Ratios of Cancer Incidence in Ten Areas Around Rocky Flats, Colorado Compared to the Remainder of Metropolitan Denver, 1980-89 with Update for Selected Areas, 1990-95

A Report to the Health Advisory Panel on Rocky Flats

Prepared by the
Colorado Central Cancer Registry
Colorado Department of Public Health and Environment

1998

Ratios of Cancer Incidence in Ten Areas Around Rocky Flats, Colorado Compared to the Remainder of Metropolitan Denver, 1980-89 with Update for Selected Areas, 1990-95

A Report to the Health Advisory Panel on Rocky Flats

Prepared by:

Colorado Central Cancer Registry

Emergency Medical Services and Prevention Division

1998

Colorado Department of Public Health and Environment
Roy Romer, Governor
Patti Shwayder, Executive Director

Dedicated to protecting and improving the health and environment of the people of Colorado

Main Building
4300 Cherry Creek Dr. S.
Denver, Colorado 80246-1530

Acknowledgements

Appreciation is extended to those persons listed below for their support of the Colorado Central Cancer Registry and/or their assistance in compiling this report. This publication would not have been possible without them:

John W. Berg, M.D., Senior Scientific and Medical Advisor, Colorado Central Cancer Registry, Colorado Department of Public Health and Environment (CDPHE).

Jack L. Finch, M.S., Statistical Analyst, Colorado Central Cancer Registry, CDPHE.

Shelley Karp, B.A., Statistician, Abacus Statistical Consultants.

Robin Bott, C.T.R., Director, Colorado Central Cancer Registry, CDPHE.

Richard Hoffman, M.D., Chief Medical Officer, CDPHE.

Jillian Jacobellis, Ph.D.(C), M.S., Director, Emergency Medical Services and Prevention Division, CDPHE.

Ellen Mangione, M.D., Chair, Rocky Flats Health Advisory Panel and Director, Disease Control and Environmental Epidemiology Division, CDPHE.

Norma Morin, Ph.D., M.P.H., Program Administrator, Rocky Flats Health Studies, Disease Control and Environmental Epidemiology Division, CDPHE.

Walter Young, M.A., Senior Research Associate, AMC Cancer Research Center.

Colorado Central Cancer Registry Personnel for their hard work and dedication in producing quality data: Mary Lu Moline, CTR; Candise Lozier, CTR; Randi Rycroft, CTR; Annie Nelson, CTR; Vicki Schniepp, ART, CTR; Winona Redhorse, CTR; Sue Lynch, CTR; Susan Haylor; Arlene Schmidt and Huilin Feng, M.S.

Colorado Hospitals and Private Pathology Laboratories for making cancer data available to the Colorado Central Cancer Registry to ensure complete reporting of cancer.

Colorado Hospital Tumor Registrars for their cooperation and dedication in providing their individual hospitals and the Central Registry with timely, accurate cancer statistics.

Rocky Mountain Cancer Data System for database and statistical software for the CCCR.

Colorado Department of Local Affairs for providing special 1990 population tabulations for Denver Metropolitan census tracts by race/ethnicity, age and sex.

This project was supported in part by the U.S. Department of Energy State Health Agreement Program through grant #DE-FG01-94EH89530 and by the Colorado General Fund.

Ratios of Cancer Incidence in Ten Areas Around Rocky Flats, Colorado Compared to the Remainder of Metropolitan Denver, 1980-89 with Update for Selected Areas, 1990-95

Table of Contents

List of Figures and Tables iv

Study Background and Introduction 1

Study Design and Methods 3

Findings 7

- Observed/Expected Ratios - All Cancers Combined 7
- Observed/Expected Ratios - Specific Kinds of Cancer - Entire 10-RSA Region .. 8
- Observed/Expected Ratios - Specific Kinds of Cancer - 10 Individual RSA's 8
- Proportional Incidence Ratio (PIR) Analysis 10

Discussion and Limitations 12

Summary and Recommendations 14

Figures and Tables

Technical Appendices

- Appendix A - Colorado Central Cancer Registry (CCCR) Case Registration and Definitions A.1-A.2
- Appendix B - Population Estimation B.1-B.6
- Appendix C - Observed/Expected Ratios C.1-C.3
- Appendix D - Maps and Geography D.1-D.9
- Appendix E - Proportional Incidence Ratio (PIR) Analysis E.1
- Appendix F - Socioeconomic Adjustment F.1-F.2

References

List of Figures and Tables

Figure 1 - Ten Regional Statistical Areas (RSA's) Combined in the Vicinity of Rocky Flats 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers By Sex

Table 1a - Ten Regional Statistical Areas (RSA's) Combined in the Vicinity of Rocky Flats 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers, All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages) - Males

Table 1b - Ten Regional Statistical Areas (RSA's) Combined in the Vicinity of Rocky Flats 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers, All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages) - Females

Figure 2 - "Boulder City - Periphery" Regional Statistical Area (RSA 103) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers and 95% Confidence Intervals by Sex

Table 2a - "Boulder City - Periphery" Regional Statistical Area (RSA 103) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers, All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages) - Males

Table 2b - "Boulder City - Periphery" Regional Statistical Area (RSA 103) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers, All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages) - Females

Figure 3 - "Boulder - Tri Cities" Regional Statistical Area (RSA 106) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers and 95% Confidence Intervals by Sex

Table 3a - "Boulder - Tri Cities" Regional Statistical Area (RSA 106) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers, All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages) - Males

Table 3b - "Boulder - Tri Cities" Regional Statistical Area (RSA 106) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers, All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages) - Females

List of Figures and Tables - (continued)

Figure 4 - "Standley Lake - Periphery" Regional Statistical Area (RSA 202) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers and 95% Confidence Intervals by Sex

Table 4a - "Standley Lake - Periphery" Regional Statistical Area (RSA 202) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers, All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages) - Males

Table 4b - "Standley Lake - Periphery" Regional Statistical Area (RSA 202) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers, All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages) - Females

Figure 5 - "Arvada" Regional Statistical Area (RSA 203) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers and 95% Confidence Intervals by Sex

Table 5a - "Arvada" Regional Statistical Area (RSA 203) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers, All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages) - Males

Table 5b - "Arvada" Regional Statistical Area (RSA 203) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers, All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages) - Females

Figure 6 - "Golden" Regional Statistical Area (RSA 204) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers and 95% Confidence Intervals by Sex

Table 6a - "Golden" Regional Statistical Area (RSA 204) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers, All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages) - Males

Table 6b - "Golden" Regional Statistical Area (RSA 204) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers, All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages) - Females

List of Figures and Tables - (continued)

Figure 7 - "Wheat Ridge" Regional Statistical Area (RSA 205) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers and 95% Confidence Intervals by Sex

Table 7a - "Wheat Ridge" Regional Statistical Area (RSA 205) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers, All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages) - Males

Table 7b - "Wheat Ridge" Regional Statistical Area (RSA 205) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers, All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages) - Females

Figure 8 - "Adams - Northwest" Regional Statistical Area (RSA 301) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers and 95% Confidence Intervals by Sex

Table 8a - "Adams - Northwest" Regional Statistical Area (RSA 301) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers, All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages) - Males

Table 8b - "Adams - Northwest" Regional Statistical Area (RSA 301) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers, All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages) - Females

Figure 9 - "Adams - West" Regional Statistical Area (RSA 304) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers and 95% Confidence Intervals by Sex

Table 9a - "Adams - West" Regional Statistical Area (RSA 304) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers, All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages) - Males

Table 9b - "Adams - West" Regional Statistical Area (RSA 304) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers, All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages) - Females

List of Figures and Tables - (continued)

Figure 10 - "Adams - Clear Creek Valley" Regional Statistical Area (RSA 305) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers and 95% Confidence Intervals by Sex

Table 10a - "Adams - Clear Creek Valley" Regional Statistical Area (RSA 305) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers, All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages) - Males

Table 10b - "Adams - Clear Creek Valley" Regional Statistical Area (RSA 305) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers, All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages) - Females

Figure 11 - "Northglenn - Thornton" Regional Statistical Area (RSA 306) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers and 95% Confidence Intervals by Sex

Table 11a - "Northglenn - Thornton" Regional Statistical Area (RSA 306) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers, All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages) - Males

Table 11b - "Northglenn - Thornton" Regional Statistical Area (RSA 306) 1980-89, Ratios of Observed to Expected Counts of Invasive Cancers, All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages) - Females

Table 12 - "Arvada" Regional Statistical Area (RSA 203) 1980-89, Ratios of Observed to Expected Counts by Age and Race/Ethnicity, Brain and Central Nervous System Tumors - Females

Table 13 - "Arvada" Regional Statistical Area (RSA 203) 1980-89, Observed and Expected Counts by Histology, Brain and Central Nervous System Tumors - Females

Table 14 - "Arvada" Regional Statistical Area (RSA 203) 1990-95, Ratio of Observed to Expected Counts, Brain and Central Nervous System Tumors - Females

List of Figures and Tables - (continued)

Table 15 - "Wheat Ridge" Regional Statistical Area (RSA 205) 1980-89,
Ratios of Observed to Expected Counts by Age and Race/Ethnicity,
Colon and Rectum Cancers - Males

Table 16 - "Wheat Ridge" Regional Statistical Area (RSA 205) 1980-89,
Observed and Expected Counts by Anatomic Site,
Colon and Rectum Cancers,
Males, All Races and Ages and Non-Hispanic White Age 75+

Table 17 - "Wheat Ridge" Regional Statistical Area (RSA 205) 1990-95,
Ratio of Observed to Expected Counts,
Colon and Rectum Cancers - Males

Table 18 - "Adams - West" Regional Statistical Area (RSA 304) 1980-89,
Ratios of Observed to Expected Counts by Age and Race/Ethnicity,
Lung Cancers - Males

Table 19 - "Adams - West" Regional Statistical Area (RSA 304) 1980-89,
Smoking Status,
Lung Cancers - Non-Hispanic White Males Age 55-64

Table 20 - "Adams - West" Regional Statistical Area (RSA 304) 1980-89,
Observed and Expected Counts by Histology,
Lung Cancers,
Males, All Races and Ages and Non-Hispanic White Age 55-64

Table 21 - "Adams - West" Regional Statistical Area (RSA 304) 1990-95,
Ratio of Observed to Expected Counts by Age,
Lung Cancers - Males

Table 22 - "Adams - West" Regional Statistical Area (RSA 304) 1990-95,
Smoking Status,
Lung Cancers - Males Age 65+

Table 23 - "Adams - West" Regional Statistical Area (RSA 304) 1990-95,
Observed and Expected Counts by Histology,
Lung Cancers - Males, All Ages and Age 65+

Table 24 - "Northglenn - Thornton" Regional Statistical Area (RSA 306) 1980-89,
Ratios of Observed to Expected Counts by Age and Race/Ethnicity,
Lung Cancers - Males

List of Figures and Tables - (continued)

Table 25 - "Northglenn - Thornton" Regional Statistical Area (RSA 306) 1980-89,
Smoking Status,
Lung Cancers - Males

Table 26 - "Northglenn - Thornton" Regional Statistical Area (RSA 306) 1980-89,
Observed and Expected Counts by Histology,
Lung Cancers - Males, All Races and Non-Hispanic White

Table 27 - "Northglenn - Thornton" Regional Statistical Area (RSA 306) 1990-95,
Ratio of Observed to Expected Counts by Age,
Lung Cancers - Males

Table 28 - "Northglenn - Thornton" Regional Statistical Area (RSA 306) 1990-95,
Smoking Status,
Lung Cancers - Males

Table 29 - "Northglenn - Thornton" Regional Statistical Area (RSA 306) 1990-95,
Observed and Expected Counts by Histology,
Lung Cancers - Males

Table 30 - Proportional Incidence Ratio Analysis, 1980-89,
10 Regional Statistical Areas in the Vicinity of Rocky Flats

Study Background and Introduction

The Rocky Flats Nuclear Weapons Plant (now called the Rocky Flats Environmental Technology Site) was established in 1952 on a site 16 miles northwest of downtown Denver in Jefferson County. For four decades, the Rocky Flats plant produced nuclear weapons components for national defense. Radioactive materials such as plutonium and uranium, as well as other hazardous materials associated with manufacturing, were used at the plant. Over the course of its operating history, contaminants were released to the environment beyond the plant boundaries through routine air emissions and accidents such as fires and spills.[1]

In 1989, Colorado's Governor Roy Romer and then-Department of Energy (DOE) Secretary James Watkins signed an Agreement in Principle to provide DOE funding for state oversight of Rocky Flats for increased environmental monitoring near the plant, more emphasis on the plant's compliance with environmental laws, speedier investigation and cleanup of site contamination, and research to identify past exposures and potential health risks.[1]

For many years, there has been interest in cancer statistics in the vicinity of Rocky Flats, both within a few miles of the plant and further away. In 1981, a study by Johnson[2] used data from the National Cancer Institute's 1969-71 Third National Cancer Survey to examine the relation between cancer rates and plutonium soil sample data collected in 1970. This study concluded some cancers were increased in areas with higher soil plutonium levels. In 1982, Dreyer et. al.[3], conducted a feasibility study for an epidemiologic study of persons who lived near the plant. The study concluded that estimated exposures were not high enough to be evaluated with statistical analyses in an epidemiologic study. In 1987, a study by Crump et. al.[4] replicated the Johnson study design using 1969-71 and 1979-81 cancer diagnosis data. The study's 1969-71 findings paralleled Johnson's findings but the study could draw no conclusions about a relation between soil plutonium levels and cancer rates. The study also found no excess of cancers within 10 miles of Rocky Flats during either time period for total cancer, radiosensitive cancer or respiratory cancer.

When Colorado Department of Health epidemiologists reviewed the design and results of earlier research on the health impacts of the Rocky Flats Plant, they concluded that

previous studies did not provide enough information on releases of plutonium or other toxins and any resulting exposures that could cause health effects, such as cancer, in surrounding communities.[1,5] In some studies, conclusions about exposures were based on limited soil samples. In assessing health effects, other studies failed to consider factors such as personal smoking history, medical x-rays and exposure to cancer-causing chemicals from sources other than the Rocky Flats Plant. To overcome these types of limitations, a Toxicological Review and Dose Reconstruction Project contracted by the state has been under way since 1990 to document past contaminant releases and to provide estimates of the extent of public exposure to these toxins. Phase I of that project, completed in 1993, estimated that health risk from any releases was small but concluded that these findings were preliminary because gaps in information used to make these estimates still exist.[1] Phase II of that project is currently in progress and includes an analysis to assess the risks of exposure to plutonium, to estimate dose amounts and to estimate health risk to offsite individuals.[6]

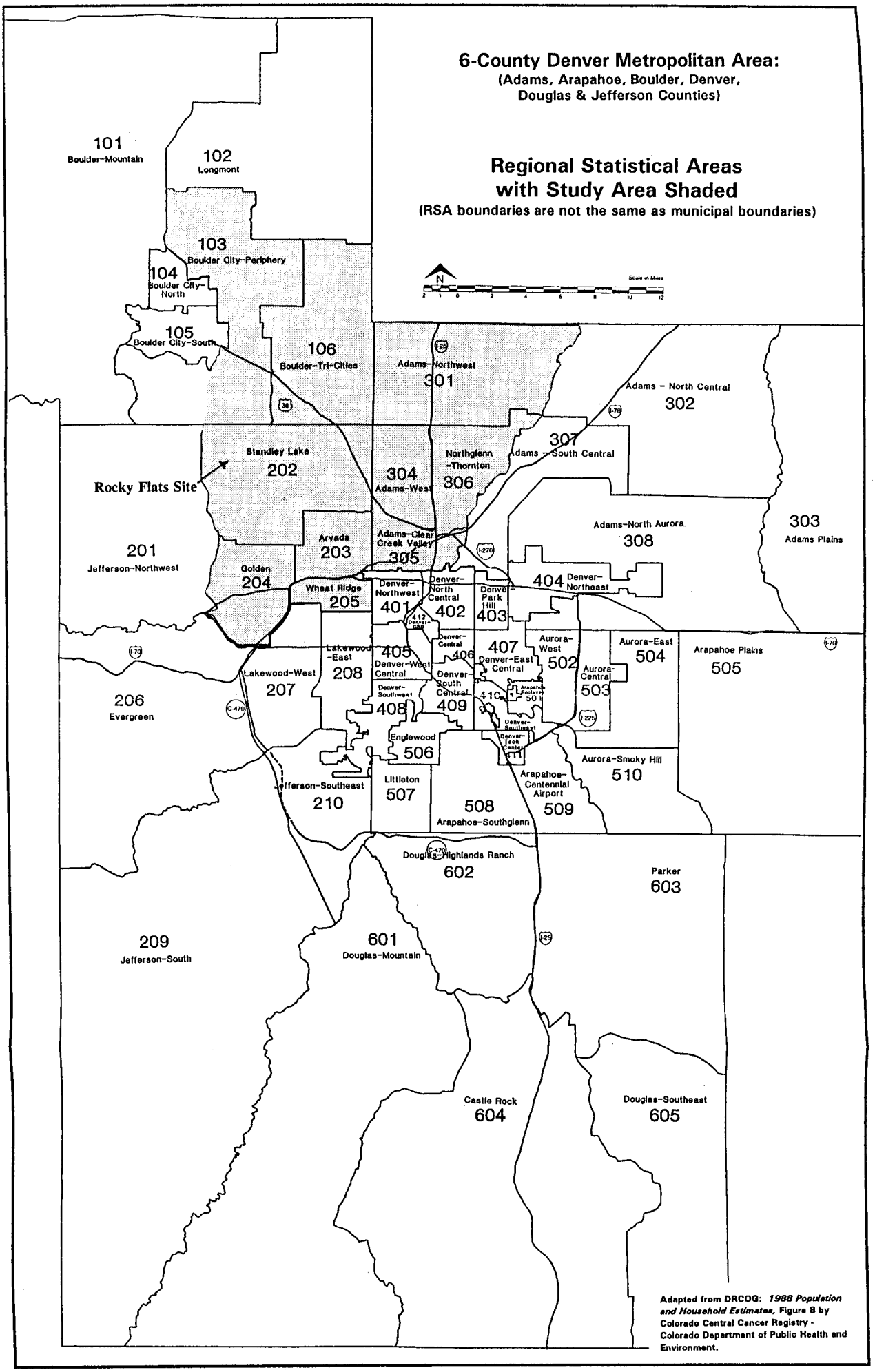
In 1990, the Colorado Central Cancer Registry (CCCR), a program of the Colorado Department of Public Health and Environment (CDPHE), proposed additional activities to help address public concerns and questions about cancer incidence in the general vicinity of Rocky Flats. The CCCR planned to: (1) assure the quality and completeness of cancer registration in Colorado (see Technical Appendix A); (2) develop methodologies for population estimation between 1980 and 1990 at the census tract level (see Technical Appendix B) and develop computer programs to calculate ratios of cancer incidence in the vicinity of the Rocky Flats plant compared to expected incidence based on the incidence rate of cancer in the remainder of the Denver Metro region (see Technical Appendix C); and (3) help assess cancer incidence among Rocky Flats workers by linking worker records electronically with CCCR records. The third goal was based on suggestive findings (Wilkinson[7], 1987) of elevated cancer risk in workers. In 1993 the CDPHE signed a cooperative agreement with the National Institute for Occupational Safety and Health (NIOSH) to carry out a five-year study of cancer incidence and mortality among workers at Rocky Flats. The CCCR is participating in this separate ongoing project along with researchers from CDPHE and the University of Colorado Health Sciences Center.[5,8]

This report summarizes CCCR work completed regarding cancer incidence among residents in the general vicinity of Rocky Flats compared to the remainder of Metropolitan Denver.

Study Design and Methods

At the beginning of the current project, because there was an absence of reliable human exposure estimates for specific areas of geography, the CCCR proposed to calculate observed/expected ratios of cancer for a fairly wide area located in the general vicinity of Rocky Flats. The intent was to develop a precise method of analysis at the census tract level that could be applied when and if exposure data were forthcoming. In the absence of exposure estimates it was still considered important to give citizens cancer incidence statistics for their communities and to describe these statistics in a way that they could compare their cancer experience to the remainder of the Denver Metro area. An analysis protocol was developed by a group comprised of Ellen Mangione, M.D. (Chair, Rocky Flats Health Advisory Panel and Director of the Disease Control and Enviromental Epidemiology Division at CDPHE), Walter Young, M.A. (then-Director, Division of Prevention Programs at CDPHE), Jack Finch, M.S. (Statistical Analyst at the CCCR), Shelley Karp (Abacus Statistical Consultants, contractor to the project) and John Berg, M.D. (Pathologist and Senior Scientific/Medical Advisor at the CCCR).

The protocol included the study of ten areas of geography called Regional Statistical Areas (RSA's) described in Technical Appendix D. The following page displays a map of the Denver Metro area with RSA boundaries. The ten RSA's were selected primarily for their proximity to Rocky Flats (generally within 12-16 miles south, southeast, east, northeast and north of the Plant) but based also on community interest and concern shown by requests to the Health Department for cancer information in these areas. They were also selected with the intent that the remainder of the Denver Metro area outside the boundaries of the ten RSA's would likely be beyond the range, or in the lower range, of any estimated or hypothesized health effects from Rocky Flats. RSA's, defined by the Denver Regional Council of Governments, were used because: (1) they are aggregates of census tracts for which the U.S. Census provides detailed population counts by race/ethnicity, sex and age


6-County Denver Metropolitan Area:
(Adams, Arapahoe, Boulder, Denver, Douglas & Jefferson Counties)
Regional Statistical Areas with Study Area Shaded
(RSA boundaries are not the same as municipal boundaries)
N
101 Boulder-Mountain
102 Longmont
103 Boulder City-Periphery
104 Boulder City-North
105 Boulder City-South
106 Boulder-Tri-Cities
Adams-Northwest 301
Adams - North Central 302
303 Adams Plains
Standley Lake 202
Rocky Flats Site
304 Adams-West
Northglenn -Thornton 306
307 Adams - South Central
Adams-North Aurora. 308
201 Jefferson-Northwest
Arvada 203
Adams-Clear Creek Valley 305
Golden 204
Wheat Ridge 205
Denver-Northwest 401
Denver-North Central 402
Denver Park Hill 403
404 Denver-Northeast
Lakewood-East 208
Lakewood-West 207
405 Denver-West Central
Denver-Central 406
407 Denver-East Central
Aurora-West 502
Aurora-Central 503
Aurora-East 504
Arapahoe Plains 505
206 Evergreen
Denver-Southwest 408
Denver-South Central 409
410
Denver-Southeast
Denver-Tech Center 411
Englewood 506
Aurora-Smoky Hill 510
Jefferson-Southeast 210
Littleton 507
508 Arapahoe-Southglenn
Arapahoe-Centennial Airport 509
Douglas-Highlands Ranch 602
Parker 603
209 Jefferson-South
601 Douglas-Mountain
Castle Rock 604
Douglas-Southeast 605
Adapted from DRCOG: 1988 Population and Household Estimates, Figure 8 by Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

(variables critical in determining expected cancer incidence); (2) they provide relatively stable, sub-county statistical units which are generally independent of shifting municipal boundaries over time, allowing for analysis of cancer data over a full decade; and (3) CCCR records contain a census tract code for each cancer case and, thus, can be aggregated to the RSA level. RSA's named after cities or towns are not the same as the incorporated municipalities but may be used to generally locate particular geographic regions. The population of the entire 10-RSA area analyzed was approximately 400,000 residents during the 1980's and the population of the remainder of the Denver Metro area (outside the 10-RSA boundaries) was approximately 1.3 million residents.

The original analysis plan was to compare observed cancer frequencies to those expected for persons of all ages combined and for children. For the all-ages and childhood cancer analyses, the observed numbers of cancers in each RSA would be compared to the expected numbers, calculated by applying race/ethnicity-sex-age-specific cancer rates from the remainder of the Denver Metro area to each RSA's population. A proportional incidence ratio analysis was also planned, in which the distribution of cancers by anatomic site in each RSA would be compared to the distribution in the remainder of the Denver Metro area. For all analyses, three race/ethnicity groups -- non-Hispanic Black, Hispanic, and non-Hispanic White -- had enough population for analysis and together accounted for 98% of the population of greater Denver in the 1980's.

Later, upon recommendation of Rocky Flats Health Advisory Panel members, it was decided to perform separate analyses of specific kinds of cancer either possibly linked with plutonium exposure or of special concern to panel members. The 10 cancers selected for study were: esophagus, stomach, colon and rectum, liver, lung, prostate, bone, leukemias, lymphomas, and brain and central nervous system. For all of these analyses the <u>ten years, 1980-89</u>, were chosen, because population estimates could be anchored at both ends to U.S. Census population counts and because the CCCR had begun cancer-case registration for the entire Denver Metro area in 1979. (Previous incidence studies for the Rocky Flats area had used cancer data only from <u>three-year</u> periods: from the 1969-1971 Third National Cancer Survey and from 1979-81 CCCR data.[2,4])

As planned, cancers in males and females were analyzed separately. If any

observed/expected ratios (see Technical Appendix C) were above statistical limits, the protocol called for identifying any race/ethnicity, sex or age strata that might be contributing to the higher ratios and checking CCCR data on smoking status and/or occupation, if available, since these variables may influence cancer incidence.

This study design is descriptive in nature and has been used in other studies conducted around communities adjacent to suspected environmental exposures since it is efficient and cost effective.[9,10,11] Because of inherent limitations this type of study is not expected to allow conclusions to be drawn about specific cause and effect relationships in the communities. For example, this study examined cancer incidence at the level of the RSA where information about an individual's toxin exposure, or complete smoking, occupation and residence or education and income status was not available. Also, in any study examining many cancers in a variety of population groups there is the possibility of finding statistical elevations which are due to chance, commonly referred to as the "multiple comparisons problem." In this study, with 190 observed/expected ratios being tested with 95% confidence intervals, about 5 ratios would be expected to be elevated statistically simply due to chance variations. The study group acknowledged the possibility of chance findings but felt it was important in the study protocol to follow up on findings of statistically higher cancer ratios to identify any factors, such as demographic, smoking or cancer cell type data, that might help interpret the findings. Updated analyses using 1990-95 CCCR data were done for any areas found to have statistically elevated cancer ratios during 1980-89.

As explained in Technical Appendix C, because the cancer case-count for the combination of all 10 RSA areas represented about a quarter of all cancers in the six Denver Metro counties, an alternative[12] to the standard method of calculating expected numbers of cases was used for the 10-RSA aggregate. Consequently, the total expected count for the 10-RSA aggregate was not identical to the sum of the 10 individual RSA expected counts.

Also, an adjustment to expected numbers of cancer cases based on estimated socioeconomic status was explored because socioeconomic status is known to be associated with incidence of some kinds of cancer. Technical Appendix F explains why, after an in-depth look at adjustments for socioeconomic levels of census tracts which yielded little change in the expected number of cancers, the adjustments were determined to be of no use.

Findings

For the entire 10-RSA region and the 10 individual RSA's, the incidence of all cancers combined for persons of all ages and for children during 1980-89 was not higher than expected compared to the remainder of the Denver Metro area. Also for the entire 10-RSA region, none of the ten selected cancers for persons of all ages was found to be higher than expected.

For the 10 individual RSA's, the incidence of ten selected cancers for persons of all ages during 1980-89 was not higher than expected compared to the remainder of the Denver Metro area, with the following exception: four individual RSA's each had one observed/expected cancer ratio above 1.00 that was beyond statistical limits of variability. These four findings which varied by cancer site and gender are described in the section on Observed/Expected Ratios - Specific Kinds of Cancers - 10 Individual RSA's.

Observed/Expected Ratios[12,13] - All Cancers Combined

As can be seen in Figure 1 and the top lines of Tables 1a and 1b, there were fewer total cancers than expected for both men and women in the 10-RSA region. The deficit for women was large enough that it would be expected to occur by chance only in about one analysis in a thousand. The deficit for men did not reach the conventional level of statistical significance of one chance in 20 but still would be expected to occur in only one of 16 or 17 analyses. Figures 2 through 11 and the top lines of Tables 2a through 11b present the ratios of observed to expected numbers (O/E ratios) of all cancers combined for males and for females for the 10 separate RSA's. All but two of the RSA's had overall cancers within statistical limits for men and women. The two exceptions had particularly low counts: (1) an observed/expected ratio of 0.89 for men in RSA 106, "Boulder - Tri-Cities," (Figure 3 and Table 3a) and (2) an observed/expected ratio of 0.90 for women from RSA 304 "Adams - West," (Figure 9 and Table 9b). Note that there were fewer cancers than expected in women in every one of the 10 RSA's.

Figures 1 through 11 and Tables 1a through 11b (second line of each table) present similar data for children 14 and younger since their characteristic cancers are different from the usual cancers in adults. The cancer case-counts for children in the 10 RSA's combined

were lower than the expected numbers. Also, boys in all but one RSA had fewer cancers than expected and no group of boys or girls had numbers of cancers that differed from expected counts more than would be expected by chance.

Observed/Expected Ratios[12,13] - Specific Kinds of Cancers - Entire 10-RSA Region

Figure 1 and Tables 1a and 1b show the observed/expected counts and ratios for the 10 kinds of cancer in men and the 9 kinds of cancer in women for the entire 10-RSA region. None of these ratios was higher than expected by chance.

Observed/Expected Ratios[12,13] - Specific Kinds of Cancers - 10 Individual RSA's

Figures 2 through 11 and Tables 2a through 11b show the observed/expected ratios for the selected cancers for men and women for the individual RSA's. There were 190 separate, independent observed/expected ratios calculated (10 cancers for males and 9 cancers for females for each of 10 RSA's). Using the standard 95% confidence interval to evaluate the 190 ratio tests, 5% of these ratios (about 10) would be expected to exceed statistical limits (about 5 lower and 5 higher than expected) simply due to random variation. In fact, only 7 of the observed/expected ratios exceeded statistical limits: that is, these 7 ratios had 95% confidence intervals that did not include the value 1.00. Three of these counts were lower than expected, four were higher. Following the original analysis protocol, we present, below, available CCCR descriptive information, such as smoking status, occupation, histology (cell type) and race/ethnicity/sex/age details, on the four groups for which the lower bound of the 95% confidence interval for the observed/expected ratio was above 1.00. Updated analyses for the 1990-95 time period are also presented for these four groups.

Figure 5 and Table 5b show that the ratio of 53 observed to 38.1 expected brain tumors, benign and malignant, in females in RSA 203, "Arvada," was 1.39 (95% confidence interval of 1.04-1.82). Additionally, Table 12 presents the case counts and observed/expected ratios for women in the area by age and race/ethnicity. Most of the excess cases occurred in non-Hispanic white women 55 years and older. The expected number of tumors for Hispanics was much below one for each age group, so that two tumors

in the 55-64 year age-group yielded a ratio above statistical limits, although the total for all age groups for Hispanics was within expected statistical limits. The histologic distribution of tumor types did not differ significantly from the distribution in Metro Denver as seen in Table 13. Half of these cases were benign meningiomas, also consistent with the percentage seen in the Metro area. Table 14 shows an updated analysis done for 1990-95 in which the ratio of brain tumors in women was not elevated (34 observed cases compared to 33 expected for a ratio of 1.03).

Figure 7 and Table 7a show that the ratio of 115 observed to 94.2 expected colon and rectum cases among men in RSA 205, "Wheat Ridge," was 1.22 (95% confidence interval of 1.01-1.47). Table 15 displays the case counts and observed/expected ratios by age and race/ethnicity. Only the case count for non-Hispanic white men age 75 and older was statistically elevated. The anatomic distribution of cases within the colon and rectum seen in Table 16 was almost exactly that seen in Metro Denver both for the entire group and for the oldest non-Hispanic white men in particular. During the 1990-95 updated time period, the ratio of 1.15 (60 observed cases compared to 52.4 expected) was within expected statistical limits as seen in Table 17.

Figure 9 and Table 9a show that the ratio of 177 observed to 141.4 expected lung cancers among men in RSA 304, "Adams West," was 1.25 (95% confidence interval of 1.07-1.45). Table 18 presents the data for lung cancers by age and race/ethnicity. The one particularly high case count was for non-Hispanic whites ages 55-64. CCCR abstract information on smoking history and occupation for the 71 patients in this group was checked because of known associations between lung cancer and smoking and certain occupational exposures. Table 19 shows that there was not a single non-smoker among the 52 men for whom a smoking history was recorded. An occupation or employer was given for 49 men. Twelve were teachers, clerks, salesmen, etc., while 26 worked in manufacturing, construction, transportation, maintenance, etc. For the others, either their occupation did not fit either of the above groups or, more often, there was no indication of what kind of work they did. The distribution of histologic types, displayed in Table 20, was almost exactly that expected from the distribution of histologies in non-Hispanic white men of this age in Metro Denver. (Many occupational clusters of lung cancers, especially those produced by

radiation, such as in uranium miners[14], have shown a definite excess of small cell carcinomas. But in this group, no excess was seen: 13 small cell carcinomas were observed compared to 13.5 expected.) An update with 1990-95 data presented in Table 21 shows a statistically elevated ratio of 1.46 (150 cases compared to 103.0 expected) with men aged 65 and over having particularly high counts. There were 101 lung cancers in this age group and only two of the 80 men for whom a smoking history was recorded were listed as non-smokers as seen in Table 22. The occupation mix was similar to the earlier time period; and Table 23 shows that the histology mix for the entire group and for the 65+ age group was not statistically different from that expected based on the histologic distribution seen in Metro Denver.

Figure 11 and Table 11a show that the ratio of 129 observed to 95.4 expected lung cancers among men in RSA 306, "Northglenn-Thornton," was 1.35 (95% confidence interval of 1.13-1.61). Table 24 presents the data for lung cancers in men in RSA 306 by age and race/ethnicity. Unlike the lung cancer excess in RSA 304 described above, non-Hispanic white men in RSA 306 had more cancers than expected in every age group from 25-34 on up. Black men also had more cancers than expected. As shown in Table 25, a smoking history was on the CCCR abstract for 96 of the 129 cases; all but two were smokers. The occupation mix was much like that in the previous group. Table 26 shows that no deviation from the expected mix of histologic types was seen in either the entire group or in non-Hispanic white men in particular. An update with 1990-95 data seen in Table 27 displays a statistically elevated ratio of 1.56 (107 cases compared to 68.8 expected). Most age groups showed elevations and Table 28 shows that only three of the 94 men for whom a smoking history was recorded were listed as non-smokers. Again, the occupation data showed no particular pattern. Table 29 presents the histology mix for this group which was not statistically different from that seen in Metropolitan Denver men.

Proportional Incidence Ratio (PIR) Analysis

Bias in population estimates can affect the numbers of expected cancer cases and, consequently, the observed to expected ratios. To check for this, a population-independent Proportional Incidence Ratio (PIR) analysis compares the anatomic distribution of cancer

sites in a study area with the anatomic distribution in the control area, taking into account any differences in race/ethnicity, sex and age of the two sets of patients (see Technical Appendix E). Since the importance of the difference is evaluated by a summary chi-square statistic, cancer sites with expected counts in the study area of less than 5 are collected into an "all other" category.

For this study, the cancer counts in each of the 10 RSA's were compared to those expected from the race/ethnicity-sex-age-specific counts in the remainder of the Denver Metro area. As Table 30 illustrates, in all ten of the RSA's the cancer site distribution was compatible with the expected. The summary chi-square test for each RSA was within statistical limits, showing that the total amount of variability across cancer sites was comparable to the remainder of Metropolitan Denver. These results support the observed/expected analysis results which used actual population estimates.

Discussion and Limitations

The study design used in this analysis of observed and expected numbers of cancer cases among residents of ten Regional Statistical Areas in the general vicinity of Rocky Flats is descriptive and ecologic in nature.[9] These types of studies have been conducted frequently around communities adjacent to suspected environmental exposures since they are efficient and cost effective.[10,11] This study's intent was to give citizens cancer incidence statistics for their communities in a way that they could compare their cancer experience to the remainder of the Denver Metro area during the 1980-89 time period, the first full decade of cancer data available from the CCCR for the Denver area. Studies of this kind are not expected to allow conclusions to be drawn about cause and effect relationships in individuals or at the community level. This study design calls for observed/expected cancer ratios to be examined at the population group level (here the Regional Statistical Area), rather than at the level of individual persons. A weakness inherent in this study design is that information on potential confounders may be lacking and the data cannot be examined for these effects. In the approach taken here, use is made of individual age, gender and race/ethnicity data both at the census tract population level and the cancer case level. However, for critical exposure variables, such as actual human exposure estimates, in- and out-migration and length of residence, which can help assess misclassification bias in studies of this nature, there was an absence of reliable data. An example of misclassification bias occurs when an area may have received exposure in a small section yet the disease rate for the entire area may not reflect it because many potentially unexposed individuals may dilute any health effect. Therefore, in this study design where exposure data is not measured or estimated directly, there is the possibility that health effects might not be detected either.

Also individual-level data on potential confounders such as income and education were not available. Information on occupation and smoking was available in the CCCR database for some cases but not all since the items are not always present in medical records and thus not recorded by the CCCR. For the two individual RSA's with higher lung cancer ratios in men, RSA 304, "Adams West" and RSA 306, "Northglenn-Thornton," the lung cancer cases had a mixture of occupations and about 75-85% of the lung cancer cases had definite evidence of smoking exposure, the strongest link to lung cancer.

When an excess of cancer cases is found for only one gender group in an area as was seen in the four individual RSA cancer ratios that were statistically elevated, the findings would have been strengthened by evidence that both genders showed the excess. Exposures which are found in or around the home should affect both genders, although one group may be preferentially affected if they spend more time in the area of interest. Conversely, excesses for a single gender may be associated with occupational exposures, gender confounding (e.g. smoking rates higher among males than females) or other gender-specific activities.

Many of the study design limitations described above potentially could be addressed with a case-control study. However, such studies are time-consuming and expensive and may not be conclusive if exposure history cannot be accurately estimated for each individual in the study. A case-control study, like other study models, also may not be able to detect a problem, due to issues of in- and out-migration and the long latency of most cancers.

In evaluating the 190 observed/expected ratios (10 cancers for males and 9 cancers for females for each of 10 RSA's) a statistical enigma known as the "multiple comparisons problem" must be addressed. The issue of multiple comparisons centers around the fact that when using the standard 95% confidence interval, 5% of these ratios (about 10) would be expected to be beyond statistical limits simply due to chance variations, about 5 tests suggesting high rates and about 5 tests suggesting low rates. In the present analysis only 7 of the observed/expected ratios were beyond statistical limits; that is, these 7 ratios had 95% confidence intervals that did not include the value 1.00. Three of these counts were lower than expected, four were higher. Only if there had been more big differences than expected would there be reason to suggest that some, at least, reflected truly higher or lower counts of cancer than expected for the populations.

The histology or cell type of a cancer and the anatomic detail may offer clues to whether an elevated observed/expected cancer ratio is indicative of a possible association with something or more likely a chance occurrence. In this study the four individual RSA's each with one cancer statistically higher than expected were checked and the distribution of cell types and/or anatomic locations of these cancers was similar to the distribution seen in Metro Denver. Also, no unusual cell types or anatomic locations were noted.

Summary and Recommendations

This report summarizes CCCR work completed regarding cancer incidence during 1980-89 among residents of ten Regional Statistical Areas in the general vicinity of Rocky Flats compared to the remainder of Metropolitan Denver. Expected numbers of cancers were determined by applying race/ethnicity-sex-age-specific cancer rates from the remainder of the Denver Metro area to each RSA's estimated population. The study included all cancers combined for persons of all ages and for children, and ten selected cancers for persons of all ages. The ten cancers selected were: esophagus, stomach, colon and rectum, liver, lung, prostate, bone, leukemias, lymphomas, and brain and central nervous system. A proportional incidence ratio analysis was also completed. It compared the distribution of cancers by anatomic site in each RSA to the distribution in the remainder of the Denver Metro area.

Several conclusions may be drawn from this study:

(1) For the entire 10-RSA region, the incidence of all cancers combined for persons of all ages during 1980-89 was not higher than expected compared to the remainder of the Denver Metro area. This conclusion is based on the finding of observed/expected ratios less than 1.00 for total cancers for both men and women in the 10-RSA region.

(2) For the entire 10-RSA region, the incidence of all cancers combined for children during 1980-89 was not higher than expected compared to the remainder of the Denver Metro area. This conclusion is based on the finding of observed/expected ratios less than 1.00 for total cancers for both boys and girls in the 10-RSA region.

(3) For the entire 10-RSA region, the incidence of ten selected cancers for persons of all ages during 1980-89 was not higher than expected compared to the remainder of the Denver Metro area. This conclusion is based on testing 19 observed/expected ratios (10 cancers for men and 9 cancers for women) in the 10-RSA region and finding none higher than expected by chance.

(4) For the 10 individual RSA's, the incidence of all cancers combined for persons of all ages during 1980-89 was not higher than expected compared to the remainder of the Denver Metro area. This conclusion is based on testing 20

observed/expected ratios for total cancers for both men and women in the individual RSA's and finding none higher than expected by chance.

(5) For the 10 individual RSA's, the incidence of all cancers combined for children during 1980-89 was not higher than expected compared to the remainder of the Denver Metro area. This conclusion is based on testing 20 observed/expected ratios for total cancers for both boys and girls in the individual RSA's and finding none higher than expected by chance.

(6) For the 10 individual RSA's, 186 out of 190 cancer ratios tested showed that the incidence of ten selected cancers for persons of all ages during 1980-89 was not higher than expected compared to the remainder of the Denver Metro area while 4 areas each had one cancer ratio that was statistically higher than expected. This conclusion is based on testing 190 observed/expected ratios for the ten selected cancers for both men and women in the ten individual RSA's and finding no more particularly high case counts than expected by chance. Out of 190 observed/expected ratios tested, about five ratios greater than 1.00 would have been expected by chance to exceed statistical limits, but only four ratios of that size (one ratio for each of four individual RSA's) were beyond those limits. That is, only four ratios above 1.00, fewer than expected by chance, had 95% confidence intervals that did not include the value 1.00. In addition, results from the proportional incidence ratio analysis showed that the total amount of variability across cancer sites in each RSA was compatible with the cancer site variability in the remainder of Metro Denver, supporting the results of the observed/expected ratio analysis. Finally, descriptive data available in the CCCR for the cancer cases included in the four observed/expected ratios found to be statistically higher was examined. In all four findings, the anatomic and/or histologic distributions of the specific cancers were comparable to the distributions seen in the Denver Metro area and excess cancers were seen in only one gender. Occupation data showed no particular pattern and smoking history information was consistent with the finding of more lung cancers than expected in men in two areas. Updates done for the 1990-95 time period resulted in findings similar to the 1980-89 period for the two areas with higher lung cancer ratios. During 1980-89, more brain tumors than expected were diagnosed in women in one area, but the types of tumors did not differ significantly from similar brain tumors

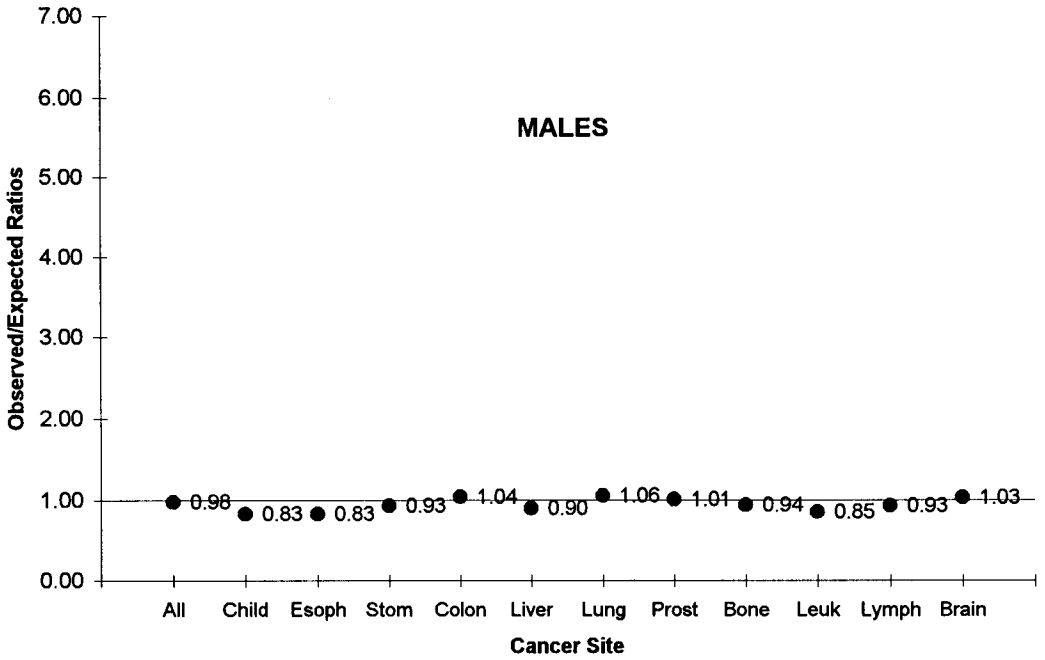
among women in the Denver Metropolitan area. An update for 1990-95 showed no elevation in brain tumors in women in this area. The number of colon and rectum cases in men in one area during 1980-89 was higher than expected but the elevation was mostly confined to one age group and the anatomic distribution within the colon was almost exactly that seen in the remainder of Metro Denver. An update for 1990-95 showed the ratio was not higher than expected by chance.

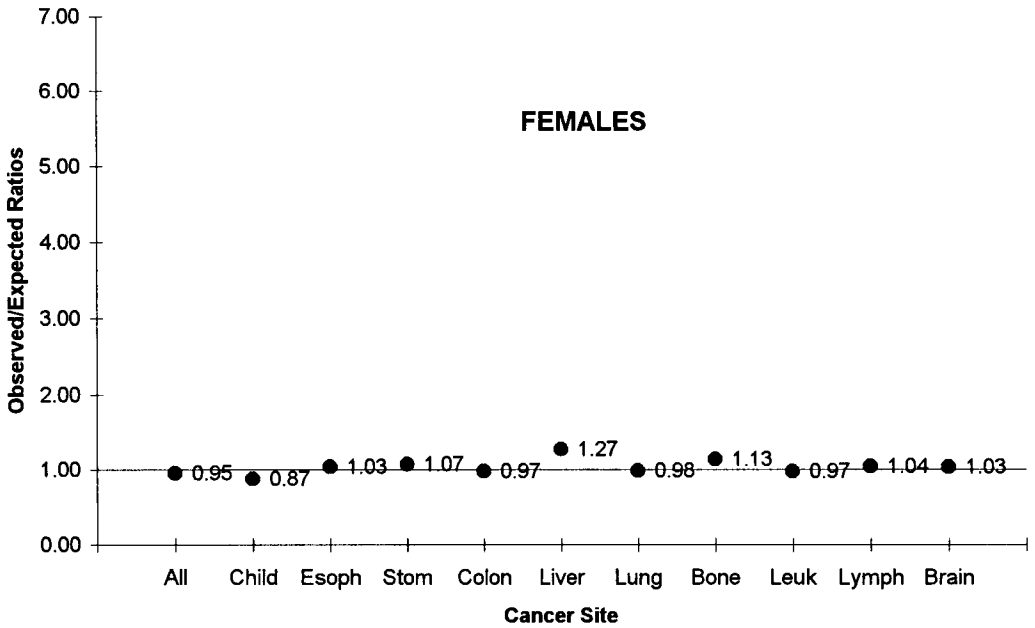
In summary, these analyses provide cancer statistics to citizens in the vicinity of the Rocky Flats plant so that they can compare their communities' cancer experience during 1980-89 to the remainder of the Denver Metropolitan area. The information provided here is not intended to resolve the controversy surrounding possible health effects from Rocky Flats releases. For example, since reliable human exposure data were not available, these analyses could not be based on exposure estimates for certain areas but rather were focused on areas primarily due to their proximity to Rocky Flats. The data presented here do show that communities in the general vicinity of Rocky Flats had cancer incidence during 1980-89 that was comparable to the remainder of the Denver Metro area. In the four areas where further analysis was done, including an update for 1990-95, there was no evidence of an ongoing problem in two areas. In the other two areas, observed lung cancer increases in both time periods were strongly associated with smoking.

Registration of cancer diagnoses for this area will continue and periodic statistical evaluations are recommended. The CCCR remains committed to monitoring cancer incidence here and throughout Colorado. When estimates of human exposure from Rocky Flats' contaminant emissions are available from the Historical Public Exposures Studies on Rocky Flats in late 1999, additional statistical assessments of cancer incidence based on exposure are recommended.

Figure 1

Ten Regional Statistical Areas (RSA's) in the Vicinity of Rocky Flats 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers by Sex





Brain includes all brain and central nervous system tumors regardless of malignancy status.
See Tables 1a and 1b for observed and expected cancer counts used to calculate O/E ratios.
No Observed to Expected Ratio was statistically significantly high.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 1a

Ten Regional Statistical Areas (RSA's) Combined in the Vicinity of Rocky Flats 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers
All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages)
Males

Cancer Site	Observed Cases	Expected Cases	Observed/ Expected Ratio[1]
All Cancers - All Ages	5,123	5,248.5	0.98
All Cancers - Age 0-14	65	78.0	0.83
Esophagus	40	48.3	0.83
Stomach	121	129.6	0.93
Colon and Rectum	707	683.0	1.04
Liver	32	35.6	0.90
Lung	889	841.1	1.06
Prostate	1144	1137.5	1.01
Bone	22	23.4	0.94
Leukemias	156	184.6	0.85*
Lymphomas	204	218.4	0.93
Brain and CNS[2]	189	183.3	1.03

[1] Mantel-Haenszel Chi-Square statistic with one degree of freedom tests statistical significance of O/E ratios for the 10-RSA's combined. (Mantel and Haenszel, Journal of the National Cancer Institute, vol. 22, No. 4, p.719-748, April, 1959.) Ratios are not considered statistically high or low unless marked with an asterisk.

[2] Brain and Central Nervous System includes all tumors regardless of malignancy status, i.e., benign, in-situ, malignant and unknown status.

* $p < 0.05$

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 1b

Ten Regional Statistical Areas (RSA's) Combined in the Vicinity of Rocky Flats 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers
All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages)
Females

Cancer Site	Observed Cases	Expected Cases	Observed/ Expected Ratio[1]
All Cancers - All Ages	5,165	5,449.9	0.95***
All Cancers - Age 0-14	47	54.1	0.87
Esophagus	19	18.5	1.03
Stomach	72	67.1	1.07
Colon and Rectum	643	659.9	0.97
Liver	30	23.6	1.27
Lung	450	460.5	0.98
Bone	17	15.0	1.13
Leukemias	124	127.6	0.97
Lymphomas	182	175.7	1.04
Brain and CNS[2]	218	211.8	1.03

[1] Mantel-Haenszel Chi-Square statistic with one degree of freedom tests statistical significance of O/E ratios for the 10-RSA's combined. (Mantel and Haenszel, Journal of the National Cancer Institute, vol. 22, No. 4, p.719-748, April, 1959.) Ratios are not considered statistically high or low unless marked with an asterisk.

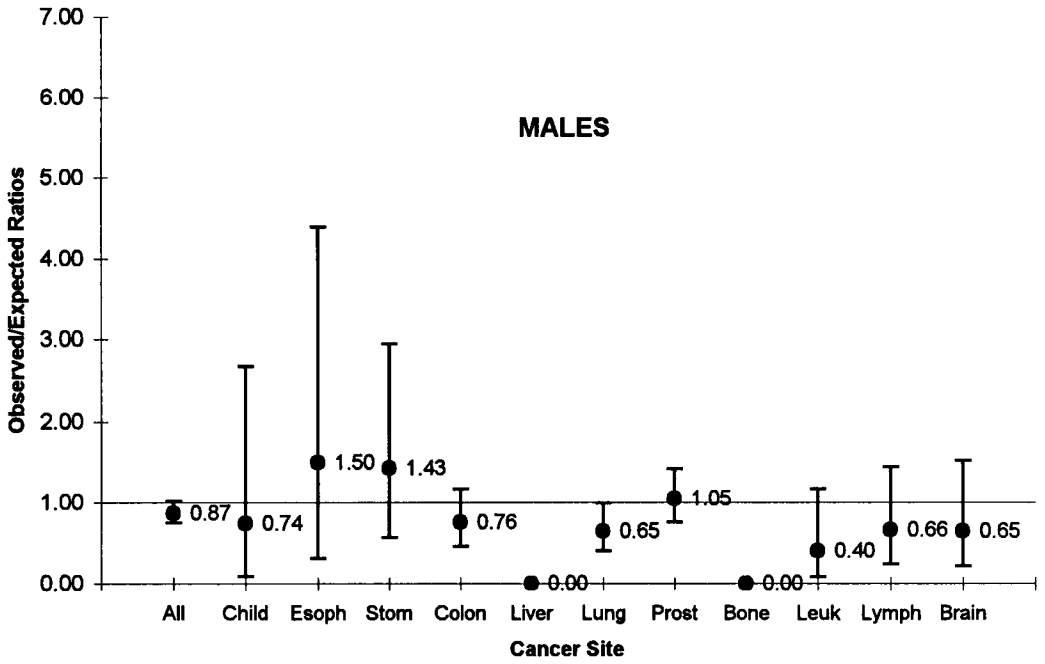
[2] Brain and Central Nervous System includes all tumors regardless of malignancy status, i.e., benign, in-situ, malignant and unknown status.

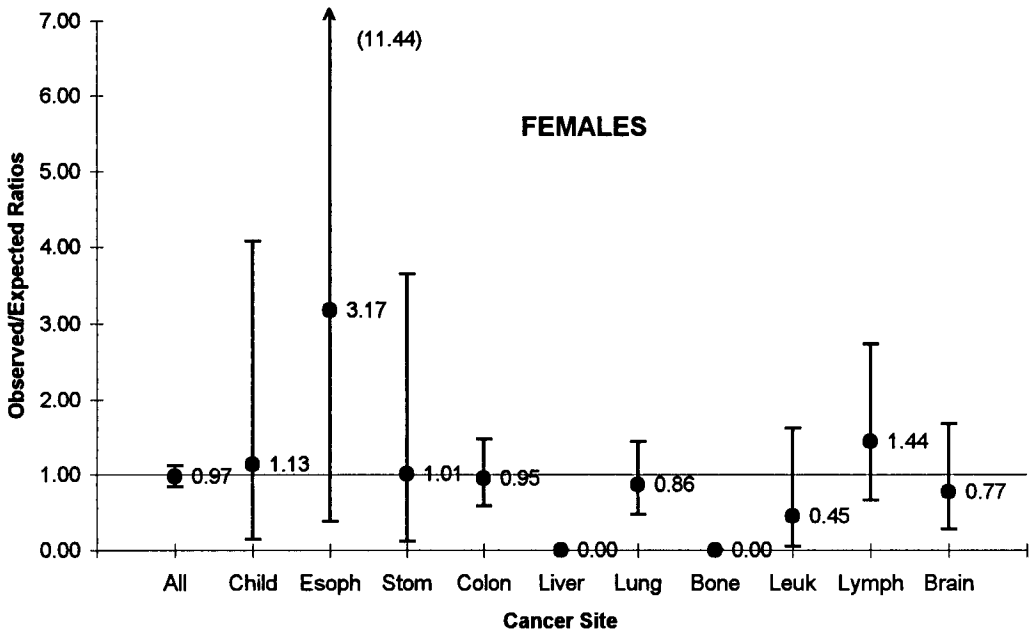
*** $p < 0.001$

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Figure 2

"Boulder City - Periphery" Regional Statistical Area (RSA 103) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers and 95% Confidence Intervals by Sex





O/E ratios with confidence intervals that include the value 1.00 are not considered statistically high or low.
Brain includes all brain and central nervous system tumors regardless of malignancy status.
See Tables 2a and 2b for observed and expected cancer counts used to calculate O/E ratios.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 2a

"Boulder City - Periphery" Regional Statistical Area (RSA 103) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers
All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages)
Males

Cancer Site	Observed Cases	Expected Cases[1]	Observed/ Expected Ratio	Confidence Interval[2] for Ratio
All Cancers - All Ages	175	202.3	0.87	0.75-1.02
All Cancers - Age 0-14	2	2.7	0.74	0.09-2.67
Esophagus	3	2.0	1.50	0.31-4.39
Stomach	7	4.9	1.43	0.57-2.95
Colon and Rectum	20	26.2	0.76	0.46-1.17
Liver	0	1.3	0.00	---
Lung	21	32.6	0.65*	0.40-0.99
Prostate	43	41.0	1.05	0.76-1.42
Bone	0	1.0	0.00	---
Leukemias	3	7.5	0.40	0.08-1.17
Lymphomas	6	9.2	0.66	0.24-1.44
Brain and CNS[3]	5	7.7	0.65	0.21-1.52

[1] Expected counts are derived from sex-, age- and race/ethnicity-specific Denver Metro rates outside the 10-RSA area.

[2] 95% confidence interval. A ratio having a confidence interval that includes the value 1.00 is not considered statistically high or low. (Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.)

[3] Brain and Central Nervous System includes all tumors regardless of malignancy status, i.e., benign, in-situ, malignant and unknown status.

* $p < 0.05$

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 2b

"Boulder City - Periphery" Regional Statistical Area (RSA 103) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers
All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages)
Females

Cancer Site	Observed Cases	Expected Cases[1]	Observed/ Expected Ratio	Confidence Interval[2] for Ratio
All Cancers - All Ages	190	196.8	0.97	0.84-1.12
All Cancers - Age 0-14	2	1.8	1.13	0.14-4.08
Esophagus	2	0.6	3.17	0.38-11.44
Stomach	2	2.0	1.01	0.12-3.65
Colon and Rectum	20	21.1	0.95	0.58-1.47
Liver	0	0.7	0.00	---
Lung	14	16.2	0.86	0.47-1.44
Bone	0	0.6	0.00	---
Leukemias	2	4.4	0.45	0.05-1.62
Lymphomas	9	6.2	1.44	0.66-2.73
Brain and CNS[3]	6	7.8	0.77	0.28-1.68

[1] Expected counts are derived from sex-, age- and race/ethnicity-specific Denver Metro rates outside the 10-RSA area.

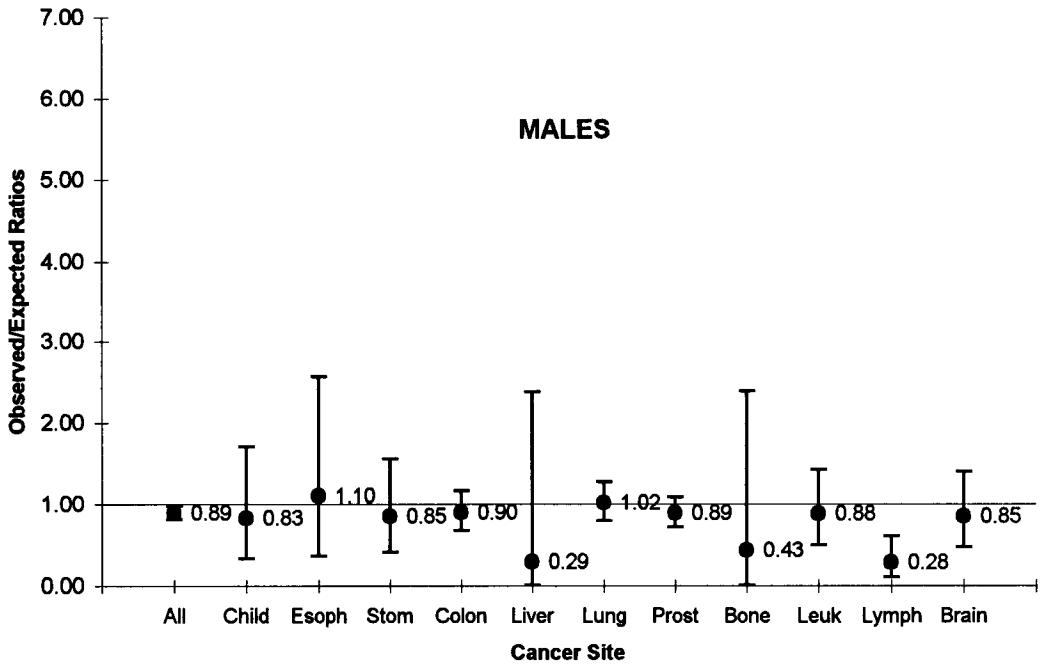
[2] 95% confidence interval. A ratio having a confidence interval that includes the value 1.00 is not considered statistically high or low. (Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.)

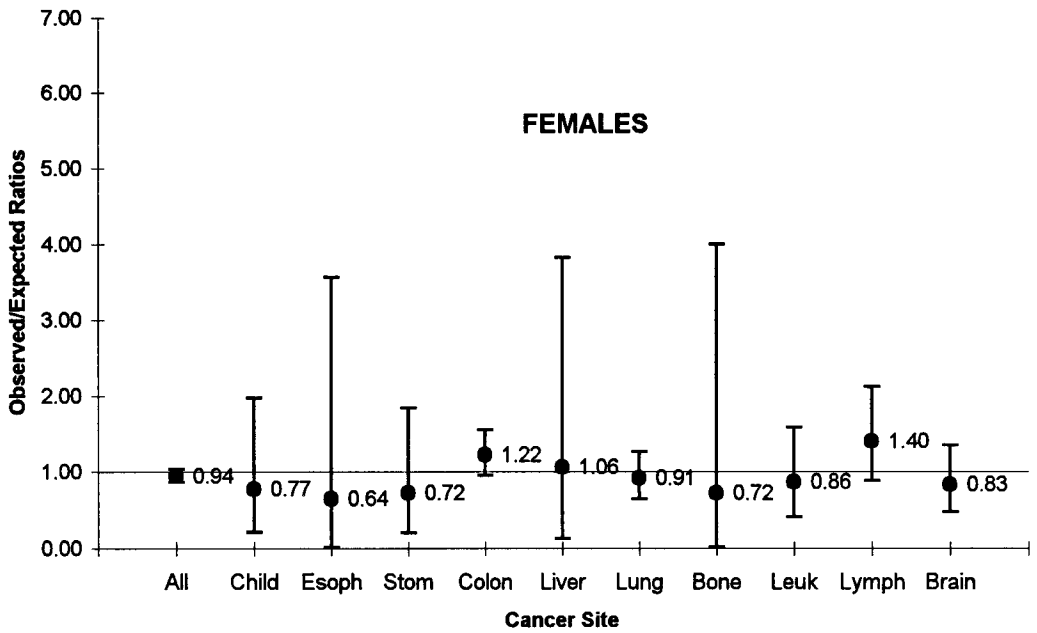
[3] Brain and Central Nervous System includes all tumors regardless of malignancy status, i.e., benign, in-situ, malignant and unknown status.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Figure 3

"Boulder - Tri Cities" Regional Statistical Area (RSA 106) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers and 95% Confidence Intervals by Sex





O/E ratios with confidence intervals that include the value 1.00 are not considered statistically high or low.
Brain includes all brain and central nervous system tumors regardless of malignancy status.
See Tables 3a and 3b for observed and expected cancer counts used to calculate O/E ratios.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 3a

"Boulder - Tri Cities" Regional Statistical Area (RSA 106) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers
All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages)
Males

Cancer Site	Observed Cases	Expected Cases[1]	Observed/ Expected Ratio	Confidence Interval[2] for Ratio
All Cancers - All Ages	421	475.2	0.89*	0.81-0.98
All Cancers - Age 0-14	7	8.5	0.83	0.33-1.71
Esophagus	5	4.6	1.10	0.36-2.57
Stomach	10	11.8	0.85	0.41-1.56
Colon and Rectum	55	61.2	0.90	0.68-1.17
Liver	1	3.4	0.29	0.01-2.38
Lung	76	74.2	1.02	0.80-1.28
Prostate	90	100.8	0.89	0.72-1.09
Bone	1	2.3	0.43	0.01-2.39
Leukemias	16	18.3	0.88	0.50-1.43
Lymphomas	6	21.2	0.28*	0.10-0.61
Brain and CNS[3]	15	17.7	0.85	0.47-1.40

[1] Expected counts are derived from sex-, age- and race/ethnicity-specific Denver Metro rates outside the 10-RSA area.

[2] 95% confidence interval. A ratio having a confidence interval that includes the value 1.00 is not considered statistically high or low. (Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.)

[3] Brain and Central Nervous System includes all tumors regardless of malignancy status, i.e., benign, in-situ, malignant and unknown status.

* $p < 0.05$

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 3b

"Boulder - Tri Cities" Regional Statistical Area (RSA 106) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers
All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages)
Females

Cancer Site	Observed Cases	Expected Cases[1]	Observed/ Expected Ratio	Confidence Interval[2] for Ratio
All Cancers - All Ages	455	482.3	0.94	0.86-1.03
All Cancers - Age 0-14	4	5.2	0.77	0.21-1.97
Esophagus	1	1.6	0.64	0.02-3.56
Stomach	4	5.6	0.72	0.20-1.84
Colon and Rectum	68	56.0	1.22	0.95-1.55
Liver	2	1.9	1.06	0.13-3.83
Lung	36	39.4	0.91	0.64-1.26
Bone	1	1.4	0.72	0.02-4.00
Leukemias	10	11.6	0.86	0.41-1.58
Lymphomas	22	15.7	1.40	0.88-2.12
Brain and CNS[3]	16	19.2	0.83	0.47-1.35

[1] Expected counts are derived from sex-, age- and race/ethnicity-specific Denver Metro rates outside the 10-RSA area.

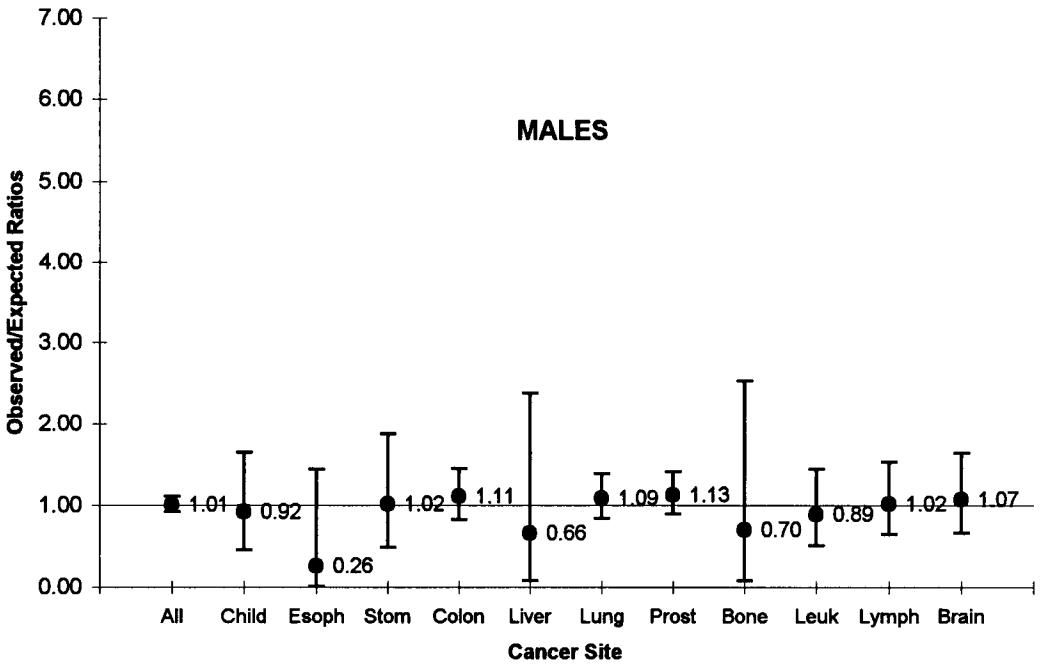
[2] 95% confidence interval. A ratio having a confidence interval that includes the value 1.00 is not considered statistically high or low. (Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.)

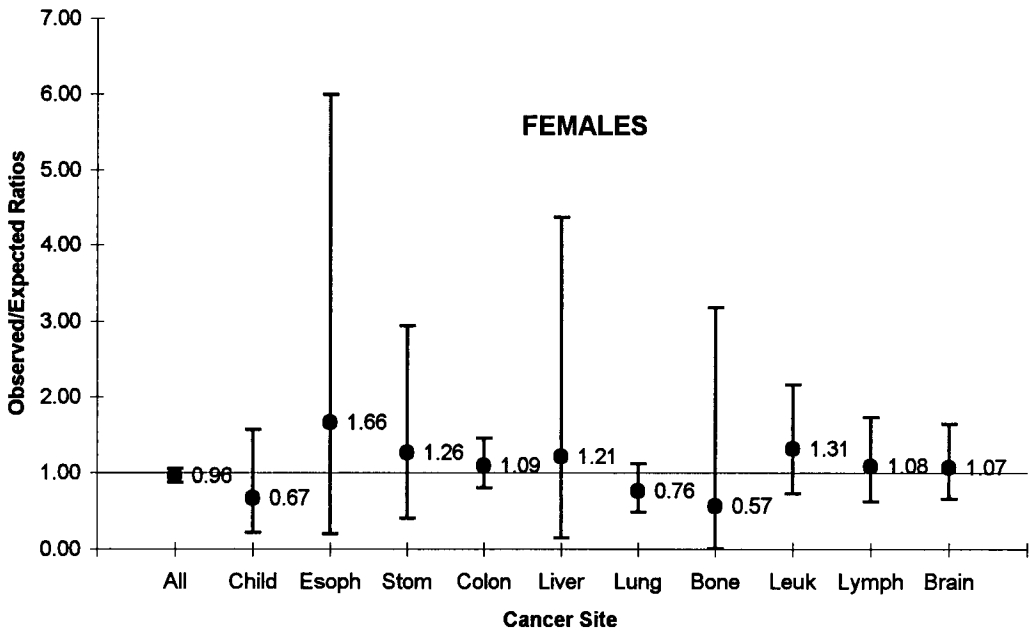
[3] Brain and Central Nervous System includes all tumors regardless of malignancy status, i.e., benign, in-situ, malignant and unknown status.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Figure 4

"Standley Lake - Periphery" Regional Statistical Area (RSA 202) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers and 95% Confidence Intervals by Sex





O/E ratios with confidence intervals that include the value 1.00 are not considered statistically high or low.
Brain includes all brain and central nervous system tumors regardless of malignancy status.
See Tables 4a and 4b for observed and expected cancer counts used to calculate O/E ratios.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 4a

"Standley Lake - Periphery" Regional Statistical Area (RSA 202) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers
All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages)
Males

Cancer Site	Observed Cases	Expected Cases[1]	Observed/ Expected Ratio	Confidence Interval[2] for Ratio
All Cancers - All Ages	419	413.6	1.01	0.92-1.11
All Cancers - Age 0-14	11	12.0	0.92	0.46-1.65
Esophagus	1	3.9	0.26	0.01-1.44
Stomach	10	9.8	1.02	0.49-1.88
Colon and Rectum	55	49.5	1.11	0.83-1.45
Liver	2	3.0	0.66	0.08-2.38
Lung	66	60.7	1.09	0.84-1.39
Prostate	79	69.8	1.13	0.90-1.41
Bone	2	2.9	0.70	0.08-2.53
Leukemias	16	18.1	0.89	0.51-1.44
Lymphomas	23	22.6	1.02	0.65-1.53
Brain and CNS[3]	21	19.6	1.07	0.66-1.64

[1] Expected counts are derived from sex-, age- and race/ethnicity-specific Denver Metro rates outside the 10-RSA area.

[2] 95% confidence interval. A ratio having a confidence interval that includes the value 1.00 is not considered statistically high or low. (Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.)

[3] Brain and Central Nervous System includes all tumors regardless of malignancy status, i.e., benign, in-situ, malignant and unknown status.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 4b

"Standley Lake - Periphery" Regional Statistical Area (RSA 202) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers
All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages)
Females

Cancer Site	Observed Cases	Expected Cases[1]	Observed/ Expected Ratio	Confidence Interval[2] for Ratio
All Cancers - All Ages	435	451.5	0.96	0.87-1.05
All Cancers - Age 0-14	5	7.5	0.67	0.22-1.57
Esophagus	2	1.2	1.66	0.20-5.99
Stomach	5	4.0	1.26	0.41-2.94
Colon and Rectum	45	41.2	1.09	0.80-1.46
Liver	2	1.7	1.21	0.15-4.37
Lung	25	32.7	0.76	0.49-1.12
Bone	1	1.8	0.57	0.01-3.17
Leukemias	15	11.4	1.31	0.73-2.16
Lymphomas	17	15.7	1.08	0.63-1.73
Brain and CNS[3]	21	19.7	1.07	0.66-1.64

[1] Expected counts are derived from sex-, age- and race/ethnicity-specific Denver Metro rates outside the 10-RSA area.

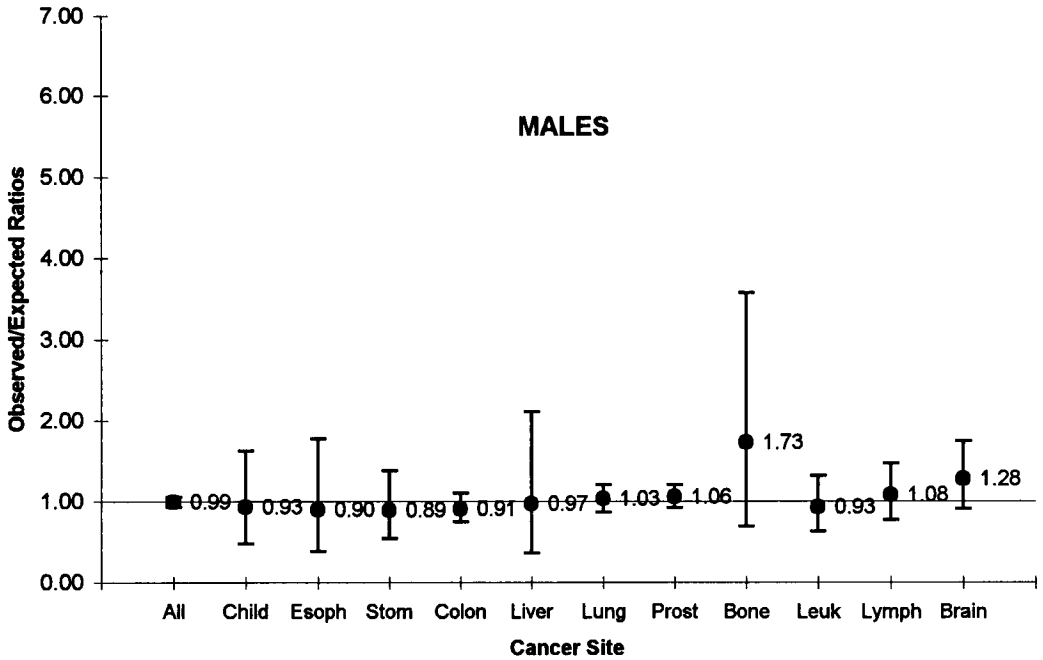
[2] 95% confidence interval. A ratio having a confidence interval that includes the value 1.00 is not considered statistically high or low. (Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.)

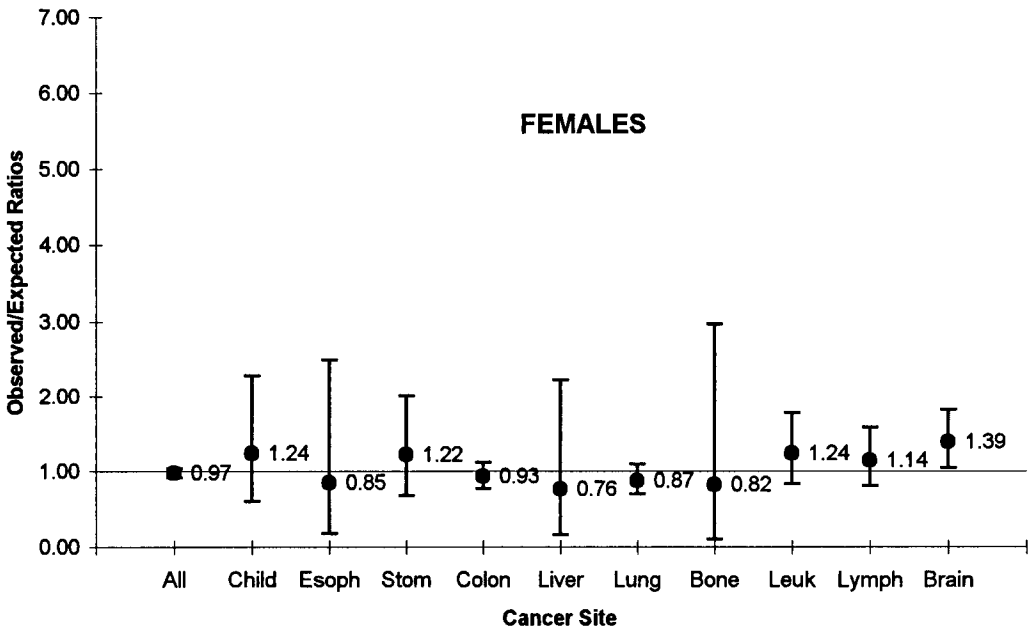
[3] Brain and Central Nervous System includes all tumors regardless of malignancy status, i.e., benign, in-situ, malignant and unknown status.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Figure 5

"Arvada" Regional Statistical Area (RSA 203) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers and 95% Confidence Intervals by Sex





O/E ratios with confidence intervals that include the value 1.00 are not considered statistically high or low.
Brain includes all brain and central nervous system tumors regardless of malignancy status.
See Tables 5a and 5b for observed and expected cancer counts used to calculate O/E ratios.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 5a

"Arvada" Regional Statistical Area (RSA 203) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers
All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages)
Males

Cancer Site	Observed Cases	Expected Cases[1]	Observed/ Expected Ratio	Confidence Interval[2] for Ratio
All Cancers - All Ages	905	915.1	0.99	0.93-1.06
All Cancers - Age 0-14	12	12.9	0.93	0.48-1.62
Esophagus	8	8.9	0.90	0.39-1.77
Stomach	20	22.6	0.89	0.54-1.38
Colon and Rectum	110	120.6	0.91	0.75-1.10
Liver	6	6.2	0.97	0.36-2.11
Lung	153	148.8	1.03	0.87-1.21
Prostate	215	203.0	1.06	0.92-1.21
Bone	7	4.0	1.73	0.69-3.57
Leukemias	31	33.4	0.93	0.63-1.32
Lymphomas	41	38.0	1.08	0.77-1.47
Brain and CNS[3]	40	31.3	1.28	0.91-1.74

[1] Expected counts are derived from sex-, age- and race/ethnicity-specific Denver Metro rates outside the 10-RSA area.

[2] 95% confidence interval. A ratio having a confidence interval that includes the value 1.00 is not considered statistically high or low. (Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.)

[3] Brain and Central Nervous System includes all tumors regardless of malignancy status, i.e., benign, in-situ, malignant and unknown status.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 5b

"Arvada" Regional Statistical Area (RSA 203) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers
All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages)
Females

Cancer Site	Observed Cases	Expected Cases[1]	Observed/ Expected Ratio	Confidence Interval[2] for Ratio
All Cancers - All Ages	977	1004.1	0.97	0.91-1.03
All Cancers - Age 0-14	10	8.1	1.24	0.60-2.28
Esophagus	3	3.5	0.85	0.18-2.49
Stomach	15	12.3	1.22	0.68-2.01
Colon and Rectum	117	126.4	0.93	0.77-1.12
Liver	3	4.0	0.76	0.16-2.22
Lung	76	87.1	0.87	0.69-1.09
Bone	2	2.4	0.82	0.10-2.96
Leukemias	29	23.4	1.24	0.83-1.78
Lymphomas	36	31.6	1.14	0.80-1.58
Brain and CNS[3]	53	38.1	1.39*	1.04-1.82

[1] Expected counts are derived from sex-, age- and race/ethnicity-specific Denver Metro rates outside the 10-RSA area.

[2] 95% confidence interval. A ratio having a confidence interval that includes the value 1.00 is not considered statistically high or low. (Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.)

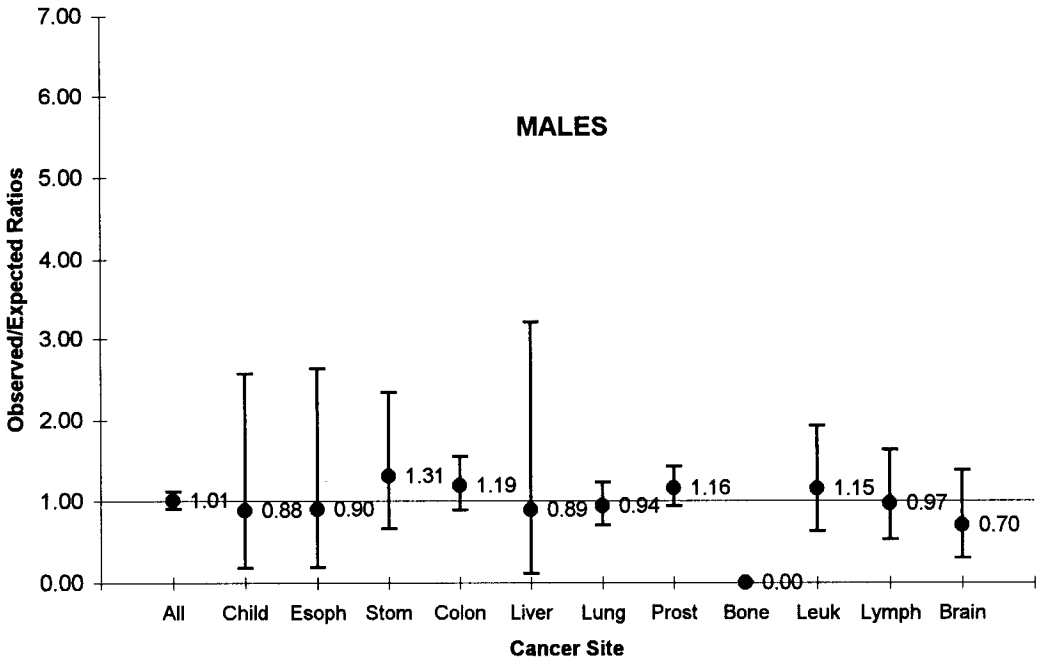
[3] Brain and Central Nervous System includes all tumors regardless of malignancy status, i.e., benign, in-situ, malignant and unknown status.

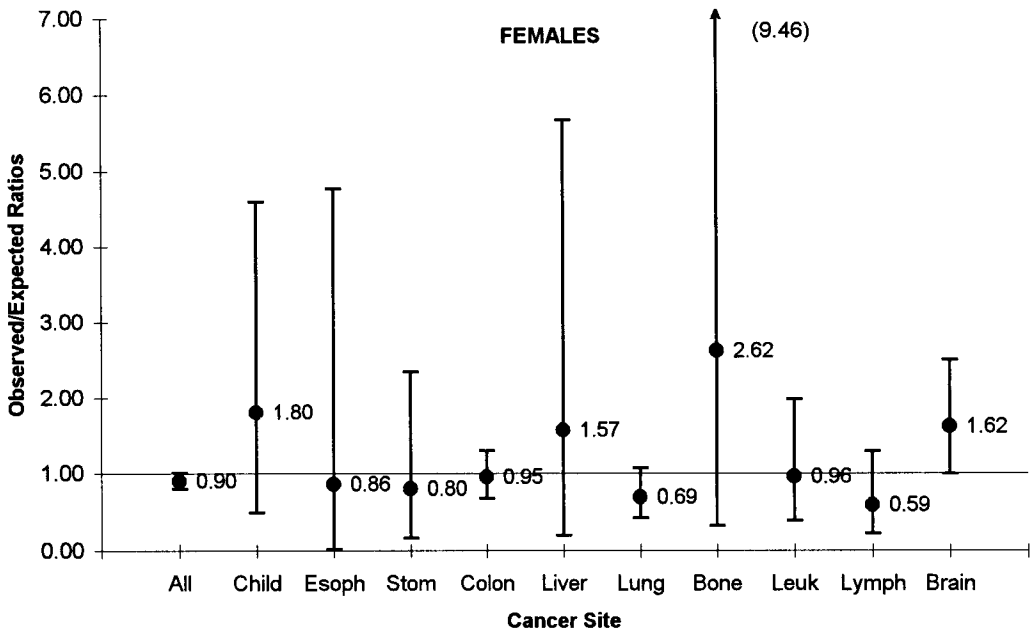
* $p < 0.05$

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Figure 6

"Golden" Regional Statistical Area (RSA 204) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers and 95% Confidence Intervals by Sex





O/E ratios with confidence intervals that include the value 1.00 are not considered statistically high or low.
Brain includes all brain and central nervous system tumors regardless of malignancy status.
See Tables 6a and 6b for observed and expected cancer counts used to calculate O/E ratios.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 6a

"Golden" Regional Statistical Area (RSA 204) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers
All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages)
Males

Cancer Site	Observed Cases	Expected Cases[1]	Observed/ Expected Ratio	Confidence Interval[2] for Ratio
All Cancers - All Ages	347	345.0	1.01	0.91-1.12
All Cancers - Age 0-14	3	3.4	0.88	0.18-2.57
Esophagus	3	3.3	0.90	0.19-2.63
Stomach	11	8.4	1.31	0.66-2.34
Colon and Rectum	54	45.5	1.19	0.89-1.55
Liver	2	2.2	0.89	0.11-3.21
Lung	53	56.4	0.94	0.70-1.23
Prostate	90	77.5	1.16	0.94-1.43
Bone	0	1.5	0.00	---
Leukemias	14	12.2	1.15	0.63-1.93
Lymphomas	14	14.4	0.97	0.53-1.63
Brain and CNS[3]	8	11.5	0.70	0.30-1.38

[1] Expected counts are derived from sex-, age- and race/ethnicity-specific Denver Metro rates outside the 10-RSA area.

[2] 95% confidence interval. A ratio having a confidence interval that includes the value 1.00 is not considered statistically high or low. Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.

[3] Brain and Central Nervous System includes all tumors regardless of malignancy status, i.e., benign, in-situ, malignant and unknown status.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 6b

"Golden" Regional Statistical Area (RSA 204) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers
All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages)
Females

Cancer Site	Observed Cases	Expected Cases[1]	Observed/ Expected Ratio	Confidence Interval[2] for Ratio
All Cancers - All Ages	293	326.5	0.90	0.80-1.01
All Cancers - Age 0-14	4	2.2	1.80	0.49-4.60
Esophagus	1	1.2	0.86	0.02-4.78
Stomach	3	3.8	0.80	0.16-2.34
Colon and Rectum	38	39.9	0.95	0.67-1.30
Liver	2	1.3	1.57	0.19-5.67
Lung	20	29.2	0.69	0.42-1.07
Bone	2	0.8	2.62	0.32-9.46
Leukemias	7	7.3	0.96	0.39-1.98
Lymphomas	6	10.2	0.59	0.22-1.29
Brain and CNS[3]	20	12.3	1.62	0.99-2.50

[1] Expected counts are derived from sex-, age- and race/ethnicity-specific Denver Metro rates outside the 10-RSA area.

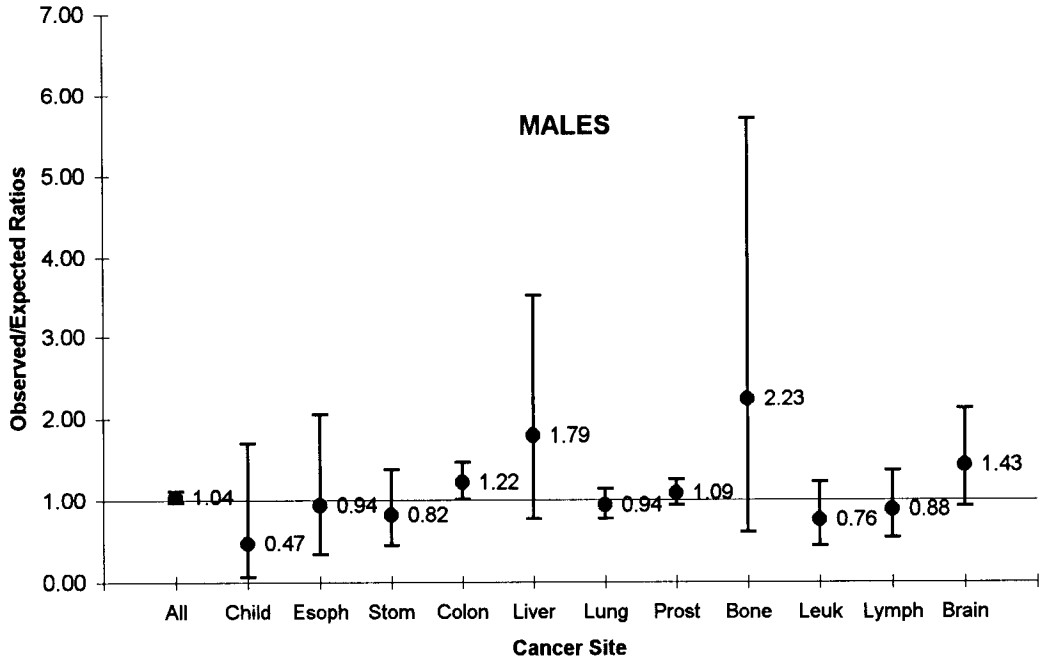
[2] 95% confidence interval. A ratio having a confidence interval that includes the value 1.00 is not considered statistically high or low. (Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.)

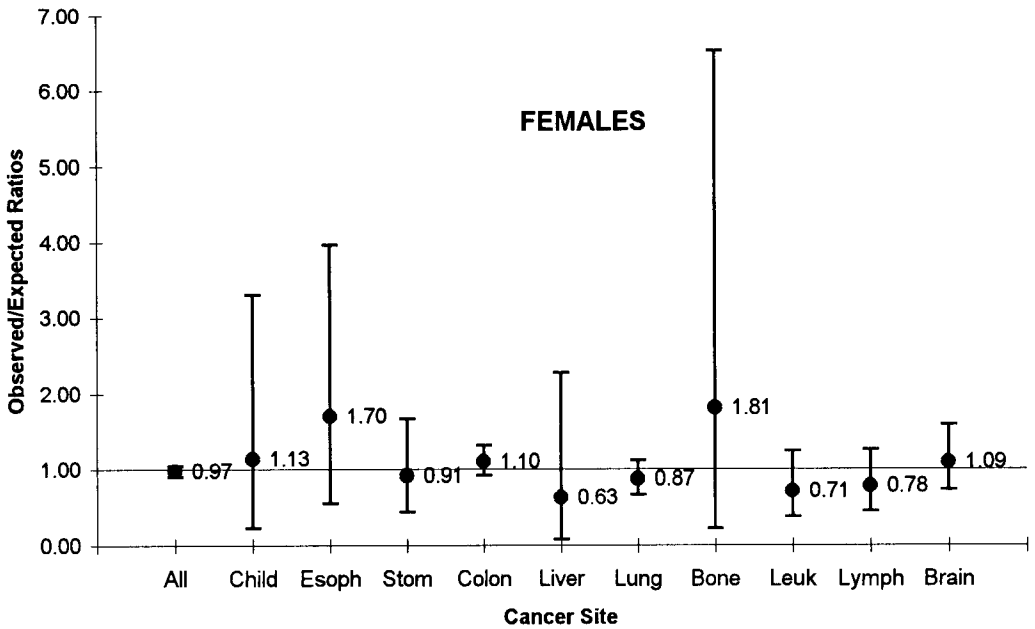
[3] Brain and Central Nervous System includes all tumors regardless of malignancy status, i.e., benign, in-situ, malignant and unknown status.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Figure 7

"Wheat Ridge" Regional Statistical Area (RSA 205) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers and 95% Confidence Intervals by Sex





O/E ratios with confidence intervals that include the value 1.00 are not considered statistically high or low.
Brain includes all brain and central nervous system tumors regardless of malignancy status.
See Tables 7a and 7b for observed and expected cancer counts used to calculate O/E ratios.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 7a

"Wheat Ridge" Regional Statistical Area (RSA 205) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers
All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages)
Males

Cancer Site	Observed Cases	Expected Cases	Observed/ Expected Ratio	Confidence Interval[1] for Ratio
All Cancers - All Ages	707	677.7	1.04	0.97-1.12
All Cancers - Age 0-14	2	4.2	0.47	0.06-1.70
Esophagus	6	6.4	0.94	0.34-2.05
Stomach	14	17.0	0.82	0.45-1.38
Colon and Rectum	115	94.2	1.22*	1.01-1.47
Liver	8	4.5	1.79	0.77-3.52
Lung	105	112.0	0.94	0.77-1.14
Prostate	194	178.4	1.09	0.94-1.25
Bone	4	1.8	2.23	0.61-5.70
Leukemias	17	22.5	0.76	0.44-1.22
Lymphomas	20	22.8	0.88	0.54-1.36
Brain and CNS[2]	25	17.5	1.43	0.92-2.11

[1] Expected counts are derived from sex-, age- and race/ethnicity-specific Denver Metro rates outside the 10-RSA area.

[2] 95% confidence interval. A ratio having a confidence interval that includes the value 1.00 is not considered statistically high or low. (Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.)

[3] Brain and Central Nervous System includes all tumors regardless of malignancy status, i.e., benign, in-situ, malignant and unknown status.

* $p < 0.05$

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 7b

"Wheat Ridge" Regional Statistical Area (RSA 205) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers
All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages)
Females

Cancer Site	Observed Cases	Expected Cases[1]	Observed/ Expected Ratio	Confidence Interval[2] for Ratio
All Cancers - All Ages	712	735.8	0.97	0.90-1.04
All Cancers - Age 0-14	3	2.7	1.13	0.23-3.30
Esophagus	5	3.0	1.70	0.55-3.97
Stomach	10	11.0	0.91	0.44-1.67
Colon and Rectum	121	110.5	1.10	0.91-1.31
Liver	2	3.2	0.63	0.08-2.27
Lung	60	68.9	0.87	0.66-1.12
Bone	2	1.1	1.81	0.22-6.53
Leukemias	12	17.0	0.71	0.37-1.24
Lymphomas	17	21.9	0.78	0.45-1.25
Brain and CNS[3]	28	25.7	1.09	0.73-1.58

[1] Expected counts are derived from sex-, age- and race/ethnicity-specific Denver Metro rates outside the 10-RSA area.

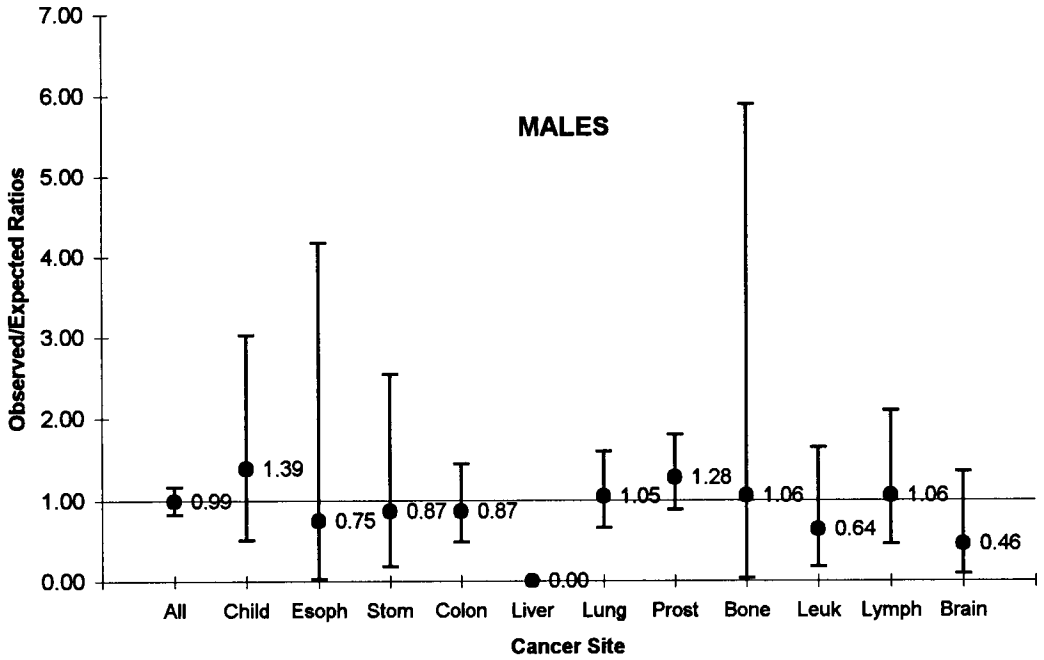
[2] 95% confidence interval. A ratio having a confidence interval that includes the value 1.00 is not considered statistically high or low. (Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.)

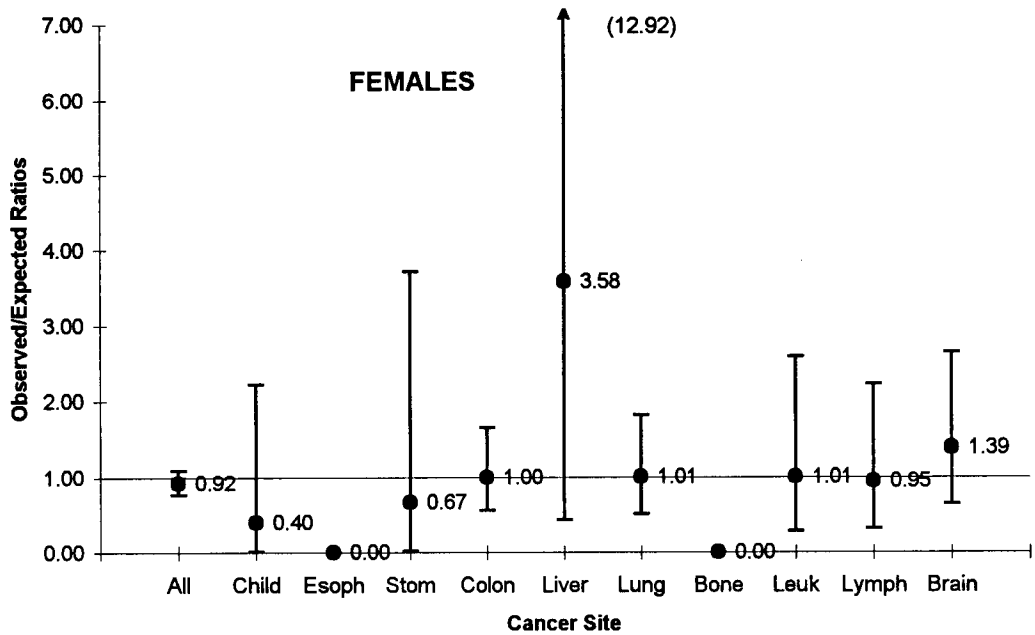
[3] Brain and Central Nervous System includes all tumors regardless of malignancy status, i.e., benign, in-situ, malignant and unknown status.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Figure 8

"Adams - Northwest" Regional Statistical Area (RSA 301) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers and 95% Confidence Intervals by Sex





O/E ratios with confidence intervals that include the value 1.00 are not considered statistically high or low.
Brain includes all brain and central nervous system tumors regardless of malignancy status.
See Tables 8a and 8b for observed and expected cancer counts used to calculate O/E ratios.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 8a

"Adams - Northwest" Regional Statistical Area (RSA 301) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers
All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages)
Males

Cancer Site	Observed Cases	Expected Cases[1]	Observed/ Expected Ratio	Confidence Interval[2] for Ratio
All Cancers - All Ages	141	142.9	0.99	0.83-1.17
All Cancers - Age 0-14	6	4.3	1.39	0.51-3.03
Esophagus	1	1.3	0.75	0.02-4.17
Stomach	3	3.5	0.87	0.18-2.54
Colon and Rectum	15	17.2	0.87	0.49-1.44
Liver	0	1.1	0.00	---
Lung	22	20.9	1.05	0.66-1.59
Prostate	33	25.7	1.28	0.88-1.80
Bone	1	0.9	1.06	0.03-5.89
Leukemias	4	6.3	0.64	0.17-1.64
Lymphomas	8	7.5	1.06	0.46-2.09
Brain and CNS[3]	3	6.5	0.46	0.09-1.35

[1] Expected counts are derived from sex-, age- and race/ethnicity-specific Denver Metro rates outside the 10-RSA area.

[2] 95% confidence interval. A ratio having a confidence interval that includes the value 1.00 is not considered statistically high or low. (Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.)

[3] Brain and Central Nervous System includes all tumors regardless of malignancy status, i.e., benign, in-situ, malignant and unknown status.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 8b

"Adams - Northwest" Regional Statistical Area (RSA 301) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers
All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages)
Females

Cancer Site	Observed Cases	Expected Cases[1]	Observed/ Expected Ratio	Confidence Interval[2] for Ratio
All Cancers - All Ages	138	150.3	0.92	0.77-1.09
All Cancers - Age 0-14	1	2.5	0.40	0.01-2.22
Esophagus	0	0.4	0.00	---
Stomach	1	1.5	0.67	0.02-3.72
Colon and Rectum	15	15.0	1.00	0.56-1.65
Liver	2	0.6	3.58	0.43-12.92
Lung	11	10.9	1.01	0.51-1.81
Bone	0	0.6	0.00	---
Leukemias	4	4.0	1.01	0.28-2.58
Lymphomas	5	5.3	0.95	0.31-2.22
Brain and CNS[3]	9	6.5	1.39	0.64-2.64

[1] Expected counts are derived from sex-, age- and race/ethnicity-specific Denver Metro rates outside the 10-RSA area.

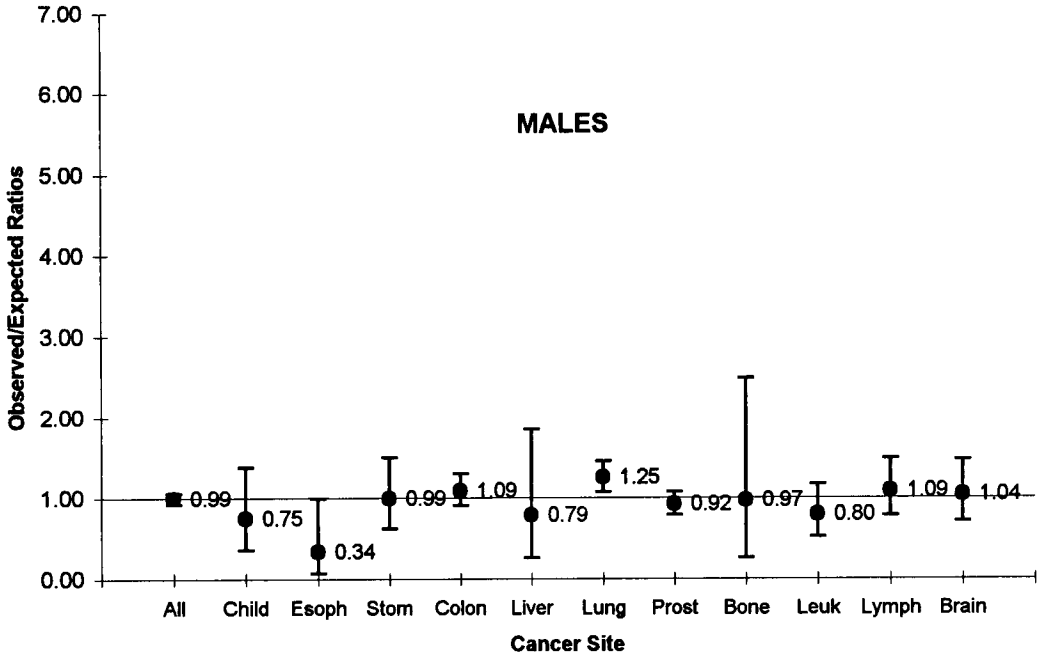
[2] 95% confidence interval. A ratio having a confidence interval that includes the value 1.00 is not considered statistically high or low. (Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.)

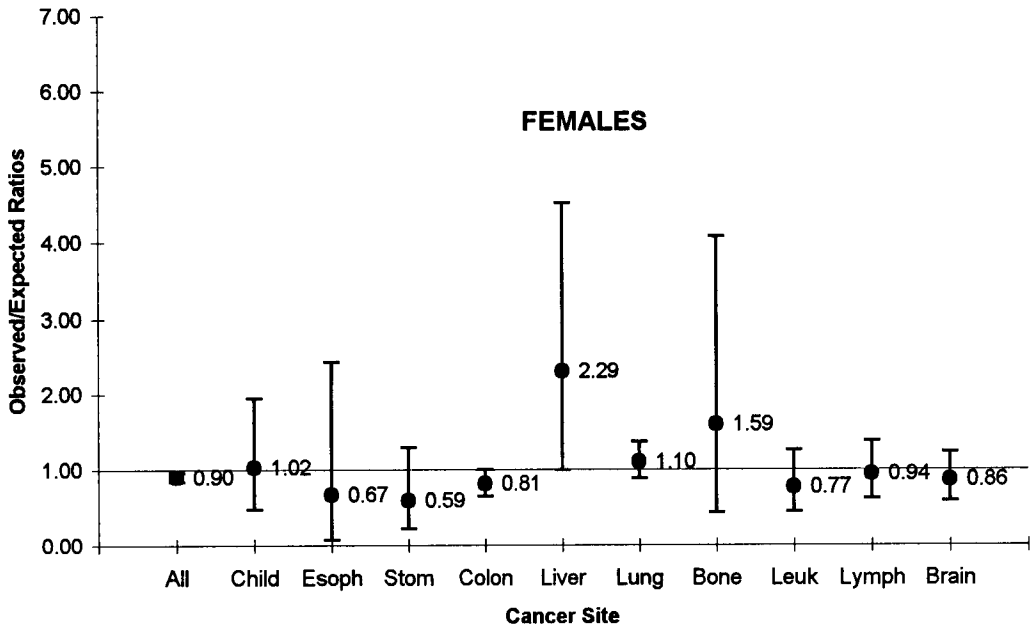
[3] Brain and Central Nervous System includes all tumors regardless of malignancy status, i.e., benign, in-situ, malignant and unknown status.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Figure 9

"Adams - West" Regional Statistical Area (RSA 304) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers and 95% Confidence Intervals by Sex





O/E ratios with confidence intervals that include the value 1.00 are not considered statistically high or low.
Brain includes all brain and central nervous system tumors regardless of malignancy status.
See Tables 9a and 9b for observed and expected cancer counts used to calculate O/E ratios.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 9a

"Adams - West" Regional Statistical Area (RSA 304) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers
All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages)
Males

Cancer Site	Observed Cases	Expected Cases[1]	Observed/ Expected Ratio	Confidence Interval[2] for Ratio
All Cancers - All Ages	865	872.5	0.99	0.92-1.06
All Cancers - Age 0-14	10	13.4	0.75	0.36-1.38
Esophagus	3	8.8	0.34*	0.07-0.99
Stomach	22	22.2	0.99	0.62-1.50
Colon and Rectum	124	114.2	1.09	0.91-1.30
Liver	5	6.3	0.79	0.26-1.85
Lung	177	141.4	1.25**	1.07-1.45
Prostate	172	186.2	0.92	0.79-1.07
Bone	4	4.1	0.97	0.26-2.48
Leukemias	26	32.3	0.80	0.52-1.17
Lymphomas	41	37.5	1.09	0.78-1.48
Brain and CNS[3]	32	30.8	1.04	0.71-1.47

[1] Expected counts are derived from sex-, age- and race/ethnicity-specific Denver Metro rates outside the 10-RSA area.

[2] 95% confidence interval. A ratio having a confidence interval that includes the value 1.00 is not considered statistically high or low. (Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.)

[3] Brain and Central Nervous System includes all tumors regardless of malignancy status, i.e., benign, in-situ, malignant and unknown status.

* $p < 0.05$
** $p < 0.01$

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 9b

"Adams - West" Regional Statistical Area (RSA 304) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers
All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages)
Females

Cancer Site	Observed Cases	Expected Cases[1]	Observed/ Expected Ratio	Confidence Interval[2] for Ratio
All Cancers - All Ages	817	902.9	0.90**	0.84-0.96
All Cancers - Age 0-14	9	8.8	1.02	0.47-1.94
Esophagus	2	3.0	0.67	0.08-2.42
Stomach	6	10.2	0.59	0.22-1.29
Colon and Rectum	84	103.4	0.81	0.65-1.00
Liver	8	3.5	2.29	0.99-4.51
Lung	86	77.8	1.10	0.88-1.36
Bone	4	2.5	1.59	0.43-4.07
Leukemias	16	20.8	0.77	0.44-1.25
Lymphomas	27	28.8	0.94	0.62-1.37
Brain and CNS[3]	30	35.0	0.86	0.58-1.23

[1] Expected counts are derived from sex-, age- and race/ethnicity-specific Denver Metro rates outside the 10-RSA area.

[2] 95% confidence interval. A ratio having a confidence interval that includes the value 1.00 is not considered statistically high or low. (Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.)

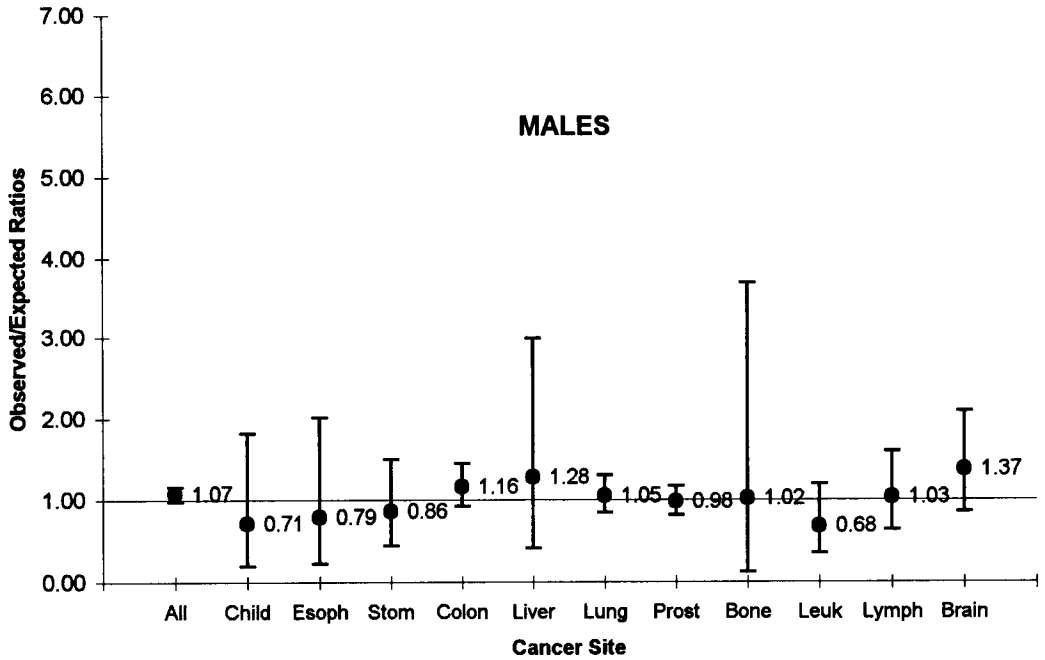
[3] Brain and Central Nervous System includes all tumors regardless of malignancy status, i.e., benign, in-situ, malignant and unknown status.

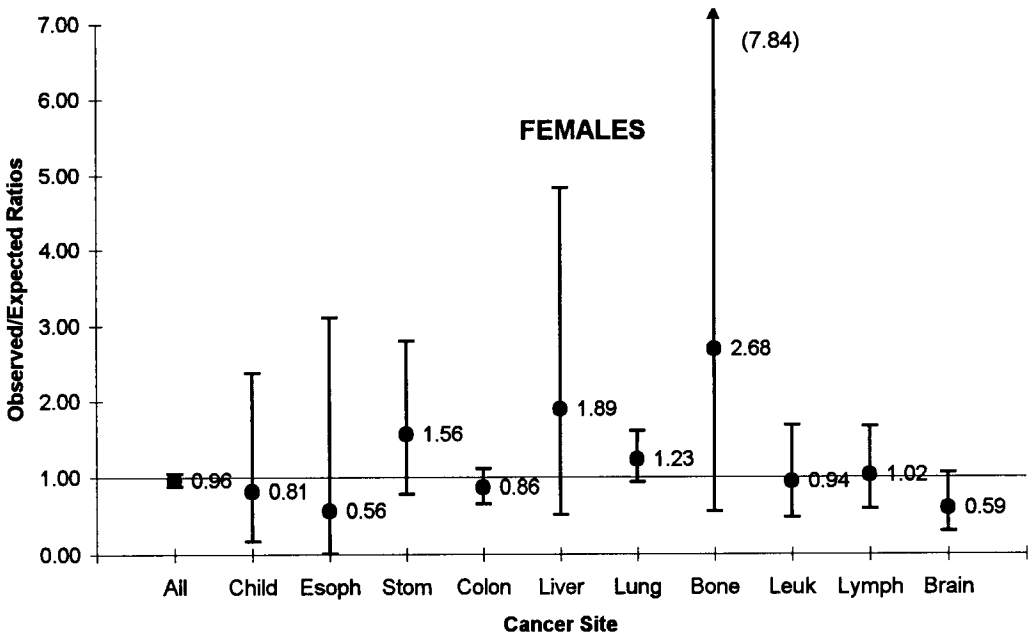
** $p < 0.01$

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Figure 10

"Adams - Clear Creek Valley" Regional Statistical Area (RSA 305) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers and 95% Confidence Intervals by Sex





O/E ratios with confidence intervals that include the value 1.00 are not considered statistically high or low.
Brain includes all brain and central nervous system tumors regardless of malignancy status.
See Tables 10a and 10b for observed and expected cancer counts used to calculate O/E ratios.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 10a

"Adams - Clear Creek Valley" Regional Statistical Area (RSA 305) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers
All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages)
Males

Cancer Site	Observed Cases	Expected Cases[1]	Observed/ Expected Ratio	Confidence Interval[2] for Ratio
All Cancers - All Ages	545	508.6	1.07	0.98-1.16
All Cancers - Age 0-14	4	5.6	0.71	0.19-1.82
Esophagus	4	5.1	0.79	0.22-2.02
Stomach	12	13.9	0.86	0.44-1.50
Colon and Rectum	80	68.9	1.16	0.92-1.44
Liver	5	3.9	1.28	0.41-2.99
Lung	87	82.9	1.05	0.84-1.30
Prostate	118	120.5	0.98	0.81-1.17
Bone	2	2.0	1.02	0.12-3.68
Leukemias	12	17.7	0.68	0.35-1.19
Lymphomas	20	19.4	1.03	0.63-1.59
Brain and CNS[3]	21	15.3	1.37	0.85-2.09

[1] Expected counts are derived from sex-, age- and race/ethnicity-specific Denver Metro rates outside the 10-RSA area.

[2] 95% confidence interval. A ratio having a confidence interval that includes the value 1.00 is not considered statistically high or low. (Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.)

[3] Brain and Central Nervous System includes all tumors regardless of malignancy status, i.e., benign, in-situ, malignant and unknown status.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 10b

"Adams - Clear Creek Valley" Regional Statistical Area (RSA 305) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers
All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages)
Females

Cancer Site	Observed Cases	Expected Cases[1]	Observed/ Expected Ratio	Confidence Interval[2] for Ratio
All Cancers - All Ages	485	507.6	0.96	0.88-1.05
All Cancers - Age 0-14	3	3.7	0.81	0.17-2.37
Esophagus	1	1.8	0.56	0.01-3.11
Stomach	11	7.1	1.56	0.78-2.79
Colon and Rectum	58	67.2	0.86	0.65-1.11
Liver	4	2.1	1.89	0.51-4.83
Lung	56	45.5	1.23	0.93-1.60
Bone	3	1.1	2.68	0.55-7.84
Leukemias	11	11.8	0.94	0.47-1.68
Lymphomas	16	15.6	1.02	0.58-1.66
Brain and CNS[3]	11	18.7	0.59	0.30-1.06

[1] Expected counts are derived from sex-, age- and race/ethnicity-specific Denver Metro rates outside the 10-RSA area.

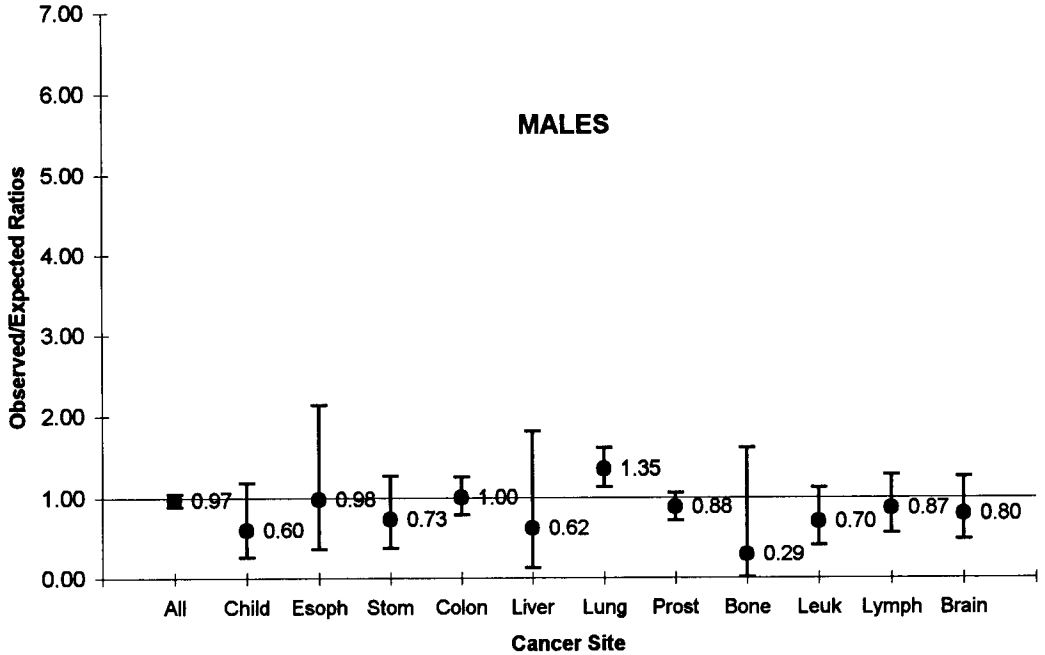
[2] 95% confidence interval. A ratio having a confidence interval that includes the value 1.00 is not considered statistically high or low. Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.

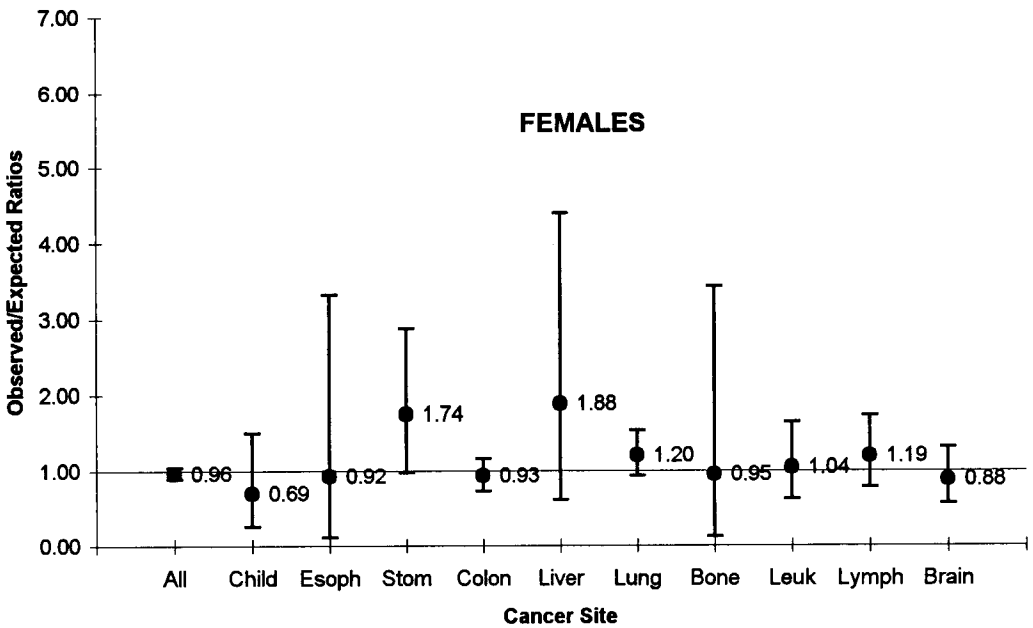
[3] Brain and Central Nervous System includes all tumors regardless of malignancy status, i.e., benign, in-situ, malignant and unknown status.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Figure 11

"Northglenn - Thornton" Regional Statistical Area (RSA 306) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers and 95% Confidence Intervals by Sex





O/E ratios with confidence intervals that include the value 1.00 are not considered statistically high or low.
Brain includes all brain and central nervous system tumors regardless of malignancy status.
See Tables 11a and 11b for observed and expected cancer counts used to calculate O/E ratios.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 11a

"Northglenn-Thornton" Regional Statistical Area (RSA 306) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers
All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages)
Males

Cancer Site	Observed Cases	Expected Cases[1]	Observed/ Expected Ratio	Confidence Interval[2] for Ratio
All Cancers - All Ages	598	617.8	0.97	0.89-1.05
All Cancers - Age 0-14	8	13.3	0.60	0.26-1.18
Esophagus	6	6.1	0.98	0.36-2.14
Stomach	12	16.4	0.73	0.38-1.27
Colon and Rectum	79	78.9	1.00	0.79-1.25
Liver	3	4.9	0.62	0.13-1.81
Lung	129	95.4	1.35**	1.13-1.61
Prostate	110	125.2	0.88	0.72-1.06
Bone	1	3.5	0.29	0.01-1.61
Leukemias	17	24.5	0.70	0.41-1.12
Lymphomas	25	28.6	0.87	0.56-1.28
Brain and CNS[3]	19	23.6	0.80	0.48-1.25

[1] Expected counts are derived from sex-, age- and race/ethnicity-specific Denver Metro rates outside the 10-RSA area.

[2] 95% confidence interval. A ratio having a confidence interval that includes the value 1.00 is not considered statistically high or low. (Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.)

[3] Brain and Central Nervous System includes all tumors regardless of malignancy status, i.e., benign, in-situ, malignant and unknown status.

** $p < 0.01$

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 11b

"Northglenn - Thornton" Regional Statistical Area (RSA 306) 1980-89
Ratios of Observed to Expected Counts of Invasive Cancers
All Cancers Combined (All Ages and Children 0-14) and Ten Selected Cancers (All Ages)
Females

Cancer Site	Observed Cases	Expected Cases[1]	Observed/ Expected Ratio	Confidence Interval[2] for Ratio
All Cancers - All Ages	663	691.4	0.96	0.89-1.04
All Cancers - Age 0-14	6	8.7	0.69	0.25-1.50
Esophagus	2	2.2	0.92	0.11-3.32
Stomach	15	8.6	1.74	0.97-2.87
Colon and Rectum	77	82.8	0.93	0.73-1.16
Liver	5	2.7	1.88	0.61-4.39
Lung	66	55.0	1.20	0.93-1.53
Bone	2	2.1	0.95	0.12-3.43
Leukemias	18	17.4	1.04	0.62-1.64
Lymphomas	27	22.7	1.19	0.78-1.73
Brain and CNS[3]	24	27.3	0.88	0.56-1.31

[1] Expected counts are derived from sex-, age- and race/ethnicity-specific Denver Metro rates outside the 10-RSA area.

[2] 95% confidence interval. A ratio having a confidence interval that includes the value 1.00 is not considered statistically high or low. (Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.)

[3] Brain and Central Nervous System includes all tumors regardless of malignancy status, i.e., benign, in-situ, malignant and unknown status.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 12

"Arvada" Regional Statistical Area (RSA 203) 1980-89
Ratios of Observed to Expected Counts by Age and Race/Ethnicity
Brain and Central Nervous System Tumors[1]
Females

Age	Non-Hispanic White			Hispanic[2]			Non-Hispanic Black		
	Obs	Exp	O/E†	Obs	Exp	O/E	Obs	Exp	O/E
0- 4	1	0.641	1.56	0	0.117	0.00	0	0.013	0.00
5- 9	0	0.551	0.00	0	0.066	0.00	0	0.012	0.00
10-14	0	0.373	0.00	0	0.000	0.00	0	0.012	0.00
15-19	2	0.641	3.12	1	0.032	31.25	0	0.000	---
20-24	2	0.809	2.47	0	0.027	0.00	0	0.000	---
25-34	1	2.819	0.35	0	0.031	0.00	0	0.004	0.00
35-44	5	4.358	1.15	1	0.173	5.78	0	0.021	0.00
45-54	5	5.805	0.86	0	0.194	0.00	0	0.012	0.00
55-64	14	7.914	1.77	2	0.205	9.76*	0	0.008	0.00
65-74	10	7.283	1.37	0	0.096	0.00	0	0.018	0.00
75+	9	6.388	1.41	0	0.170	0.00	0	0.005	0.00
Total	49	36.862	1.33	4	1.109	3.61	0	0.104	0.00

[1] Brain and Central Nervous System includes all tumors regardless of malignancy status, i.e., benign, in-situ, malignant and unknown status.

[2] Hispanic ethnicity includes persons of any race.

† O/E is the observed/expected ratio. Ratios that are statistically high or low are marked with asterisks. (Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.)

* $p < 0.05$

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 13

"Arvada" Regional Statistical Area (RSA 203) 1980-89
Observed and Expected Counts by Histology
Brain and Central Nervous System Tumors[1]
Females

ICDO[2] Code - Histology	Observed	Expected[3]
940 - Astrocytoma	8	6.94
944 - Glioblastoma	6	6.10
953 - Meningioma	26	25.07
All Other Histologies[4]	13	14.91

Summary $\chi^2_{d.f.3} = 0.43$ ($p > 0.97$)

[1] Brain and Central Nervous System includes all tumors regardless of malignancy status, i.e., benign, in-situ, malignant and unknown status.

[2] International Classification of Diseases for Oncology.

[3] Expected numbers were derived by applying the histologic type distribution of brain and CNS tumors in females in the 6-county Denver Metro area to the number of brain and CNS tumors in females in the RSA.

[4] Histologies with fewer than 5 expected cases were included in the "all other" category.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 14

"Arvada" Regional Statistical Area (RSA 203) 1990-95
Ratio of Observed to Expected Counts
Brain and CNS Tumors[1]
Females

Observed Cases	Expected Cases[2]	Observed/ Expected Ratio	Confidence Interval[3] for Ratio
34	33.0	1.03	0.71-1.44

[1] Brain and Central Nervous System includes all tumors regardless of malignancy status, i.e., benign, in-situ, malignant and unknown status.

[2] Expected counts are derived from sex- and age-specific Denver Metro rates outside the 10-RSA area.

[3] 95% confidence interval. A ratio having a confidence interval that includes the value 1.00 is not considered statistically high or low. (Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.)

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 15

"Wheat Ridge" Regional Statistical Area (RSA 205) 1980-89
Ratios of Observed to Expected Counts by Age and Race/Ethnicity
Colon and Rectum Cancers
Males

Age	Non-Hispanic White			Hispanic[1]			Non-Hispanic Black		
	Obs	Exp	O/E[†]	Obs	Exp	O/E	Obs	Exp	O/E
0- 4	0	0.000	---	0	0.000	---	0	0.000	---
5- 9	0	0.000	---	0	0.000	---	0	0.000	---
10-14	0	0.043	0.00	0	0.000	---	0	0.001	0.00
15-19	0	0.000	---	0	0.000	---	0	0.000	---
20-24	0	0.023	0.00	0	0.000	---	0	0.000	---
25-34	1	0.447	2.24	0	0.013	0.00	0	0.005	0.00
35-44	2	1.463	1.37	0	0.074	0.00	0	0.027	0.00
45-54	4	4.977	0.80	0	0.259	0.00	0	0.022	0.00
55-64	17	17.417	0.98	0	0.517	0.00	0	0.040	0.00
65-74	41	34.538	1.19	1	0.427	2.34	0	0.065	0.00
75+	48	33.086	1.45*	1	0.732	1.37	0	0.006	0.00
Total	113	91.993	1.23*	2	2.022	0.99	0	0.167	0.00

[1] Hispanic ethnicity includes persons of any race.

[†] O/E is the observed/expected ratio. Ratios that are statistically high or low are marked with asterisks. (Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.)

* $p < 0.05$

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 16

"Wheat Ridge" Regional Statistical Area (RSA 205) 1980-89
Observed and Expected Counts by Anatomic Site
Colon and Rectum Cancers
Males, All Races and Ages and Non-Hispanic White Age 75+

ICDO[1] Code - Anatomic Site	All Races, All Ages		Non-Hispanic White, Age 75+	
	Observed	Expected[2]	Observed	Expected
18.0 - Cecum	13	16.15	9	8.00
18.2 - Ascending Colon	12	10.19	7	5.12
18.4 - Transverse Colon	8	7.17	see footnote[3]	
18.6 - Descending Colon	6	6.58	see footnote[3]	
18.7 - Sigmoid Colon	30	30.45	10	12.96
19.9 - Rectosigmoid Junction	13	12.53	see footnote[3]	
20.9 - Rectum, Not Otherwise Specified	23	21.97	7	7.68
All Other Sites[3]	10	9.96	15	14.23

Summary $\chi^2_{d.f.7}$ = 1.20 ($p > 0.99$), All Races, All Ages

Summary $\chi^2_{d.f.4}$ = 1.80 ($p > 0.70$), Non-Hispanic White, Age 75+

[1] International Classification of Diseases for Oncology.

[2]Expected numbers were derived by applying the anatomic site distribution of colon and rectum cancers in males in the 6-county Denver Metro area to the number of colon and rectum cancer cases in males in the RSA.

[3]Anatomic sites with fewer than 5 expected cases were included in the "all other" category.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 17

"Wheat Ridge" Regional Statistical Area (RSA 205) 1990-95
Ratio of Observed to Expected Counts
Colon and Rectum Cancers
Males

Observed Cases	Expected Cases[1]	Observed/ Expected Ratio	Confidence Interval[2] for Ratio
60	52.4	1.15	0.88-1.48

[1] Expected counts are derived from sex- and age-specific Denver Metro rates outside the 10-RSA area.

[2] 95% confidence interval. A ratio having a confidence interval that includes the value 1.00 is not considered statistically high or low. (Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.)

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 18

"Adams - West" Regional Statistical Area (RSA 304) 1980-89
Ratios of Observed to Expected Counts by Age and Race/Ethnicity
Lung Cancers
Males

Age	Non-Hispanic White			Hispanic[1]			Non-Hispanic Black		
	Obs	Exp	O/E[†]	Obs	Exp	O/E	Obs	Exp	O/E
0- 4	0	0.000	---	0	0.000	---	0	0.000	---
5- 9	0	0.000	---	0	0.000	---	0	0.000	---
10-14	0	0.064	0.00	0	0.000	---	0	0.000	---
15-19	0	0.064	0.00	0	0.000	---	0	0.000	---
20-24	0	0.058	0.00	0	0.066	0.00	0	0.000	---
25-34	0	0.697	0.00	0	0.121	0.00	0	0.010	0.00
35-44	1	2.496	0.40	1	0.670	1.49	0	0.156	0.00
45-54	15	15.891	0.94	2	1.394	1.43	0	0.299	0.00
55-64	71	45.752	1.55**	0	2.621	0.00	1	0.723	1.38
65-74	58	47.481	1.22	2	1.641	1.22	1	0.388	2.58
75+	25	19.867	1.26	0	0.856	0.00	0	0.112	0.00
Total	170	132.368	1.28**	5	7.368	0.68	2	1.688	1.18

[1] Hispanic ethnicity includes persons of any race.

[†] O/E is the observed/expected ratio. Ratios that are statistically high or low are marked with asterisks. (Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.)

** $p < 0.01$

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 19

"Adams - West" Regional Statistical Area (RSA 304) 1980-89
Smoking Status
Lung Cancers
Non-Hispanic White Males Age 55-64

Smoking Status	Number	Percent
Smoker	52	73.2
Non-Smoker	0	0.0
Not reported to Central Cancer Registry	19	26.8
Total	71	100.0

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 20

"Adams - West" Regional Statistical Area (RSA 304) 1980-89
Observed and Expected Counts by Histology
Lung Cancers
Males, All Races and Ages and Non-Hispanic White Age 55-64

ICDO[1] Code - Histology	All Races, All Ages		Non-Hispanic White, Age 55-64	
	Observed	Expected[2]	Observed	Expected
800 - Neoplasm, Not Otherwise Specified	12	12.45	see footnote[3]	
801 - Carcinoma, Not Otherwise Specified; Epithelioma; Large Cell Carcinoma	24	20.65	9	8.24
804 - Small Cell Carcinoma	29	33.34	13	13.50
807 - Squamous Cell Carcinoma	63	60.24	29	24.40
814 - Adenocarcinoma	35	32.10	13	14.22
825 - Bronchiolo-Alveolar Adenocarcinoma	2	5.45	see footnote[3]	
All Other Histologies[3]	12	12.77	7	10.64

Summary $\chi^2_{d.f.6}$ = 3.74 ($p > 0.70$), All Races, All Ages

Summary $\chi^2_{d.f.4}$ = 2.31 ($p > 0.60$), Non-Hispanic White, Age 55-64

[1]International Classification of Diseases for Oncology.

[2]Expected numbers were derived by applying the histologic type distribution of lung cancers in males in the 6-county Denver Metro area to the number of lung cancers in males in the RSA.

[3]Histologies with fewer than 5 expected cases were included in the "all other" category.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 21

"Adams - West" Regional Statistical Area (RSA 304) 1990-95
Ratio of Observed to Expected Counts by Age
Lung Cancers
Males

Age	Observed	Expected[1]	O/E[2]
0-4	0	0.000	---
5-9	0	0.000	---
10-14	0	0.052	0.00
15-19	0	0.000	---
20-24	0	0.101	0.00
25-34	0	0.666	0.00
35-44	2	2.604	0.77
45-54	10	8.796	1.14
55-64	37	30.806	1.20
65-74	63	40.623	1.55**
75+	38	19.388	1.96**
Total	150	103.035	1.46**

[1] Expected counts are derived from sex- and age-specific Denver Metro rates outside the 10-RSA area.

[2]O/E is the observed observed/expected ratio. Ratios that are statistically high or low are marked with asterisks. (Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.)

** $p < 0.01$

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 22

"Adams - West" Regional Statistical Area (RSA 304) 1990-95
Smoking Status
Lung Cancers
Males Age 65+

Smoking Status	Number	Percent
Smoker	78	77.2
Non-Smoker	2	2.0
Not reported to Central Cancer Registry	21	20.8
Total	101	100.0

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 23

"Adams - West" Regional Statistical Area (RSA 304) 1990-95
Observed and Expected Counts by Histology
Lung Cancers
Males, All Ages and Age 65+

ICDO[1] Code - Histology	All Ages		Age 65+	
	Observed	Expected[2]	Observed	Expected
800 - Neoplasm, Not Otherwise Specified	8	10.73	6	9.53
801 - Carcinoma, Not Otherwise Specified; Epithelioma; Large Cell Carcinoma	17	21.32	10	15.08
804 - Small Cell Carcinoma	34	26.39	23	16.89
807 - Squamous Cell Carcinoma	43	41.51	35	29.43
814 - Adenocarcinoma	38	36.72	21	22.44
All Other Histologies[3]	10	13.30	6	7.60

Summary $\chi^2_{d.f.5}$ = 4.68 ($p > 0.40$), All Races, All Ages

Summary $\chi^2_{d.f.5}$ = 6.71 ($p > 0.20$), Age 65+

[1]International Classification of Diseases for Oncology.

[2]Expected numbers were derived by applying the histologic type distribution of lung cancers in males in the 6-county Denver Metro area to the number of lung cancers in males in the RSA.

[3]Histologies with fewer than 5 expected cases were included in the "all other" category.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 24

"Northglenn - Thornton" Regional Statistical Area (RSA 306) 1980-89
Ratios of Observed to Expected Counts by Age and Race/Ethnicity
Lung Cancers
Males

Age	Non-Hispanic White			Hispanic[1]			Non-Hispanic Black		
	Obs	Exp	O/E†	Obs	Exp	O/E	Obs	Exp	O/E
0- 4	0	0.000	---	0	0.000	---	0	0.000	---
5- 9	0	0.000	---	0	0.000	---	0	0.000	---
10-14	0	0.058	0.00	0	0.000	---	0	0.000	---
15-19	0	0.053	0.00	0	0.000	---	0	0.000	---
20-24	0	0.045	0.00	0	0.054	0.00	0	0.000	---
25-34	1	0.667	1.50	0	0.133	0.00	0	0.011	0.00
35-44	3	2.121	1.41	0	0.664	0.00	1	0.166	6.02
45-54	19	11.198	1.70*	0	1.202	0.00	1	0.317	3.15
55-64	39	29.598	1.32	3	2.382	1.26	2	0.526	3.80
65-74	35	26.567	1.32	1	2.226	0.45	0	0.316	0.00
75+	24	15.155	1.58*	0	1.371	0.00	0	0.151	0.00
Total	121	85.462	1.42**	4	8.482	0.47	4	1.487	2.69

[1] Hispanic ethnicity includes persons of any race.

† O/E is the observed/expected ratio. Ratios that are statistically high or low are marked with asterisks. (Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.)

* $p < 0.05$
** $p < 0.01$

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 25

"Northglenn - Thornton" Regional Statistical Area (RSA 306) 1980-89
Smoking Status
Lung Cancers
Males

Smoking Status	Number	Percent
Smoker	94	72.9
Non-smoker	2	1.6
Not Reported to Central Cancer Registry	33	25.6
Total	129	100.0

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 26

"Northglenn - Thornton" Regional Statistical Area (RSA 306) 1980-89
Observed and Expected Counts by Histology
Lung Cancers
Males, All Races and Non-Hispanic White

ICDO[1] Code - Histology	All Races		Non-Hispanic White	
	Observed	Expected[2]	Observed	Expected
800 - Neoplasm, Not Otherwise Specified	7	9.91	7	9.37
801 - Carcinoma, Not Otherwise Specified; Epithelioma; Large Cell Carcinoma	17	14.97	16	14.05
804 - Small Cell Carcinoma	25	24.13	22	22.56
807 - Squamous Cell Carcinoma	43	42.74	41	40.18
814 - Adenocarcinoma	18	23.68	17	22.06
All Other Histologies[3]	19	13.58	18	12.79

Summary $\chi^2_{d.f.5} = 4.69$ ($p > 0.40$), All Races

Summary $\chi^2_{d.f.5} = 4.19$ ($p > 0.50$), Non-Hispanic White

[1]International Classification of Diseases for Oncology.

[2]Expected numbers were derived by applying the histologic type distribution of lung cancers in males in the 6-county Denver Metro area to the number of lung cancers in males in the RSA.

[3]Histologies with fewer than 5 expected cases were included in the "all other" category.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 27

"Northglenn - Thornton" Regional Statistical Area (RSA 306) 1990-95
Ratio of Observed to Expected Counts by Age
Lung Cancers
Males

Age	Observed	Expected[1]	O/E
0-4	0	0.000	---
5-9	0	0.000	---
10-14	0	0.052	0.00
15-19	0	0.000	---
20-24	0	0.079	0.00
25-34	1	0.614	1.63
35-44	4	2.348	1.70
45-54	14	6.273	2.23*
55-64	33	20.551	1.61*
65-74	41	25.613	1.60**
75+	14	13.279	1.05
Total	107	68.810	1.56**

[1] Expected counts are derived from sex- and age-specific Denver Metro rates outside the 10-RSA area.

[2] O/E is the observed/expected ratio. Ratios that are statistically high or low are marked with asterisks. (Bailar and Ederer, Biometrics, v.20, #3, p.639-643, Sept, 1964.)

*$p < 0.05$

**$p < 0.01$

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 28

"Northglenn - Thornton" Regional Statistical Area (RSA 306) 1990-95
Smoking Status
Lung Cancers
Males

Smoking Status	Number	Percent
Smoker	91	85.0
Non-Smoker	3	2.8
Not Reported to Central Cancer Registry	13	12.1
Total	107	100.0

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 29

"Northglenn - Thornton" Regional Statistical Area (RSA 306) 1990-95
Observed and Expected Counts by Histology
Lung Cancers
Males

ICDO[1] Code - Histology	Observed	Expected[2]
800 - Neoplasm, Not Otherwise Specified	5	5.75
801 - Carcinoma, Not Otherwise Specified; Epithelioma; Large Cell Carcinoma	20	14.53
804 - Small Cell Carcinoma	18	19.21
807 - Squamous Cell Carcinoma	26	28.14
814 - Adenocarcinoma	25	27.60
All Other Histologies[3]	13	11.77

Summary $\chi^2_{d.f.5} = 2.77$ ($p > 0.70$)

[1]International Classification of Diseases for Oncology.

[2]Expected numbers were derived by applying the histologic type distribution of lung cancers in males in the 6-county Denver Metro area to the number of lung cancers in males in the RSA.

[3]Histologies with fewer than 5 expected cases were included in the "all other" category.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Table 30

Proportional Incidence Ratio[1] Analyses, 1980-89
10 Regional Statistical Areas in the Vicinity of Rocky Flats

Regional Statistical Area	Number of Cancer Sites	Chi-square	Probability[2]
103 - "Boulder City - Periphery"	18	16.48	0.49
106 - "Boulder - Tri-Cities"	27	18.40	0.86
202 - "Standley Lake - Periphery"	27	14.54	0.97
203 - "Arvada"	33	28.15	0.66
204 - "Golden"	23	20.78	0.53
205 - "Wheat Ridge"	30	34.65	0.22
301 - "Adams - Northwest"	17	9.13	0.91
304 - "Adams - West"	32	43.52	0.07
305 - "Adams - Clear Creek Valley"	28	30.00	0.31
306 - "Northglenn-Thornton"	31	42.32	0.07

[1]For PIR computation, expected numbers were derived by applying the age-, sex- and race/ethnicity-specific cancer type distribution in the non-study portion of the 6-county Denver Metro area to the number of age-, sex- and race/ethnicity-specific cancer cases in the RSA, and summing them. A cancer site was included in the Chi-square computation if the expected number of cases for that site was 5 or greater. Sites with expected numbers of cases less than 5 were grouped in an "all other" category.

[2]A probability greater than 0.05 indicates that the distribution of cancers by anatomic site within a Regional Statistical Area is not considered statistically different from the distribution of cancers in the non-study portion of Metropolitan Denver.

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Technical Appendices

Technical Appendix A - Colorado Central Cancer Registry (CCCR) Case Registration and Definitions

Technical Appendix B - Population Estimation

Technical Appendix C - Observed/Expected Ratios

Technical Appendix D - Maps and Geography

Technical Appendix E - Proportional Incidence Ratio (PIR) Analysis

Technical Appendix F - Socioeconomic Adjustment

Technical Appendix A - Colorado Central Cancer Registry (CCCR) Case Registration and Definitions

Long-term collection and analysis of cancer data offer the opportunity to identify new patterns in incidence, early detection, treatment, survival and mortality. This information educates health professionals and citizens about specific cancer rates; it also focuses cancer control activities, such as developing health services and screening programs. The CCCR has been collecting data on cancer cases for parts of the state since 1969 and for all of the Denver Metropolitan area since 1979.

Section 25-1-107(l)(f), Colorado Revised Statutes 1973, established the Colorado Central Cancer Registry (CCCR) in the Colorado Department of Health to provide for the reporting to the Department of information related to cancer cases. In 1980, the Colorado Board of Health enacted the first regulation declaring cancer a reportable disease in Colorado. Starting with 1988 diagnosed cases, all cancers in Colorado have been reported to the statewide, population-based Registry located in the Colorado Department of Public Health and Environment (CDPHE). Reporting of cancer cases statewide in Colorado is accomplished through the cooperative efforts of hospitals and hospital tumor registries, pathology laboratories, Colorado physicians, the Health Statistics Section of CDPHE, and the CCCR. This complete statewide reporting of cancer cases enabled the CCCR to compute county-specific incidence rates for the first time in 1993. These 1988-90 statistics were reported in a series of booklets, Cancer in Colorado.

Among the data collected and computerized by the CCCR is information important to this incidence study, such as sex, age, race/ethnicity, date of diagnosis, and geographical descriptors such as address, zip code, county and census tract. Although not computerized, occupation and smoking history information is often reported to the CCCR and recorded on the paper abstract. The anatomical site, histology (or cell type) and behavior (whether benign or malignant) of each cancer diagnosed are coded in the CCCR according to the International Classification of Diseases for Oncology (ICD-O).[15] For the purposes of this study, cancer sites and/or histologies were grouped into ICD-O topography and morphology categories. The grouping of cancer sites differs in one respect from that used by the National Cancer Institute's Surveillance, Epidemiology and End Results and similar

programs, in that lymphomas of organs such as the stomach and brain were grouped with those organs while others group them with the nodal lymphomas despite their different epidemiology. A less important difference may be in the diagnoses included in the "soft tissue" rubric which has tended over time to be somewhat variable in other compilations.

As part of the work to analyze cancer incidence in the vicinity of Rocky Flats, it continues to be important to assure the quality and completeness of cancer registration in Colorado. Data quality assurance and completeness audits are conducted regularly by the CCCR. These include re-casefinding and re-abstracting audits, and improved computerized quality control in processing of cancer abstract information received from hospitals, pathology laboratories and other sources. Quality assurance especially vital to the calculation of cancer incidence in the Denver Metro area was also completed on thousands of cases to correct a variety of historical errors or omissions, such as unknown census tract codes, race and ethnicity errors, and vital status information. For example, all cases diagnosed from 1979 to the present (over 100,000 records) were matched electronically with death certificate data to update vital status and confirm case registration. In addition, all Spanish surname cases were checked to ensure reliable coding of Hispanic ethnicity. Also, all Denver Metro unknown census tract codes were examined and corrected where possible, resulting in only 1.5% of cases with an unknown census tract.

Technical Appendix B - Population Estimation

U.S. Census data for Colorado for 1980 and 1990 were used as a basis for population determination for the observed/expected analysis. Limitations in the Census data required that estimates be developed for 1980 and the intercensal years. Cancer incidence rates are dependent on the race and ethnicity of the population but the 1980 Census data did not include the exact race/ethnicity groupings needed. Therefore, for 1980, populations in nearly all census tracts had to be estimated by race/ethnicity. In addition, the Census Bureau suppresses population estimates for confidentiality reasons if there is a small number of persons of a race/ethnicity group in the geographic area. In this analysis, for which census tracts were grouped into Regional Statistical Areas (RSA's), there were some tracts in which there were too few persons for the Census Bureau to provide population figures. For both 1980 and 1990, populations in census tracts with small numbers of persons in certain race/ethnicity categories also had to be estimated.

The race/ethnicity groups needed for the analysis were non-Hispanic white, non-Hispanic black and Hispanic since there are clear differences among these groups in incidence of certain cancers. While the Denver Metropolitan area is home to a growing number of persons of other races and ethnic groups, during the 1980's, populations of these other race/ethnicity groups were too small to conduct analyses of data. In addition, known differences in cancer incidence among these other groups precluded them from being combined into an "other race/ethnicity" category.

1980 Population Estimation

Data used for 1980 population estimation came from two sources. Some census tract population figures by sex (total and female) and age group were obtained from the U.S. Census Bureau publication, 1980 Census of Population and Housing, Census Tracts, Denver-Boulder, Colo. SMSA, PHC80-2-138.[16] These data are displayed in tables by race or ethnicity:

Race	Published Table
All Races	P-1
Total white	P-2
Total black	P-3
Hispanic	P-6

In the tables, total white and total black include Hispanics and Hispanics are persons of any race with Hispanic ethnicity. Additional data were obtained from the Colorado Department of Local Affairs, which provided a print-out of Table 8 from the 1980 Census STF2 file. All estimation was done for one census tract at a time. In all estimation procedures, the number of males was derived by subtracting females from the total.

Estimating Number of Persons Where Census Information Was Suppressed

For some census tracts, the number of persons of all races and/or total white, total black and total Hispanic by age and sex were fully reported in either STF2 Table 8 or in the published tables. For tracts for which any race, sex and age distribution was unknown, estimates were computed based on known information from the census tract and/or information for Adams, Arapahoe, Boulder, Denver and Jefferson Counties, (referred to below as "5-County") combined.

Many census tracts are divided into "partials," with each partial being in a different municipality. For some tracts, information was known about one or more partials, but not

about the entire tract. For others, the race, sex and age distribution was not available for either the whole tract or any of its partials. Depending on the extent of known information, different methods were used to estimate populations.

If the sex-age distribution was not available for either the whole tract or any part of the tract for a race group, the distribution was derived from information about that race:

Total number of persons for the tract was obtained from published Table P-7, "Race and Spanish Origin".

For each age group, # Males+Females = Published total # of persons x (# of 5-County persons this age / total # of 5-County persons)

For each age group, # Females = Published total # of persons x proportion of 5-County persons who are Female x (# of 5-County persons this age who are Female / total # of 5-County persons this age)

If the sex-age distribution for a race was known in a partial but unknown in another partial of the census tract, and the sex-age distribution was known for all races combined in that partial, the distribution was derived from information about that race and all races combined:

For each sex-age group, # persons = STF2 # of persons this race, sex and age in $partial_1$ + [published total # of persons this race in $partial_2$ x (STF2 # of persons of all races this sex and age in $partial_2$ / STF2 # of persons of all races in $partial_2$)]

If the sex and age distribution for a race was known in a partial but unknown in another partial of the census tract, and the distribution was not known for all races in that partial, the distribution was derived from information about that race in the whole census tract:

For each sex-age group, # persons = STF2 # of persons this race, sex and age in $partial_1$ x [published # of persons this race in Census Tract / # persons this race in $partial_1$]

If this race was not reported in STF2 but the distribution for all races for the census tract was known, the distribution was derived from information about that race and all races in the census tract:

For each sex-age group, # persons = Published # of persons of this race in census tract x (STF2 # of persons of all races this sex and age in census tract / STF2 # of persons of all races in census tract)

Estimating Non-Hispanic White and Non-Hispanic Black Populations

Once total white, total black and Hispanic populations were estimated, it was necessary to compute estimates of non-Hispanic whites and non-Hispanic blacks. These estimates were computed, starting with the estimates derived as described above for:

(a) all races

(b) total Hispanic

(c) total white

(d) total black

The computations were as follows:

(e) total other = a - c - d

(f) Hispanic other = e x Hispanic other/total other

(Hispanic other and total other from published Table P-6)

(g) Hispanic black = d x Hispanic black/total black

(Hispanic black and total black from published Table P-6)

(h) Hispanic white = b - f - g

(i) non-Hispanic white = c - h

(j) non-Hispanic black = d - g

(k) non-Hispanic other = e - f

1990 Population Estimation

For the 1990 Census, persons were classified by race and ethnicity in such a way that it was possible to determine numbers of non-Hispanic white and black persons. Using Census data, the Colorado Department of Local Affairs prepared the "Modified Age-Race-Sex (M.A.R.S.)" data in September, 1992, which was used for this project.

Population Estimation Between 1980 and 1990 Censuses

Population data by census tract for 1980 and for 1990, estimated as described above, was aggregated into RSA's. Unfortunately, since available intercensal projected total populations by census tract were incompatible with the 1990 Census counts, they were not used for the interpolation. Instead, for each RSA, the person-years in each race/ethnicity-sex-age category were calculated as [(1980 population + 1990 population)/2] x 10, i.e., it was assumed that the two Census populations could be used as estimates of the January 1 populations for those years and that their average was an estimate of the average year's population in the interval so that 10 times this value was an estimate of the total person-years.

Population Estimation Between 1990 and 1995

Population data from the 1990 Census is described above. Overall Denver Metro population estimates by sex and age for the years 1991 through 1995 were obtained from the Colorado Department of Local Affairs. Estimates of total population by census tract for 1995 were obtained from the Denver Regional Council of Governments.[17] These census tract estimates were not available by race/ethnicity, sex or age, so populations for individual

RSA's by sex and age for 1995 were estimated by aggregating 1995 census tract population estimates within each RSA and then applying 1990 Census RSA population proportions by sex and age to the 1995 total estimated population for each RSA. Population estimation by race/ethnicity was not done because interpolation was impossible without data from the next decennial census to be conducted in 2000. RSA population estimates by sex and age for the 1990-95 time period were then calculated by averaging between 1990 and 1995.

Technical Appendix C - Observed/Expected Ratios

During the course of this project, a series of Prodas[18] computer programs was developed to run on a Xenix-based computer at the CCCR. These programs develop the cancer case files and population data files, count cancer cases, compute expected numbers of cases and compute observed/expected ratios. The programs also evaluate the ratios statistically according to the well-known Poisson distribution.[13]

The approach taken was to compare the number of diagnosed cancers during 1980-89 in each Regional Statistical Area (RSA) to the expected number of cancers based on the cancer rates by race/ethnicity, sex and age of a larger comparison population, in this case the remainder of the Denver Metro area outside the 10-RSA region defined in Technical Appendix D. This "Poisson method" or "observed/expected ratio technique" evaluates the ratio of a Poisson variable to its expectation. The Poisson distribution provides a reasonably good approximation of the occurrence of many diseases including cancer.

Once the "study" area (the 10 RSA's) was defined, expected numbers of cases for 1980-89 were derived by first computing cancer incidence rates by race/ethnicity (non-Hispanic white, non-Hispanic black and Hispanic persons of any race) in the remaining 6-County Denver Metropolitan area (Adams, Arapahoe, Boulder, Denver, Douglas and Jefferson counties) outside the 10-RSA region. The cancer incidence rate for each of these race/ethnicity groups was then applied to the populations of each of those race/ethnicity groups in the individual RSA's, yielding an expected number of cancer cases. The expected numbers of cases for the three race/ethnicity groups were summed and compared to the total number of observed cancer cases among persons of the three race/ethnicity groups in each RSA.

Observed/expected ratios for 1990-95 were calculated using sex and age strata but not race/ethnicity strata due to the unavailability of population estimates by race/ethnicity (see Technical Appendix B) after 1990 at the census tract level.

The program compares observed and expected numbers of cancer cases using a two-tailed Poisson test. The program uses the Poisson function in Prodas for expected numbers < 700:

If the observed number > the expected number:

p = 2 x (1 - (poisson(exp,obs-1)))

If the observed number <= the expected number:

p = 2 x (poisson(exp,obs))

The Prodas Poisson function breaks down when the expected number reaches 744. To be consistent with Bailar and Ederer[13], the chi-square test was used for expected numbers of 700 or higher:

x = pow((obs-exp),2) / exp

p = 1 - (probchi(x,1))

where **pow** is the power function, raising (observed - expected) to the power of 2, that is, squaring the difference, and

probchi is the chi-square value for x with 1 degree of freedom.

Using the Bailar and Ederer[13] approach, 95% confidence intervals were generated for each observed/expected ratio with a separate computer program written in "Unix bc."

This standard test for determining how different the cancer counts are in a study population compared to the expected counts for the study population based on the rates in a control group, assumes that the control population is quite large compared to the study population, so that the variability in the former can be ignored. The populations in the ten RSA's taken separately are small enough compared to the remainder of the Denver Metro area to make this assumption reasonable. However, the population of the combined 10-RSA region comprises about a quarter of the population of the entire Denver Metro area. As a result, variability in both the 10-RSA total population and the remaining Denver Metro control population must be taken into account and the differences in rates evaluated by treating each of the 66 race/ethnicity-sex-age population groups (3 race/ethnicity groups, 2 sex groups and 11 age groups) as a stratum for the Mantel-Haenszel method[12] of comparing

cancer occurrence in two groups. The numbers of cancer patients were counted as before and the numbers of non-cancer person years were estimated as:

stratum population - (number of cancer patients x 5)

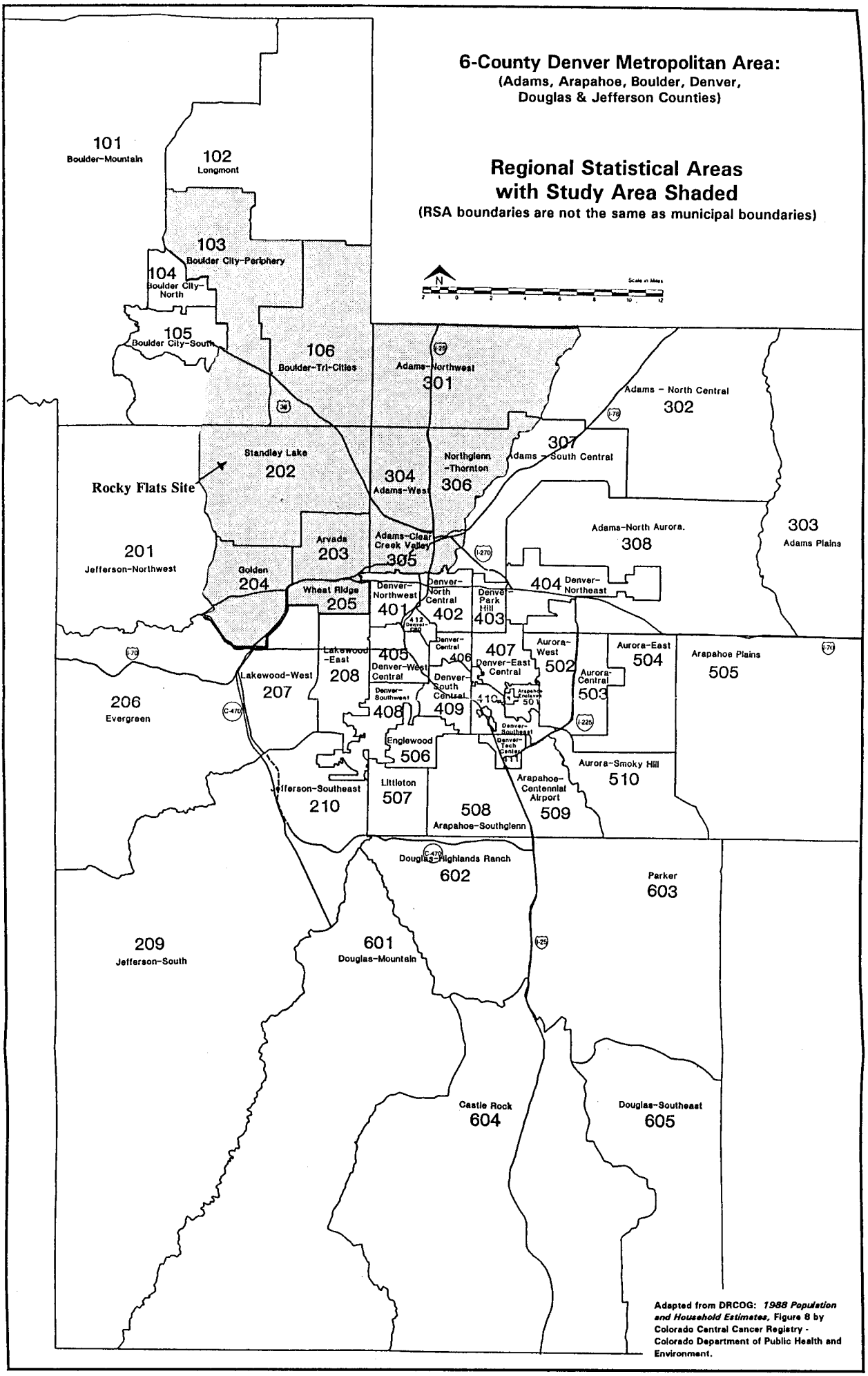
because on average the cancers occurred at the midpoints of the 10-year observation period and patients with cancer should be subtracted from the non-cancer population at time of diagnosis. The result of the Mantel-Haenszel test is a chi-square value with one degree of freedom.

Technical Appendix D - Maps and Geography

Page D.2 contains a map showing RSA boundaries for the Denver Metropolitan Area.

Pages D.3 and D.4 contain the community listing with RSA designations. It can be used to identify a particular community or portion of a community and look up the corresponding RSA used in the analysis.

Pages D.5 through D.9 contain the detailed description of each RSA's boundaries and aggregated census tracts. This can be used to locate RSA boundaries by street or other geographical landmarks.


6-County Denver Metropolitan Area:
(Adams, Arapahoe, Boulder, Denver, Douglas & Jefferson Counties)
Regional Statistical Areas with Study Area Shaded
(RSA boundaries are not the same as municipal boundaries)
N
101 Boulder-Mountain
102 Longmont
103 Boulder City-Periphery
104 Boulder City-North
105 Boulder City-South
106 Boulder-Tri-Cities
Adams-Northwest 301
Adams - North Central 302
303 Adams Plains
304 Adams-West
305 Adams-Clear Creek Valley
306 Northglenn -Thornton
307 Adams - South Central
308 Adams-North Aurora
Standley Lake 202
Rocky Flats Site
201 Jefferson-Northwest
Golden 204
Arvada 203
Wheat Ridge 205
Denver-Northwest 401
Denver-North Central 402
Denver-Park Hill 403
404 Denver-Northeast
Lakewood-East 208
Lakewood-West 207
405 Denver-West Central
Denver-Central 406
407 Denver-East Central
Aurora-West 502
Aurora-East 504
Arapahoe Plains 505
Aurora-Central 503
206 Evergreen
Denver-Southwest 408
Denver-South Central 409
Denver-Southeast
Denver-Tech Center 411
Englewood 506
Aurora-Smoky Hill 510
Jefferson-Southeast 210
Littleton 507
Arapahoe-Centennial Airport 509
508 Arapahoe-Southglenn
Douglas-Highlands Ranch 602
Parker 603
209 Jefferson-South
601 Douglas-Mountain
Castle Rock 604
Douglas-Southeast 605
Adapted from DRCOG: 1988 Population and Household Estimates, Figure 8 by Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

Community Listing with Regional Statistical Area (RSA) Designations

Community Description	RSA on Map
Arvada	
- east of Sheridan Blvd.	RSA 305
- west of Ward Rd. and south of 64th Ave.	RSA 204
- west of Ward Rd. and north of 64th Ave.	RSA 202
- east of Ward Rd., south of 80th Ave. and west of Sheridan Blvd.	RSA 203
Boulder City - Periphery	
- located in Boulder County generally between 4-6 miles immediately northeast, east, and southeast of Boulder city limits	RSA 103
Broomfield	
- north of 120th Ave. and west of Sheridan Blvd.	RSA 106
- north of 120th Ave. and east of Sheridan Blvd.	RSA 301
- south of 120th Ave.	RSA 202
Erie (portion in Boulder County)	RSA 106
Federal Heights	RSA 304
Golden (portion north and east of Hwy 6)	RSA 204
Lafayette	RSA 106
Louisville	
- east of McCaslin Blvd.	RSA 106
- west of McCaslin Blvd.	RSA 103
Marshall	
- east of Hwy. 93	RSA 103
Northglenn	
- west of I-25	RSA 304
- east of I-25	RSA 306
- north of 120th Ave.	RSA 301

Community Listing with Regional Statistical Area (RSA) Designations (continued)

Community Description	RSA on Map
Superior	
- east of McCaslin Blvd.	RSA 106
- west of McCaslin Blvd.	RSA 103
Thornton	
- east of I-25 and north of 120th Ave.	RSA 301
- west of I-25	RSA 304
- east of I-25 and south of 120th Ave.	RSA 306
Westminster	
- west of Sheridan Blvd.	RSA 202
- north of 120th Ave.	RSA 301
- east of Sheridan Blvd., south of 120th Ave., and north of Denver-Boulder Turnpike	RSA 304
- east of Sheridan Blvd. and south of Denver-Boulder Turnpike	RSA 305
Wheat Ridge (excluding south of 32nd Ave. and west of Kipling)	RSA 205

Regional Statistical Areas

RSA 103 - "Boulder City - Periphery"

- located in Boulder County generally between 4-6 miles immediately northeast, east and southeast of Boulder City Limits (excludes mountain areas and northern half of county)

includes:
- Louisville west of McCaslin Blvd.
- Marshall east of Hwy. 93
- Superior west of McCaslin Blvd.

- 1980 Census Tracts: 127.01, 127.03, 127.04, 127.05, 127.06, 127.07
(Since 125.10 was listed as being only partially in RSA 103 it was excluded)

Boundaries: Nebo Rd., 35th St., Nimbus Rd., 41st St., Oxford Rd., 67th St., Nimbus Rd.
73rd St., Niwot Rd., 71st St. By-pass, Diagonal Hwy. (Hwy. 119), Mineral Rd., 71st St.
Lookout Rd.
95th St.
Arapahoe Rd. (Hwy. 7)
75th. St., Baseline Rd., 76th St., S. Boulder Rd., McCaslin Blvd.
Boulder-Jefferson County Line
S. Foothills Hwy. (Hwy. 93), S. Boulder Creek, Denver-Boulder Turnpike (Hwy. 36), Cherryvale Rd. (60th St.), Baseline Rd., 55th St. (Valley View Dr.), Valmont Rd., Airport Rd., unnamed road parallel to west boundary of Boulder Airport, Independence Rd., Diagonal Hwy. (Hwy. 119), 28th St., North Foothills Hwy. (Hwy. 36)

Regional Statistical Areas (continued)

RSA 106 - "Boulder - Tri Cities"

- located generally in the extreme southeast corner of Boulder County

includes:
- Broomfield north of 120th Ave. and west of Sheridan Blvd.
- Erie (portion in Boulder County)
- Lafayette
- Louisville east of McCaslin Blvd.
- Superior east of McCaslin Blvd.

- 1980 Census Tracts: 128.00, 129.01, 129.02, 130.00, 131.02, 131.03, 131.04, 131.05

Boundaries: Lookout Rd., 115th St., Kenosha Rd.
Boulder-Weld County Line
Boulder-Jefferson County Line (W. 120th Ave.)
McCaslin Blvd., S. Boulder Rd., 76th St., Baseline Rd., 75th St.
Arapahoe Rd. (Hwy. 7)
95th St.

RSA 202 - "Standley Lake"

- located generally northern Jefferson County north of 64th Ave. and east of Hwy. 93

includes:
- the Rocky Flats Site
- Arvada west of Ward Rd. and N. of 64th Ave.
- Arvada north of 80th Ave.
- Broomfield south of 120th Ave.
- Westminster west of Sheridan Blvd.

- 1980 Census Tracts: 98.03, 98.11, 98.12, 98.13, 98.14, 98.15

Boundaries: Jefferson-Boulder County line (W. 120th Ave.)
Sheridan Blvd. (Adams-Jefferson County Line)
W. 80th Ave.
Sims
W. 64th Ave., Yankee, W. 66th Ave., W. 68th Ave.
Hwy. 93 (Foothills Rd.)

Regional Statistical Areas (continued)

RSA 203 - "Arvada"

includes:
- Arvada east of Ward Rd., south of 80th Ave. and west of Sheridan Blvd.

1980 Census Tracts: 102.03, 102.04, 102.05, 102.06, 102.07, 103.03, 103.04, 103.05, 103.06, 103.07, 103.08, 104.02, 104.04

Boundaries: 80th Ave.
Sheridan Blvd. (Adams-Jefferson County Line)
Denver-Jefferson County Line
Clear Creek, I-70
Ward Rd., 64th Ave., Sims

RSA 204 - "Golden"

- located in Jefferson County generally south of 64th Ave, west of Ward Rd., west of I-70, north and east of Hwy. 6, and east of Hwy. 93

includes:
- Arvada west of Ward Rd and south of 64th Ave.
- Golden north and east of Highway 6

- 1980 Census Tracts: 98.04, 98.05, 98.06, 99.00, 100.00, 101.00

Boundaries: W. 68th Ave. W. 66th Ave., Yankee, W. 64th Ave
Ward Rd., I-70, Indiana
Hwy. 6, Clear Creek
Hwy. 93 (Foothills Rd.)

RSA 205 - "Wheat Ridge"

includes:
- Wheat Ridge except south of 32nd Ave. and west of Kipling

- 1980 Census Tracts: 104.03, 105.02, 105.03, 106.03, 106.04, 107.00

Boundaries: I-70, Clear Creek, I-70
Sheridan Blvd.
W. 26th Ave., Kipling, W. 32nd Ave.

Regional Statistical Areas (continued)

RSA 301 - "Adams - Northwest"

- located generally in Adams County north of 120th Ave. and west of South Platte River

includes:
- Broomfield north of 120th Ave. and east of Sheridan Blvd.
- Northglenn north of 120th Ave.
- Thornton north of 120th Ave. and east of I-25
- Westminster north of 120th Ave. and east of I-25

- 1980 Census Tracts: 85.09, 85.10, 85.13

Boundaries: Adams-Weld County Line
South Platte River
Henderson Rd., Riverdale Rd., E. 128th Ave., Quebec
E. 120th Ave.
Boulder-Adams County Line

RSA 304 - "Adams - West"

- located generally in Adams County south of 120th Ave., west of I-25, east of Sheridan Blvd. and north of Denver-Boulder Turnpike (Hwy. 36)

includes:
- Federal Heights
- Northglenn west of I-25
- Thornton west of I-25
- Westminster east of Sheridan Blvd., south of 120th Ave. and north of Denver-Boulder Turnpike (Hwy. 36)

- 1980 Census Tracts: 93.04, 93.06, 93.07, 93.08, 93.09, 93.10, 93.11, 93.12, 93.13, 93.14, 94.01, 94.03, 94.04

Boundaries: E. 120th Ave.
I-25
Denver-Boulder Turnpike (Hwy. 36)
Sheridan Blvd. (Adams-Jefferson County Line)

Regional Statistical Areas (continued)

RSA 305 - "Adams - Clear Creek Valley"

- located generally in Adams County south of Denver-Boulder Turnpike, west of I-25, east of Sheridan Blvd. and north of 52nd Ave.

includes:
- Arvada east of Sheridan Blvd.
- Westminster east of Sheridan Blvd. and south of Denver-Boulder Turnpike (Hwy. 36)

- 1980 Census Tracts: 89.52, 95.01, 95.02, 95.53, 96.03, 96.04, 96.05, 96.06, 97.50

Boundaries: Denver-Boulder Turnpike (Hwy. 36)
I-25
Adams-Denver County Line
Sheridan Blvd. (Adams-Jefferson County Line)

RSA 306 - "Northglenn - Thornton"

- located generally in Adams County east of I-25, south of 120th Ave. and west of South Platte River

includes:
- Northglenn east of I-25
- Thornton east of I-25 and south of 120th Ave.

- 1980 Census Tracts: 85.05, 85.06, 85.07, 85.08, 85.11, 90.01, 90.02, 90.03, 91.01, 91.02, 92.01, 92.02, 92.03

Boundaries: E. 120th Ave., Quebec, E. 128th Ave., Riverdale Rd., Henderson Rd.
South Platte River
Adams-Denver County Line
I-25

Technical Appendix E - Proportional Incidence Ratio (PIR) Analysis

Bias in population estimates can affect the numbers of expected cancer cases and, consequently, the observed to expected ratios. To check for this, a population-independent Proportional Incidence Ratio (PIR) analysis may be conducted. The PIR uses the chi-square test to compare the cancer site distributions of observed and expected cases.

Chi-square tests were carried out to compare the overall proportional distribution of cancer sites in each of the ten RSA's separately, with the expected distribution of cancers based on cases in the remaining 6-county Denver Metropolitan area. For each analysis, individual cancer sites were included if the expected number of cases was at least five. (The chi-square test is most accurate when the expected number in each category is sufficiently large; five cases is generally accepted as sufficient.) All other cancer sites were grouped, for this analysis, into an "all other" category.

To compute the expected number of cases in an RSA for a particular type of cancer, the race/ethnicity-, sex- and age-specific cancer counts in the RSA were multiplied by the corresponding race/ethnicity-, sex- and age-specific percents of that specific cancer found in the 6-county Denver Metro area outside of the 10-RSA area, and summed. To compare the observed with the resulting expected cancer site distributions,

$$(\text{observed \# cases} - \text{expected \# cases})^2 \ / \ \text{expected \# cases}$$

for each cancer site was computed. The results of these computations for all the cancer sites were summed, yielding the chi-square statistic. This summary statistic was then checked against a table of chi-square values to determine the probability that the differences in the site distributions were due to chance.

The chi-square test indicates how often the <u>total</u> amount of variability would be seen by chance when samples of this size were repeatedly drawn from the same population of cancers. Only if the summary chi-square test statistic exceeds the critical value, taking into account the planned number of tests, is it reasonable to look at the variation in counts of particular types of cancers to see which were primarily responsible for the total chi-square value.

Technical Appendix F - Socioeconomic Adjustment

"Socio-Economic Status" (SES) is known to have a major influence on incidence rates of several cancers. An example of this in the Denver Metro area is that during 1980-89 the poorest tenth of the population had a lung cancer rate about 40% above that for the middle six-tenths, while the most affluent tenth had a lung cancer rate about 40% below the middle six-tenths of the population. SES-adjustment of the expected numbers of cancers for the observed/expected analysis was explored because of the possibility that SES might have a large impact on cancer incidence in the 10 RSA's which was not being addressed by the standard race/ethnicity, sex and age adjustments. A preliminary test of this idea, which involved using only percentage of college graduates[16,19-21] as the measure of SES, indicated that some of the study RSA's differed significantly in SES from the rest of the Denver Metro area, resulting in additional examination of SES adjustment. A more comprehensive index of SES status was then derived from six measures[16,19-21]: percentage of college graduates, median household income, percentage of families below the poverty level, median house value, median monthly rent and per capita income. With this index, none of the RSA's contained many census tracts with both a large population and a large deviation in SES from the Denver Metro average, so resulting SES adjustments to the expected numbers of cancers were small.

In the table on page F.2, results of three methods of computing expected numbers of lung cancers in males illustrate that in each of the ten RSA's neither of two SES adjustment methods resulted in important differences in estimates of expected cancers (or observed/expected ratios) from the race/ethnicity-, sex- and age-adjustment already described in Technical Appendix C. The expected numbers labeled "Direct" are those computed as per Appendix C. The "Crude SES" expected numbers were computed using the 6-factor index for SES adjustment, described above, while the "Linear SES" expected numbers were derived from the best straight line regression line given the relative risks of the first, second, third through eighth combined, ninth and tenth SES deciles. In the example for male lung cancer, a cancer site perhaps most likely to reflect SES differences, in most cases the adjustments brought the observed and expected numbers slightly closer together. In no RSA

was the difference between the observed and expected cancers increased enough to change a statistically "non-significant" difference to a "significant" one. Consequently, no SES adjustment was used in the data presented in this report.

Lung Cancer
Ratios of Observed to Expected Counts with Socioeconomic Adjustment
by Regional Statistical Area 1980-89
Males

RSA	Observed Cases	Expected Cases			Observed/Expected Ratio		
		Direct[1]	Crude[2] SES	Linear[3] SES	Direct	Crude SES	Linear SES
103	21	32.55	24.05	24.02	0.65*	0.87	0.87
106	76	74.19	71.52	71.76	1.02	1.06	1.06
202	66	60.70	51.47	52.18	1.09	1.28	1.26
203	153	148.79	151.72	154.21	1.03	1.01	0.99
204	53	56.38	50.11	50.30	0.94	1.06	1.05
205	105	111.48	111.48	111.48	0.94	0.94	0.94
301	22	20.91	20.91	20.91	1.05	1.05	1.05
304	177	141.43	144.28	146.31	1.25**	1.23**	1.21*
305	87	82.90	86.73	87.37	1.05	1.00	1.00
306	129	95.43	96.46	97.09	1.35**	1.34**	1.33**

[1] "Direct method" of computing expected cancers as per Appendix C
[2] "Crude SES" method of computing expected cancers using 6-factor index for SES adjustment
[3] "Linear SES" method of computing expected cancers using best straight line regression given the relative risks of the selected SES deciles

* $p < 0.05$
** $p < 0.01$

Source: Colorado Central Cancer Registry - Colorado Department of Public Health and Environment.

References

[1] Health Advisory Panel's Report to Colorado Citizens on the Phase I Study of the State of Colorado's Health Studies on Rocky Flats, October, 1993.

[2] Johnson, C.J. Cancer Incidence in an Area Contaminated with Radionuclides Near A Nuclear Installation. Ambio, 10(4), 176-182, 1981.

[3] Dreyer, N.A., Loughlin, J.E., Fahey, F.H. and Harley, N.H. The Feasibility of Epidemiologic Studies of Cancer in Relation to the Rocky Flats Plant. Health Physics, 42(1), 65-68, 1982.

[4] Crump, K.S., Ng, T.-H. and Cuddihy, R.G. Cancer Incidence Patterns in the Denver Metropolitan Area in Relation to the Rocky Flats Plant. American Journal of Epidemiology, 126(1), 127-135, 1987.

[5] Technical Topics: Research on Adverse Health Effects Related to the Rocky Flats Plant, Rocky Flats Health Studies Unit, Colorado Department of Public Health and Environment, December, 1993.

[6] Draft Report: Assessing Risks of Exposure to Plutonium. Part of Task 3: Independent Analysis of Exposure, Dose and Health Risk to Offsite Individuals. Historical Public Exposure Studies on Rocky Flats, Phase II: Toxicity Assessment and Risk Characterization. Radiological Assessment Corporation, May, 1996.

[7] Wilkinson, G.S., Tietjen, G.L., Wiggs, L.D., Galke, W.A., Acquavella, J.F., Reyes, M., Voelz, G.L. and Waxweiler, R.J. Mortality Among Plutonium and Other Radiation Workers at a Plutonium Weapons Facility. American Journal of Epidemiology, 125(2), 231-250, 1987.

[8] Rocky Flats Workers Study Newsletter, Vol. 1, No. 1, Spring, 1995.

[9] Blumenthal, D.S. and Ruttenber, J. Introduction to Environmental Health, Revised Second Edition, Springer Publishing Company, 1995.

[10] Fiore, B.J., Harahan, L.P. and Anderson, H.A. Public Health Response to Reports of Clusters. State Health Department Response to Disease Cluster Reports: A Protocol for Investigation. Am. J. Epidemiology, Vol. 132(Suppl.1):S14-S22, 1990.

[11] Warner, S.C. The Status of Cancer Cluster Investigations Undertaken by State Health Departments. American Journal of Public Health, Vol. 78, No. 3: 306-307, March, 1988.

[12] Mantel and Haenszel, Journal of the National Cancer Institute, Vol. 22, No. 4, p. 719-748, April, 1959.

[13] Bailar, J. and Ederer, F. Significance Factors for the Ratio of a Poisson Variable to its Expectation. Biometrics, Vol. 20, No. 3, p. 639-643, Sept., 1964.

References (continued)

[14] Saccomanno, G. et. al., Histologic Types of Lung Cancers Among Uranium Miners. Cancer 27: 515-523, 1971.

[15] Percy, C., Van Holten, V. and Muir, C. International Classification of Diseases for Oncology, 2nd Edition, World Health Organization, Geneva, 1990.

[16] 1980 Census of Population and Housing, Census Tracts, Denver-Boulder, Colo., Standard Metropolitan Statistical Area, PHC80-2-138, U.S. Department of Commerce, Bureau of the Census, June, 1983.

[17] 1995 Population and Household Estimates - For Counties, Municipalities, Regional Statistical Areas and Census Tracts, Denver Regional Council of Governments, January, 1996.

[18] Professional Data Analysis System (PRODAS), Conceptual Software, Inc., Houston, 1983-93.

[19] 1990 Census of Population and Housing, Population and Housing Characteristics for Census Tracts and Block Numbering Areas, Denver-Boulder, CO CMSA (Part), Denver, CO PMSA, 1990 CPH-3-132B, (Section 1 of 2), U.S. Department of Commerce, Bureau of the Census, May, 1993.

[20] 1990 Census of Population and Housing, Population and Housing Characteristics for Census Tracts and Block Numbering Areas, Denver-Boulder, CO CMSA (Part), Denver, CO PMSA, 1990 CPH-3-132B, (Section 2 of 2), U.S. Department of Commerce, Bureau of the Census, May, 1993.

[21] 1990 Census of Population and Housing, Population and Housing Characteristics for Census Tracts and Block Numbering Areas, Denver-Boulder, CO CMSA (Part), Boulder-Longmont, CO PMSA, 1990 CPH-3-132A, U.S. Department of Commerce, Bureau of the Census, April, 1993.

To obtain additional copies, please contact:

Colorado Central Cancer Registry
EMS and Prevention Division
Colorado Department of Public
Health and Environment
PPD-CR-A5
4300 Cherry Creek Drive South
Denver, CO 80246-1530

303-692-2540

Colorado Department of Public Health and Environment

Printed on recycled paper

97811214-22