incidence, diagnosis, prevention, treatment, and rehabilitation. The SEER program is operated by the NCI. For more information, see: http://www.cancer.gov/.

**Prevalence** The term prevalence refers to the number of cases that exist either at a moment in time or during a period of time (e.g., annual, lifetime, etc.). When using this term, the time should be included. The 2009 national lifetime cancer prevalence rate is approximately 414.65 cases of cancer among 1,000 population. Cancer prevalence is the total number of cases that exist. For more information, see: http://www.cancer.gov/statistics/glossary/prevalence.

**Rate** Sometimes called an incidence rate, this is a ratio of the cancer incidence (the number of new cancer diagnoses) over the total population. When computing a multiple year rate, the total population added from each year of the rate period is used to get the rate. For more information, see: http://www.cancer.gov/statistics/glossary/incidence.

**SAS** SAS (originally from "Statistical Analysis System") is a globally recognized system of integrated computer software products provided by SAS Institute Inc. The SAS system includes a large variety of data manipulation and statistical analysis processes. The EEP uses the desktop version 9.3. For more information, see: http://www.sas.com.

**SEER** Surveillance, Epidemiology, and End Results Program. The SEER program is an agency within the NCI that works with state cancer registries to develop and disseminate incidence and mortality statistics about cancer in the United States. The SEER program also establishes standards for the analysis of cancer data and interpretation of cancer statistics. For more information, see: http://seer.cancer.gov/.

**SIR** Standardized incidence ratio. See the **Formulas** section below for an in depth explanation.

**SLCoHD** Salt Lake County Health Department. One of the 13 local health departments with public health jurisdiction in Utah. SLCoHD provides public health services to all residents within Salt Lake County. For more information, see: http://slcohealth.org/ or call (385) 468-4100.

**Standardized** See the **Formulas** section below for an in-depth explanation.

**UBRFS** Utah Behavioral Risk Factors Survey. The UBRFS is an ongoing telephonic survey conducted by the Office of Public Health Assessment, UDOH. This survey

collects data about health-related behaviors in the non-institutionalized Utah adult population. For more information, see: http://health.utah.gov/opha/OPHA_BRFSS.htm.

**UCR** Utah Cancer Registry. The UCR is operated under authority from the UDOH by the University of Utah. The UCR was established in 1966 to be a statewide population-based cancer registry. Utah administrative rule requires the reporting of cancer diagnoses to the UCR. The UCR collaborates with the NCI, SEER, and the NAACCR to implement data standards for cancer data. The UCR provides cancer data to the EEP through the UEPHTN. For more information, see: http://ucr.utah.edu/.

**UDOH** Utah Department of Health. The UDOH is one of the executive agencies within Utah state government. The UDOH strives to improve health in Utah through promoting healthy lifestyles, evidence-based interventions, creating healthy and safe communities, and eliminating health disparities. The EEP is a program within the UDOH. For more information, see: http://health.utah.gov/.

**UEPHTN** Utah Environmental Public Health Tracking Network. The UEPHTN is a data warehouse that contains health outcomes, environmental, and supporting data. Data from the UCR and population data derived from the USCB is warehoused in the UEPHTN. For more information, see: http://epht.health.utah.gov/epht-view/.

**USCB** U.S. Census Bureau. Officially the "Bureau of the Census," the USCB is an agency authorized by Federal law within the U.S. Department of Commerce that is charged with preparing and conducting regular surveys and censuses of the U.S. population. In addition to the decennial population survey, the USCB conducts a number of other surveys and has recently implemented the ACS. For more information, see: http://www.census.gov/.

**WHO** The World Health Organization is an agency of the United Nations that deals with international health concerns and policies. For more information, see: http://www.who.int/en/.

# APPENDIX D: FORMULAS

**Indirect Standardized Incidence Rate**: The raw (sometimes called "crude") disease incidence rate (number of case incidences per time period divided by the person-years per period) reflects reality. The raw rate is the simplest and most straightforward summary of the population experience. Interpretation of a disease incidence rate involves a comparison of that rate with some comparison or acceptable rate to determine if the rate in question is high or low. Because rates will almost always involve comparing two populations with two different age distributions, comparison of a raw disease incidence rate with a comparison rate is problematic. It does not make sense to compare the rate of disease of a relatively young population with a relatively older population for a disease that is more common in the elderly; it would not be possible to state with confidence that the disease rate is higher or lower than expected. For this reason, when the objective is to compare two rates, age standardized rates are preferable. However, it should be noted that the rate itself, once standardized, is not the exact disease burden. The standardized rate should be of the same magnitude as the raw rate.

The indirect standardization method is the preferred method when the disease count in each age group is small or zero. A disadvantage of the indirect method is that the rate is comparable to the comparison population used in its computation, but is not comparable to other population rates. For example, for this study, the study area cancer rates are adjusted using the Utah state population and therefore are comparable to the Utah state rates. However, they are not comparable to the county rates or to national rates.

The Indirect Standardized Rate for the study area ($ISR_M$) is calculated by:

$$ISR_M = \frac{C_M}{\sum_{age}\left(\frac{C_{U,age}}{P_{U,age}} P_{M,age}\right)} \times \left(\frac{C_U}{P_U}\right) \times 100{,}000$$

Where: $ISR_M$ is the Indirect Standardized Incidence Rate for the study area.

$C_M$ is the total cancer incidence count for the study area for a specific analytical period (e.g., 1990 - 1994).

$C_{U,age}$ is an age-group (e.g., 0 to 19 year in age, etc.) specific cancer incidence count for the state of Utah for a specific analytical period.

$P_{U,age}$ is the age-group specific count of person-years (e.g., number of 0-19 year olds in 1990 plus number of 0-19 year olds in 1991 plus number of 0-19 year olds in 1992 ...) for the state of Utah for a specific analytical period.
$P_{M,age}$ is the age-group specific count of person-years for the study area for a specific analytical period.

$C_U$ is the total cancer incidence count for the state of Utah for a specific analytical period.

$P_U$ is the total count of person-years for the state of Utah for a specific analytical period.

For purposes of presentation, it is standard practice to present rates per a population of 100,000 people. For example, 60 cases per 100,000 people is easier to understand than 0.00006 cases per person.

$E_M$ is the expected case count of cancer incidence for the study area for a specific analytical period. This is the denominator factor of the first term of the rate formula.

$$E_M = \sum_{age}\left(\frac{C_{U,age}}{P_{U,age}} P_{M,age}\right)$$

**Standardized Incidence Ratio**. The standardized incidence ratio (SIR) is a way of comparing two rates. When using the indirect standardized rate method, the SIR is the first term of the formula to compute the rate.

$$SIR = \frac{C_M}{\sum_{age}\left(\frac{C_{U,age}}{P_{U,age}} P_{M,age}\right)} = \frac{C_M}{E_M}$$

The Byar's 95% confidence limits ($Z_\alpha = 1.96$) can be calculated for the SIR by:

$$\underline{\overline{SIR}} = \frac{(C_M + k)}{E_M} \times \left[1 - \left(\frac{1}{3 \cdot (C_M + k)}\right) + \left(\frac{\pm 1.96}{3 \cdot \sqrt{C_M + k}}\right)\right]^3$$

Where:

SIR is the standardized incidence ratio. The bar over and under means the upper and lower confidence limits of the SIR.

$C_M$ is the total case count of cancer incidence count for the study area for a specific analytical period.

$E_M$ is the expected case count of cancer incidence for the study area for a specific analytical period.

K is a constant for symmetry. For the upper confidence limit, k = 1. For the lower confidence limit, k = 0.

±1.96 is the normal distribution ($Z_\alpha$) function for a 95% confidence interval. For the upper confidence interval it is a positive value. For the lower confidence interval it is a negative value.

# APPENDIX E: RESOURCES

## RESOURCES

*Links to websites may wrap onto multiple lines.*

| | |
|---|---|
| American Cancer Society: | http://www.cancer.org/cancer/ovariancancer/ |
| American Society of Clinical Oncology: | http://www.cancer.net/cancer-types/ovarian-cancer |
| Huntsman Cancer Institute: | http://healthcare.utah.edu/huntsmancancerinstitute/cancer-information/cancer-types-and-topics/ovarian-cancer.php |
| Intermountain Healthcare Cancer Services: | http://intermountainhealthcare.org/services/cancer/Pages/home.aspx |
| National Cancer Institute: | http://www.cancer.gov/ |
| Utah Cancer Action Network: | http://www.ucan.cc/ |
| Utah Cancer Control Program: | http://cancerutah.org/ |
| Utah Cancer Specialists: | http://www.utahcancer.com/ |