Health Consultation

PRYOR GIGGEY COMPANY
12393 SLAUSON AVENUE
WHITTIER, LOS ANGELES COUNTY, CALIFORNIA

EPA FACILITY ID: CAD982505950

SEPTEMBER 28, 2007

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Prepared By:

California Department of Health Services
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

References

Foreword

Libby vermiculite was distributed to and processed by facilities located throughout the United States. Because human exposure to asbestos has possibly occurred in communities near these facilities, the Division of Health Studies of the federal Agency for Toxic Substances and Disease Registry (ATSDR) initiated a nationwide follow-up effort. This project is designed to screen for similar impacts on the health of populations living near facilities that received shipments of Libby vermiculite. As part of that effort, the Environmental Health Investigation Branch of the California Department of Health Services (CDHS) received funding to conduct health statistics reviews on communities located near facilities that received Libby vermiculite.

This health consultation presents the results of the health statistics review for the population living near the former Pryor Giggey Company facility in Whittier, California.

The objectives of the health statistics review are:

1. to identify the residential area at highest risk of exposure to hazardous levels of asbestos from the exfoliation and processing of Libby vermiculite at Pryor Giggey;

2. to determine whether the population living in this area had higher incidence rates of asbestos-related cancers than the U.S. population;

3. to determine whether the population residing in this area had higher mortality rates from asbestos-related disease than the U.S. population; and

4. to determine whether the population residing in this area had higher mortality rates from asbestos-related disease than the U.S. population.

Asbestos and Asbestos-related Disease

Asbestos is the name of a group of minerals that occur naturally in the environment. Asbestos minerals have long, thin, and separable fibers. Asbestos fibers do not evaporate into air or dissolve in water, and they are resistant to heat, fire, and chemical and biological degradation (1). Asbestos fibers in vermiculite entered the air when Libby vermiculite was handled, processed, or disturbed after processing at Pryor Giggey (3). Small diameter fibers and fiber-containing particles may remain in the air for a long time and may be carried long distances by wind or water currents before settling to the ground (1).

Asbestos fibers can enter the body when inhaled (breathed in) or ingested (eaten or drunk). When asbestos fibers are inhaled, some of the fibers can become lodged in the lungs. Because asbestos fibers are very durable, they remain in lung tissue throughout life. Asbestos fibers can accumulate in lung tissue and cause scarring and inflammation. Repeated scarring and inflammation can affect breathing and lead to disease.

Exposure to asbestos does not cause disease immediately; instead, disease develops many years later. The time period between when someone is first exposed to asbestos and when they develop disease is called the latency period.

Background

In 1881, miners searching for gold unearthed a mica-like material from an area 7 miles northeast of the town of Libby, Montana. It was not until 1919 that a local businessman discovered the unique properties of this mineral: while he was walking through an abandoned mine, his torch contacted the surface of the mine, resulting in an expansion or "popping" of the vermiculite. The newly formed Zonolite Company opened a mine at this location during the following year. Since then, vermiculite has been marketed for many uses, such as loose-fill insulation, fireproofing, a fertilizer carrier, a soil conditioner, and an aggregate in many construction products.

WR Grace and Company purchased the vermiculite mine from the Zonolite Company in 1963 and expanded operations. Between the 1960s and 1980s, as much as 80% of the vermiculite used worldwide came from the WR Grace and Company mine near Libby (6). (Vermiculite from the WR Grace and Company mine near Libby will be referred to as Libby vermiculite in this document.) Libby vermiculite was shipped to over 200 locations in 30 states in this country for processing or packaging. Twenty of these facilities were located in California, including the Pryor Giggey Company refractory products facility in Whittier, California. (This facility will be referred to as Pryor Giggey in this document.) Libby vermiculite was shipped to Pryor Giggey between the years 1985 and 1988 (3). WR Grace and Company mining operations in Libby, Montana, closed in 1990, and the last shipments of Libby vermiculite occurred in 1992 (7).

All vermiculite contains a range of other minerals that were formed along with the vermiculite in the rock. The vermiculite found near Libby contains 21% to 26% asbestos (8), a mineral toxic to humans when inhaled (breathed in). Inhalation of asbestos is known to cause asbestosis (a non cancerous scarring of the lungs), lung cancer, and mesothelioma (cancer of the tissues lining the lung and abdomen). (The asbestos contained in Libby vermiculite will be referred to as Libby asbestos in this document.)

In 1999, a series of Seattle Post-Intelligencer articles about high rates of asbestos-related disease brought national attention to the WR Grace and Company vermiculite mine in Libby, Montana. ATSDR, in cooperation with the Montana Department of Public Health and Human Services, analyzed mortality statistics (information on causes of death obtained from death certificates) for the Libby community for a 20-year period (1979-1998). This review found that death due to asbestosis was 40 times more common in the Libby population than in the rest of the state of Montana, and 80 times more common than in the rest of the U.S. population. Death due to lung cancer was 20% to 30% (1.2 to 1.3 times) higher than expected. Although rates of mesothelioma were elevated, it was not possible to quantify by how much. Still, these elevations were high enough that they were considered unlikely to have been due to natural fluctuations in the occurrence of these diseases (9). Findings from the review of mortality statistics led to several follow-up activities to address the health impacts to those who lived and worked in Libby (10, 11).

Health statistics reviews are statistical analyses of information from cancer registry and death certificate records that investigate whether people in a particular community have developed cancer or have died from a particular disease more often than another comparison population. The health statistics reviews are being conducted in communities located near facilities that

received Libby vermiculite, regardless of whether that community was in fact exposed to hazardous levels of asbestos from the vermiculite. (Usually, reviews of health information are conducted only when exposure to a harmful chemical is known to have occurred.) Communities are being screened because, given the experience in the Libby community, it is not unrealistic to think that exposure to levels of asbestos high enough to have caused disease might have occurred in these communities.

Finding an excess of asbestos-related cancers or disease in a community would alert ATSDR and CDHS to the possibility that workers or community members might have been exposed to hazardous levels of asbestos as a result of the facility's handling or processing of Libby vermiculite. If, however, the health statistics review does not find an excess of asbestos-related disease, this does not prove that the community was not exposed to Libby asbestos.

Pryor Giggey Exfoliation Operations and Worker and Community Exposure to Asbestos

Pryor Giggey was located at 12393 Slauson Avenue in Whittier, California. The former Pryor Giggey site contains a single-story, wood-frame office in the front (12). In back of the office is a building composed of metal frame and sheet metal siding construction. Northeast of the former Pryor Giggey facility site is a railroad spur and a light manufacturing facility. Southeast of the site are a cluster of light manufacturing or commercial facilities. At least ¼ mile east of the site is a residential neighborhood. About ¾ mile northwest of the site is a school.

From 1985 through 1988, the facility received approximately 198 tons of Libby vermiculite. At the Whittier site, Pryor Giggey manufactured refractory products. Refractory products include heat-resistant materials, such as bricks, kiln furniture, and crucibles, for high-temperature equipment, as well as other processing units and equipment that can withstand extremes of corrosion, temperature, and abrasion (13). CDHS contacted Pryor Giggey to determine which manufacturing steps involved the handling of vermiculite. Upon their request, CDHS provided to an attorney representing Pryor Giggey, copies of WR Grace invoices documenting the shipping of crude vermiculite from Libby, Montana, to Pryor Giggey's facility in Whittier. However, according to Pryor Giggey's attorney, workers involved in manufacturing during this time period do not recall the purchase, sale, or use of crude vermiculite (14). Furthermore, according to Pryor Giggey's attorney, the worker responsible for ordering materials during this time period does not recall what may have happened to crude vermiculite. Thus, CDHS was unable to determine how former Pryor Giggey workers may have been exposed to Libby vermiculite during the manufacturing of refractory products.

Pryor Giggey currently does not own or operate the facility at this site. Currently the former Pryor Giggey site is occupied by Cal-Air, Inc., an air-conditioning subcontractor.

Discussion

It is known that Libby vermiculite was delivered to the Pryor Giggey site in Whittier, California. It is not known if or how this vermiculite was used at the facility. Asbestos fibers in the Libby vermiculite could have been released to the air during the handling and processing of vermiculite at the Pryor Giggey facility. If so, people who worked at the Pryor Giggey between 1985 and 1988 could have been exposed to hazardous levels of asbestos. People who lived with former

workers could also have been exposed to hazardous levels of asbestos from fibers carried home on workers' hair and clothing. Similarly, CDHS does not know if or how much exposure could have occurred to people who lived near Pryor Giggey between 1985 and 1988. However, it is possible that residents during this time period were exposed to hazardous levels of asbestos from Libby vermiculite.

The Pryor Giggey no longer owns the site. Current operations by Cal-Air, Inc. at the former Pryor Giggey site are not causing community exposure to asbestos from Libby vermiculite. Based on a site visit, a contractor of the U.S. Environmental Protection Agency (EPA) stated it is likely that contaminated soils and vermiculite-containing materials previously used by Pryor Giggey have been removed (12). Subsequent to that assessment, EPA did not require a site investigation.

Current Exposure to Asbestos from Commercial Products Made with Libby Vermiculite

Much of the vermiculite from the WR Grace mine in Libby was used to produce attic insulation products, often sold under the brand name Zonolite. Vermiculite was commonly sold in gardening and hardware stores. It was used as a soil amendment (a conditioner to improve soil quality), fertilizer carrier, and was an ingredient in many potting soil mixes. Vermiculite was also used in fireproofing materials, gypsum wallboard, and as a lightweight aggregate in construction materials (15).

Current and future exposure to asbestos from use of products made with Libby vermiculite is possible, though the extent of this risk depends on which product and how the product is being used or disturbed. ATSDR has created a fact sheet on products containing Libby vermiculite and how to protect against exposure to asbestos from these products. This fact sheet has been distributed to the local county health department and is available on the CDHS website.

Toxicology of Asbestos

Asbestos and Cancer

Asbestos has been classified by U.S. and international health agencies as a substance that is known to cause cancer in humans. Numerous studies of occupational exposure to asbestos (exposure to asbestos during work) have shown that exposure to asbestos can cause two types of cancer: mesothelioma and lung cancer. Other studies have suggested that asbestos exposure might also increase the risk of some gastrointestinal and digestive cancers.

- Mesothelioma is the uncontrolled growth of abnormal cells in the tissue that lines the lungs and abdomen. Mesothelioma is relatively rare in the general population (approximately two out of one million people will get mesothelioma), but does occur more frequently in populations of workers in industries that use asbestos. About 5% of people who are exposed to asbestos develop mesothelioma (16). Mesothelioma has a latency period of 30 to 40 years (17).

- Lung cancer is the uncontrolled growth of abnormal cells in one or both of the lungs. While normal lung tissue cells reproduce and develop into healthy lung tissue, these abnormal cells

reproduce rapidly and never grow into normal lung tissue. Lumps of cancer cells (tumors) then form and disrupt lung function (18). Studies have shown that people who were exposed to asbestos at work are five times more likely to develop lung cancer than workers who are not exposed to asbestos. In addition, people exposed to asbestos at work who also smoke are 50 to 90 times more likely to develop lung cancer than workers who do not smoke and who were not exposed to asbestos. The latency period for asbestos-caused lung cancer is 20 to 30 years (17).

- A number of studies suggest that asbestos exposure may increase the risk of some gastrointestinal (digestive organ) cancers. Some studies have observed slightly higher rates of death from gastrointestinal cancer among workers exposed to asbestos. This is presumed to be due to the transfer of inhaled fibers from the lung to the gastrointestinal tract. However, these studies were not able to determine whether the excess death from gastrointestinal cancer was due to asbestos or to other factors (e.g., exposure to other chemicals, misdiagnosis, dietary factors, alcohol intake) (1). Currently, there is no conclusive evidence that exposure to asbestos does or does not cause gastrointestinal cancer.

Asbestos and Respiratory Illness

Exposure to asbestos can also lead to several non-cancer respiratory illnesses, including asbestosis and abnormalities in the pleural (the lining of the lungs).

- Asbestosis is a serious, chronic, respiratory illness that occurs when asbestos fibers lodged in lung tissue cause scarring. Scarred lung tissue does not expand and contract like normal lung tissue and so breathing becomes difficult. Oxygen and carbon dioxide do not pass through the lungs as easily and blood flow to the lungs may also be decreased, which can cause the heart to enlarge (1). Asbestosis can lead to heart failure. The latency period for asbestosis is typically 10 to 20 years (19).

- Pleural abnormalities are changes in the lining of the lung (called the pleura). The most common change is the formation of thick, fibrous areas called plaques. Other effects of asbestos exposure include diffuse (wide-spread) thickening of the pleura, fibrosis (the formation of fibrous, scar-like tissue), and areas of pleural effusions (an abnormal collection of fluid between the pleura and the wall of the chest cavity). Small areas of pleural plaques are not thought to be of significant health concern. However, diffuse thickening of the pleura and large areas of pleural plaques or pleural effusions can impair respiratory function (1). Pleural abnormalities are not likely to be identified as a cause of death.

Health Outcome Data Analysis

The analysis of incidence rates of asbestos-related cancers will be referred to as the "cancer statistics review" and the analysis of mortality rates of asbestos-related disease will be referred to as the "mortality statistics review."

- A cancer registry is a center that collects, organizes and analyzes information on cancer cases that have been diagnosed or treated in a geographic area (for example, California).
- A death certificate is an official legal record of a death. They include information on the cause of death (determined by a physician) and demographic characteristics of the deceased.
- Incidence rate is a measure of the occurrence of disease in a population. It is the number of people in a population who get a disease in a specific time period, per (divided by) the number of people in that population during the time period. For example, the incidence rate of lung cancer in California for the year 1997 was 60.1 per 100,000 people (4).
- Mortality rate is a measure of the occurrence of death from a disease in a population. It is the number of people in a population who die from a disease in a specific time period divided by the number of people in that population during the time period. For example, the mortality rate for lung cancer in California for the year 1997 was 41.8 per 100,000 people (5).

Diseases Evaluated in the Health Statistics Review

The ATSDR Division of Health Studies selected a variety of diseases for evaluation in order to 1) assess the full burden of disease and death that exposure to asbestos could have had on a population, and 2) confirm information obtained from cancer registries and vital statistics records for this review as consistent and therefore comparable.

Exposure to asbestos is known to cause lung cancer, cancer of the mesothelioma, and asbestosis. Some studies suggest that exposure to asbestos might also increase the risk of certain digestive organ cancers. It is also possible that exposure to asbestos might worsen and cause premature death from certain diseases of the pulmonary and circulatory system.

One factor complicating the study of asbestos-related diseases is that physicians often misdiagnose these diseases, particularly when establishing a cause of death. This review also evaluated the number of people getting or dying from certain diseases because these people might have had an asbestos-related disease that was misdiagnosed.

Incidence rates of eight types of cancers or cancer groups were evaluated in the cancer statistics review (see list below). Lung and bronchus cancer, mesothelioma, and digestive organ cancers were studied because of their known or suspected association with asbestos exposure. Cancer of the peritoneum, retroperitoneum and pleura, and cancer of the respiratory system and intrathoriacic organs were evaluated because people with these diagnoses might actually have had an asbestos-related cancer instead.

Lastly, all types of cancer, female breast cancer, and prostate cancer were evaluated to determine whether cancer was underreported to the cancer registries that provided information for this review.

Mortality rates from 13 types of diseases or disease groups were evaluated as part of the mortality statistics review (see list, at right). Lung and bronchus cancer, cancer of the peritoneum, retroperitoneum and pleura (including mesothelioma), asbestosis, and digestive organ cancers were evaluated because of their known or suspected association with asbestos exposure.

Respiratory system and intrathoriacic organ cancers, cancer (no specification of site), pneumoconioses, and chronic obstructive pulmonary disease were evaluated because these deaths might have included people with misdiagnosed asbestos-related diseases. Chronic obstructive pulmonary disease, disease of the pulmonary circulation, and other diseases of the respiratory system were evaluated because asbestos-exposure might have worsened these conditions and led to premature death. Lastly, all types of cancer, female breast cancer, and prostate cancer were evaluated to determine whether causes of death were underreported to the registries that provided information for the mortality statistics review.

The cancer statistics review evaluated the following types of cancer:

- Lung and bronchus
- Mesothelioma
- Digestive organs
- Peritoneum, retroperitoneum, and pleura
- Respiratory system and intrathoracic organs
- All types of cancer
- Female breast
- Prostate

The mortality statistics review evaluated death from the following diseases*:*

- Lung and bronchus cancer
- Cancer of the peritoneum, retroperitoneum, and pleura, including mesothelioma
- Asbestosis
- Digestive organ cancers
- Respiratory system and intrathoriacic organ cancers
- Cancer (no specification of site)
- Pneumoconioses
- Chronic obstructive pulmonary disease
- Diseases of pulmonary circulation
- Other diseases of respiratory system
- All types of cancer
- Female breast cancer
- Prostate cancer

Evaluating Mesothelioma

During the years that were evaluated in this review, cancer and causes of death were coded in cancer registries and on death certificates according to two classification systems: International Classification of Diseases, Oncology Codes, Revision 2 (ICD-O-2) (used by cancer registries), and International Classification of Diseases, Injury, and Causes of Death Codes, Revision 9 (ICD-9) (used for death certificates).

The ICD-O-2 system has a specific code for mesothelioma, which makes it possible to evaluate the incidence rate of this cancer in the Whittier community. In contrast, the ICD-9 system does not have a specific code for mesothelioma. Therefore, it is not possible to analyze mortality rates for mesothelioma alone; only a larger group of diseases (cancer of the peritoneum, retroperitoneum, and pleura, including mesothelioma) can be evaluated. Nearly all of the deaths

in this cancer group are, in fact, deaths from mesothelioma (W. Kaye, ATSDR, personal communication, 2004). Therefore, evaluating mortality from this group of cancers reflects, with relative accuracy, the occurrence of death from mesothelioma.

Populations Evaluated

As mentioned above, though it is currently unknown if people who lived near Pryor Giggey between 1985 and 1988 were exposed to asbestos from Libby vermiculite, or at what levels they could have been exposed to, these levels may have been hazardous.

Therefore, the first step of the health statistics review was to determine which area near Pryor Giggey was most likely to have experienced an increased burden of asbestos-related disease (assuming that Pryor Giggey did emit asbestos into the surrounding air). CDHS concluded that the population living within ¼ mile of Pryor Giggey was most likely to have been exposed to levels of asbestos high enough to cause a detectable excess burden of asbestos-related disease. This distance was selected based on information presented in this health consultation, as well as on information from health studies of lung cancer and mesothelioma rates in communities near asbestos industries (20-23).

Figure 1 shows the location of the Whittier Plant and the area of Whittier located within ¼ mile of the facility. The health statistics review would ideally evaluate the incidence and mortality rates of asbestos-related disease in the population residing in this area. But the smallest geographic area on which cancer statistics are publicly available is the census tract (providing information on a smaller geographic area could make it possible to identify a cancer patient, and thus would violate their right to privacy). For similar reasons pertaining to privacy, the smallest geographic area on which mortality statistics are publicly available is the ZIP Code.

Census tracts are small geographic areas defined by the U.S. Census Bureau. Census tracts usually have 2,500 to 8,000 residents with similar population characteristics, economic status, and living conditions.

Therefore, for the cancer statistics review, CDHS studied the population living in census tract 5020.02. For the mortality statistics review, CDHS studied the population residing in ZIP Code 90602. Figure 2 shows the location of Pryor Giggey, the area that CDHS determined was most likely to experience an excess of asbestos-related disease, and census tract 5020.02. Figure 3 shows the location of Pryor Giggey, the area that CDHS determined was most likely to experience an excess of asbestos-related disease, and ZIP Code 90602.

Figure 1: Area of Whittier that is most likely to have been exposed to levels of asbestos high enough to cause a detectable excess burden of asbestos-related disease, assuming that Pryor Gyggey emitted asbestos into the surrounding air.

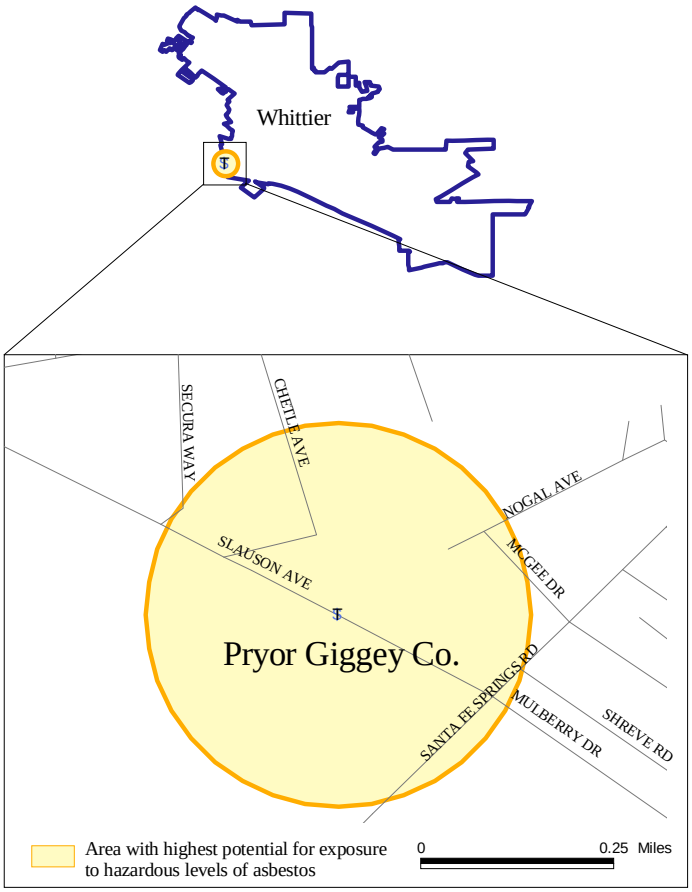


Figure 2: Map of Census Tract 5020.02 in Relationship to the Area Located Within ¼ Mile of Pryor Giggey, Whittier, California.

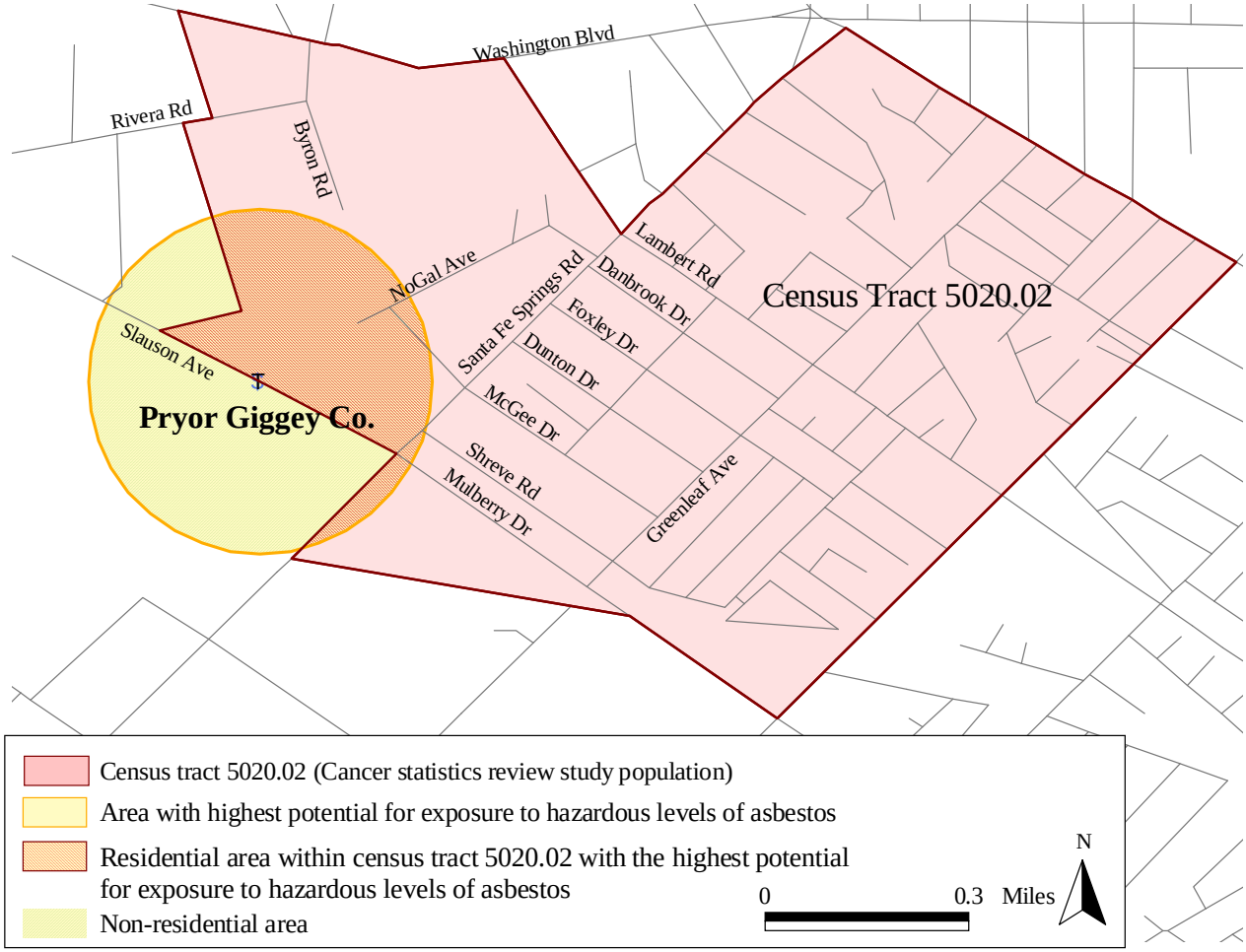
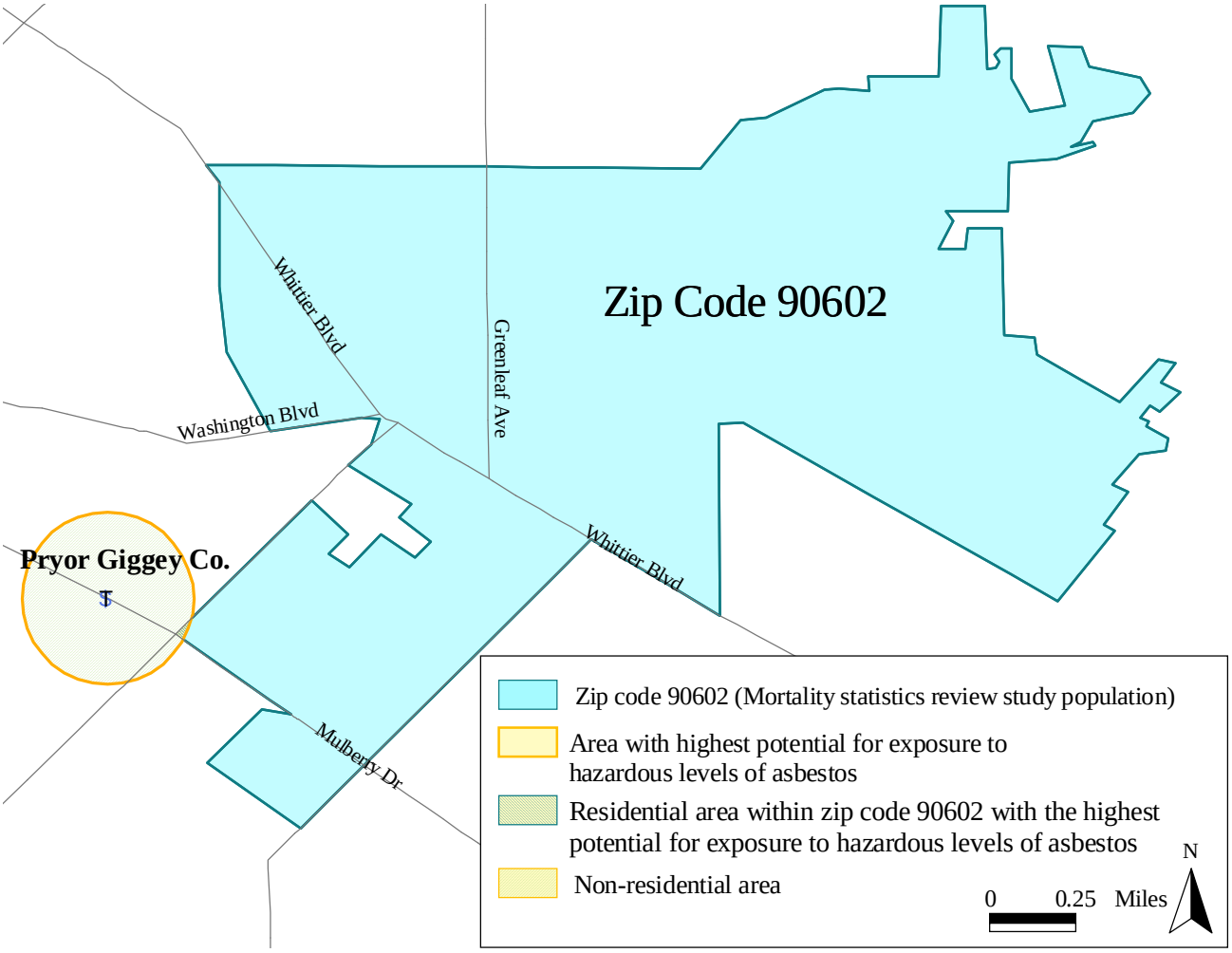


Figure 3: Map of ZIP Code 90602 in Relationship to the Area Located Within ¼ Mile of Pryor Giggey, Whittier, California.



Time Periods of Health Statistics Review

The cancer statistics review studied the period from January 1, 1986, through December 31, 1995, and the mortality statistics review studied the period January 1, 1989, through December 31, 1998. ATSDR selected these periods for two reasons: 1) they come closest to corresponding to the time of exposure and the latency period of asbestos-related disease; and 2) a 10-year period provides the minimum amount of data required for informative statistical analysis (24).

Demographic Information on the Study Populations

In 1990, 6,492 people lived in census tract 5020.02 and 23,805 people lived in ZIP Code 90602 (see Table 1). Both study populations had fewer males than females and had sizeable Hispanic (white and other race) and non-Hispanic white populations. Compared to the U.S. population, the census tract population had a larger youth population. The socioeconomic status of the study populations, as measured by the percentage of people in the labor force, employment status, and poverty status, was similar to that of the United States.

Statistical Analysis

CDHS followed a health statistics review protocol developed by the ATSDR Division of Health Studies (24). The statistical analysis was designed to screen for an excess of asbestos-related disease in communities with facilities that received Libby vermiculite. Specifically, the following questions are explored:

1. Is the number of people who were diagnosed with an asbestos-related cancer

Table 1. Demographic Characteristics of the Populations Living in Census Tract 5020.02, ZIP Code 90602 and in the United States (2), Pryor Giggey Company, Whittier, California.

	Census Tract 5020.02	ZIP Code 90602	U.S.
Total population	6,492	23,805	--
Sex			
Males	49%	48%	49%
Females	52%	51%	51%
Race/Ethnicity			
Non-Hispanic			
White	28%	43%	76%
Black	0%	1%	12%
Asian/Pacific Islander	4%	3%	3%
Hispanic			
White	22%	20%	5%
Other	46%	31%	4%
Age			
Under 18 years old	34%	28%	26%
18-64 years old	58%	61%	62%
65 and over	8%	12%	12%
Education			
Less than 9th grade	25%	13%	9%
Some high school	25%	19%	15%
High school graduate	24%	23%	30%
Some college or higher	26%	45%	45%
Employment			
In labor force	66%	65%	65%
Not in labor force	34%	35%	35%
Employed	91%	94%	94%
Unemployed	9%	6%	6%
Poverty			
Income below poverty level	13%	14%	13%

while residing in census tract 5020.02 from 1986-1995 higher than what we would expect if the incidence rates of these cancers in census tract 5020.02 population were the same as the rates in the U.S. population?

2. Are the incidence rates of asbestos-related cancers in census tract 5020.02 population from 1986-1995 higher than the rates in the U.S. population?

3. Is the number of people who died from asbestos-related disease while residing in ZIP Code 90602 from 1989-1998 higher than what we would expect if mortality rates in the ZIP Code 90602 population were the same as the mortality rates in the U.S. population?

4. Are the mortality rates for asbestos-related disease in the ZIP Code 90602 population from 1989-1998 higher than the mortality rates in the U.S. population?

These four questions are similar in that they all compare the incidence and mortality rates in the Whittier community with the incidence and mortality rates in the U.S. population. They differ, however, in how the comparison is made.

Statistical Measures of Comparison

The first question is explored by calculating a statistical measure called the standardized incidence ratio (SIR). SIR is a numerical expression that compares how many people in the census tract 5020.02 population were diagnosed with cancer and how many diagnoses would be expected (hypothetically) if the incidence rate of cancer in the census tract 5020.02 population was the same as the incidence rate of cancer in the U.S. population. Details on how SIR is calculated are provided in Appendix B. If the number of people who were diagnosed with an asbestos-related cancer while residing in census tract 5020.02 is the same as the expected number, SIR will equal 1. If the number of people in the census tract 5020.02 population who were diagnosed with an asbestos-related cancer is less than the expected number, SIR will be less than 1. If the number of people in the census tract 5020.02 population who were diagnosed with an asbestos-related cancer is more than one would expect, SIR will be greater than 1.

The second question is explored by calculating a statistical measure called the standardized rate ratio (SRR). SRR is the ratio of the number of expected cancer diagnoses in the U.S. population, based on incidence rates of cancer in the census tract 5020.02 population, to the number of observed cancer diagnoses in the U.S. population. Details on how SRR is calculated are provided in Appendix C. If the incidence rate of cancer in the census tract 5020.02 population is the same as the incidence rate of cancer in the U.S. population, SRR will equal 1. If the incidence rate of cancer in the census tract 5020.02 is higher than the incidence rate of cancer in the U.S. population, then SRR will be greater than 1. If the incidence rate of cancer in the census tract 5020.02 is lower than the incidence rate of cancer in the U.S. population, then SRR will be less than 1.

The third question is explored by calculating a statistical measure called the standardized mortality ratio (SMR). SMR is essentially the same measure as SIR except that it evaluates the number of people who died from a disease rather than the number of people who were diagnosed with a disease. Thus, SMR is a numerical expression that compares how many people in ZIP

Code 90602 died of an asbestos-related disease, and how many would be expected to die (hypothetically) if the mortality rates of asbestos-related disease in the ZIP Code 90602 population were the same as the mortality rates in the U.S. population. Details on how SMR is calculated are provided in Appendix D. If the number of people who died from an asbestos-related disease while residing in ZIP Code 9060.02 is the same as the expected number, SMR will equal 1. If the number of ZIP Code 90602 residents who died from an asbestos-related disease is less than the expected number, SMR will be less than 1. If the number of people in ZIP Code 90602 who died from an asbestos-related disease is more than one would expect, SMR will be greater than 1.

Lastly, the fourth question is also answered by calculating SRR for mortality rates instead of cancer incidence rates. So SRR in this case is the ratio of number of expected cancer deaths in the U.S. population, based on mortality rates of cancer in ZIP Code population 90602, to the number of observed cancer deaths in the U.S. population.

Interpreting the Expected Number of People to Develop or to Die from a Disease

SIR, SMR, and SRR all compare the actual number of people to get or to die from a disease with an expected number. This expected number of people is a calculated and theoretical number that is often not a whole number. For example, the expected number might be 2.6 people. Because it is not possible for a fraction of a person to get or die from a disease, the expected number can be thought of as an approximation. In this example, the expected number 2.6 people can be interpreted to mean that either two or three people are expected to get or die from a disease.

Accounting for Differences between the Study Populations and the Comparison Population

In this review, the incidence and mortality rates of disease in the Whittier and U.S. populations are compared because it is thought that the Whittier population might have higher rates of disease due to past exposure to harmful levels of asbestos. However, other characteristics can also increase the risk for developing many of the diseases linked to asbestos. If the study populations differ from the U.S. population in terms of how common these characteristics are, then these differences can bias (i.e., create a faulty appearance) the results of the comparison unless they are accounted for in the analysis. For example, smoking can increase the risk of developing lung cancer. If smoking rates in the Whittier populations are lower than the smoking rates in the U.S. population, but the analysis does not adjust for this difference, then the study populations might appear to have lower rates of lung cancer in comparison with the U.S. population than they in fact do. This bias can hide a true excess of disease or it can create the appearance of an excess when none really exists.

This analysis did account for differences in age and sex, but did not account for other risk factors for asbestos-related disease (e.g., smoking, race/ethnicity, socioeconomic status).

Statistical Tests

The number of people who get or die from cancer or other diseases in a given geographic area changes from year to year; this fluctuating pattern is characteristic of the occurrence of disease

and is expected. Because of this, the values of SIR, SMR, and SRR will also change, depending on which time period is under study. If the number of cases occurring in one time period under study is higher than average, then SIR, SMR, or SRR will be higher than 1 (e.g., 1.2). If a different time period was under study when the number of cases was lower than average, SIR, SMR, and SRR will be less than 1 (e.g., 0.9). Some degree of fluctuation in the SIR, SMR, and SRR values from one time period to another is normal and expected.

An important question is, when is SIR, SMR, or SRR higher or lower than what would be expected, given that the number of people getting disease in a given geographic area normally varies over time? In other words, is the incidence rate or mortality rate in the Whittier population the same as that in the U.S. population, or is disease or death occurring less or more frequently in the Whittier population than in the U.S. population?

To answer this question, a statistical test measure called a confidence interval (CI) was calculated for SIR, SMR, and SRR using Byar's approximation method (25). A confidence interval is a range of possible values for SIR, SMR, or SRR that are consistent with the normal variation in disease over time in a geographic area. If the CI range includes the value one, then there is no "statistically significant" difference between the incidence or mortality rates in the Whittier and U.S. populations, as represented by SIR, SMR, or SRR. That is, the incidence or mortality rate in the Whittier population is the same as the incidence or mortality rate in the U.S. population. If the CI range is less than 1 or greater than 1, then there is a "statistically significant" difference between the incidence or mortality rates in the two populations: the incidence rate or mortality rate in the Whittier population is not the same as the incidence rate or mortality rate in the U.S. population.

Part of the process of calculating a confidence interval includes selecting a level of certainty for this statistical test. CDHS used a 95% level of certainty that is the standard value selected for these types of analyses.

Sources of Information on Incidence and Mortality Rates

Information on the number of people who developed cancer while residing in census tract 5020.02 was obtained from the California Cancer Registry (CCR). Information on cancer rates in the U.S. population was obtained from the Surveillance, Epidemiology, and End Results program of the National Cancer Institute (SEER) (26).

Information on the number of people who died while residing in ZIP Code 90602 was obtained from CDHS, Center for Health Statistics, Office of Vital Records (CDHS-OVR). Information on mortality rates in the U.S. population was obtained from the National Center for Health Statistics (NCHS) (27).

Results of the Cancer Statistics Review

SIRs and SRRs for the census tract 5020.02 population are presented in Table 2. Table 2 shows:

For each cancer group evaluated

- the reason for evaluating that type of cancer.

For the SIR analysis

- the number of people who were diagnosed with the type of cancer while residing in census tract 5020.02;
- the number of people expected to be diagnosed (if the census tract 5020.02 population had the same incidence rate as the U.S. population); and
- SIR and 95% CI for SIR.

For the SRR analysis

- the number of people who were diagnosed with the type of cancer while residing in the United States;
- the number of people expected to be diagnosed (if the U.S. population had the same incidence rate as the census tract 5020.02 population); and
- SRR and 95% CI for SRR.

Table 2. Standardized incidence ratio (SIR), standardized rate ratio (SRR), and 95% confidence intervals (CI) of selected cancers in the census tract 5020.02 population, 1986-1995. Pryor Giggey Company, Whittier, California.

Cancer Group (ICD-O-2 Code)	Reason*	Census Tract 5020.02			U.S. Population		
		Number of diagnoses	Number expected	SIR (95% CI)	Number of diagnoses	Number expected	SRR (95% CI)
Lung and bronchus (C340:C349†)	1	16	25.1	0.64 (0.36-1.04)	148,246	94,917.6	0.64 (0.38–1.07)
Mesothelioma (M-9050:9053)	1	0	0.4	0 (0-9.22)‡	2,360		0§
Digestive organs (C150: C218, C260:C269†)	2	28	27.2	1.03 (0.68-1.49)	163,384	174,055.8	1.07 (0.74–1.52)
Respiratory system and intrathoracic organs (C320:C399†)	3	18		0.65 (0.39-1.03)	162,067	107,379.3	0.66 (0.41–1.07)
Peritoneum, retroperitoneum, and pleura (C480:C488, C384†)	3	0	0.7	0 (0-5.27)‡	3,814		0§
All cancers (C000:C809†)	4	118	184.1	**0.64 (0.53-0.77)**	1,045,968	690,454.4	**0.66 (0.55–0.79)**
Female breast (C500:C509†)	4	16	26.3	**0.61 (0.35-0.99)**	154,568		**0.59 (0.36–0.97)**
Prostate (C619†)	4	19	26.4	0.72 (0.43-1.12)	153,845	113,802.0	0.74 (0.47–1.16)

†Excluding M-9590:9989.

‡Exact confidence interval based on Poisson distribution.

§Confidence interval not calculated since expected number of deaths was 0 (W. Kaye, ATSDR, personal communication, 2004).

Bold typeface indicates a statistically significant result.

*Reason for studying:

1. Exposure to asbestos is known to cause a type of cancer in this cancer group.
2. There is some, but inconclusive, evidence that exposure to asbestos might be associated with some digestive organ cancers.
3. This cancer group might include people with an asbestos-related cancer that was misdiagnosed.
4. This cancer or cancer group was studied to confirm that information on cancer diagnoses is reported to CCR and SEER in a consistent manner.

Between 1986 and 1995, the incidence rates of asbestos-related cancers in the census tract 5020.02 population were not statistically significantly different from the incidence rates in the U.S. population. Sixteen people were diagnosed with lung or bronchial cancer, when 25.1 diagnoses would be expected if the incidence rate in the census tract 5020.02 population was the same as the incidence rate in the U.S. population (SIR=0.64). 95% CI (0.36-1.04) indicates that there is no statistically significant difference between the incidence rates of lung and bronchus cancer in the census tract 5020.02 population and the U.S. populations, as measured by SIR. There is also no statistically significant difference between the incidence rates of lung and bronchus cancer in the census tract 5020.02 population and U.S. populations, as measured by SRR. SRR for lung and bronchus cancer was 0.64, with a 95% CI of 0.38-1.07. There was also no statistically significant difference between the incidence rate of mesothelioma in the census tract 5020.02 and U.S. populations (SIR=0 and 95% CI, 0-9.22, and SRR=0).

Between 1986 and 1995, the incidence rate of digestive organ cancers in the census tract 5020.02 population was not statistically significantly different from the incidence rate in the U.S. population, as measured by the SIR analysis (SIR=1.03 and 95% CI, 0.68-1.49) and the SRR analysis (SRR=1.07 and 95% CI, 0.74-1.52).

The incidence rate of cancer of the respiratory system and intrathoracic organs in the census tract 5020.02 population was not statistically significantly different from the incidence rate in the U.S. population, as evaluated by the SIR analysis (SIR=0.65 and 95% CI, 0.39-1.03) and the SRR analysis (SRR=0.66 and 95% CI, 0.41-1.07). Neither was the incidence rate of cancer of the peritoneum, retroperitoneum, and pleura in the census tract 5020.02 population statistically significantly different from that in the U.S. population (SIR=0 and 95% CI 0-5.27, and SRR=0).

In terms of reference outcome analyses, according to both the SIR and SRR analysis, the incidence rates of all types of cancer and female breast cancer in the census tract 5020.02 population were statistically significantly lower than the incidence rates in the U.S. population. For all types of cancer, SIR=0.64 and 95% CI, 0.53-0.77; and SRR=0.66 and 95% CI, 0.55-0.79. For female breast cancer, SIR=0.61 and 95% CI, 0.35-0.99; and SRR=0.59 and 95% CI, 0.36-0.97. This analysis did not produce any evidence that the census tract 5020.02 and U.S. populations had different incidence rates of prostate cancer: SIR=0.72 and 95% CI 0.43-1.12; and SRR=0.74 and 95% CI 0.47-1.16.

A possible reason for deficits in cancer overall and female breast cancer is that the Hispanic population comprises a greater percentage of the census tract 5020.02 population than the U.S. population (Table 1). As a group, Hispanics have substantially lower rates of cancer overall and breast cancer than non-Hispanic whites (28, 29). Other factors which may contribute to these deficits are unknown and beyond the scope of this analysis, but may include population differences associated with health such as smoking status, race/ethnicity, diet, and obesity, or other aspects of the data reporting/recording, either for numerators or denominators.

Results of the Mortality Statistics Review

SMRs and SRRs for the ZIP Code 90602 population are presented in Table 3. Table 3 shows:

For each disease group evaluated

- the reason for evaluating the disease.

For the SMR analysis

- the number of people who died from the disease while residing in ZIP Code 90602;
- the number of people expected to die (if this population had the same disease mortality rate as the U.S. population); and
- SMR and 95% CI for SMR.

For the SRR analysis

- the number of people who died from the disease while residing in the United States;
- the number of people expected to die (if the U.S. population had the same disease mortality rate as the ZIP Code 90602 population); and
- SRR and 95% CI for SRR.

Table 3. Standardized Mortality Ratio (SMR), Standardized Rate Ratio (SRR) and 95% Confidence Intervals (CI) of Selected Causes of Death Occurring in ZIP Code 90602, 1989-1998. Pryor Giggey Company, Whittier, California.

Cause of Death (ICD-9 Code)	Reason*	ZIP Code 90602			U.S. Population		
		Number of deaths	Number expected	SMR (95% CI)	Number of deaths		
Cancer of the lung and bronchus (162.2-162.9)	1	85	112.7	**0.75 (0.60, 0.93)**	1,476,326	1,153,197.8	**0.78 (0.71, 0.86)**
Cancer of the peritoneum, retroperitoneum and pleura (including mesothelioma) (158, 163)	1	1		1.20 (0.02, 6.70)	10,615	12,251.6	1.15 (0.17, 7.87)
Asbestosis (501)	1	0	0.3	0 (0-12.30)†	3,367		
Cancer of the digestive organs (150-154, 159)	2	55	65.9	0.83 (0.63, 1.09)	832,523	726,502.6	0.87 (0.77, 1.00)
Cancer of the respiratory system and intrathoracic organs (161-165)	3	87		**0.75 (0.60, 0.92)**	1,524,872	1,178,792.9	**0.77 (0.70, 0.85)**
Cancer (no site specified) (199)	3	13	25.8	**0.50 (0.27, 0.86)**	327,646	178,550.7	**0.54 (0.42, 0.71)**
Pneumoconiosis (500-505)	3	0	0.9	0 (0-4.10)†	11,617	0.0	0‡
Chronic obstructive pulmonary disease (490-496)	3, 4	71	79.7	0.89 (0.70, 1.12)	986,772		
Other diseases of the respiratory system (510-519)	4	8	14.2	0.56 (0.24, 1.11)	172,155	99,015.8	**0.58 (0.41, 0.80)**
Diseases of pulmonary circulation (415-417)	4	4		0.41 (0.11, 1.05)	119,554	53,452.6	**0.45 (0.27, 0.75)**
All cancers (140-208)	5	274	409.2	**0.67 (0.59, 0.75)**	5,259,810	3,714,403.9	**0.71 (0.67, 0.75)**
Female breast cancer (174)	5	26	33.3	0.78 (0.51, 1.14)	430,680	349,917.0	**0.81 (0.67, 0.99)**
Prostate cancer (185)	5	24	25.0	0.96 (0.61, 1.43)	334,151	341,722.0	1.02 (0.83, 1.26)

†Exact confidence interval based on Poisson distribution. ‡Confidence interval not calculated since expected number of deaths was 0 (W. Kaye, ATSDR, personal communication, 2004). **Bold** typeface indicates a statistically significant result. * Reason for studying:

1. Exposure to asbestos is known to cause a type of cancer in this cancer group or this disease.
2. There is some, but inconclusive, evidence that exposure to asbestos might be associated with some digestive organ cancers.
3. This cancer group might include people with an asbestos-related cancer that was misdiagnosed.
4. Exposure to asbestos might have exacerbated the condition of people with these diseases and thereby led to premature or increased chance of death.
5. This cancer or cancer group was studied to confirm that information is reported to CDHS-OVR and NCHS in a consistent manner.

The mortality statistics review found no evidence that the ZIP Code 90602 population experienced statistically significantly higher rates of death from some asbestos-related disease than the U.S. population between the years 1989-1998. In fact, the ZIP Code 90270 population had statistically significantly lower mortality rates for cancer of the lung and bronchus: SMR=0.75 and 95% CI 0.60-0.93; and SRR=0.78 and 95% CI 0.71-0.86. There was no statistically significant difference between the mortality rates for cancer of the peritoneum, retroperitoneum and pleura (including mesothelioma), and for asbestosis in the ZIP Code 90270 and U.S. populations. For cancer of the peritoneum, retroperitoneum and pleura (including mesothelioma), SMR=1.20 and 95% CI 0.02-6.70 and SRR=1.15 and 95% CI 0.17-7.87. For asbestosis, SMR=0 and 95% CI 0-12.30 and SRR=0.

Neither the SMR nor the SRR analyses produced evidence that the ZIP Code 90270 population experienced statistically significantly different rates of death from digestive organ cancers, which have been inconclusively linked to asbestos exposure in previous epidemiologic studies. SMR=0.83 and 95% CI 0.63-1.09, and SRR=0.87 and 95% CI 0.77-1.00.

The ZIP Code 90602 population had statistically significantly lower mortality rates from cancer of the respiratory system and intrathoracic organs (SMR=0.75 and 95% CI 0.60-0.92, and SRR=0.77 and 95% CI 0.70-0.85) and from cancer (no site-specified) (SMR=0.50 and 95% CI 0.27-0.86, and SRR=0.54 and 95% CI 0.42-0.71). There was no evidence that the ZIP Code 90602 and U.S. populations had different mortality rates for pneumoconiosis (SMR=0 and 95% CI 0-4.10, and SRR=0) and chronic obstructive pulmonary disease (SMR=0.89 and 95% CI 0.70-1.12, and SRR=0.91 and 95% CI 0.81-1.02).

Also, there was inconsistent evidence that the ZIP Code 90602 and U.S. populations had different mortality rates for other disease of the respiratory system and diseases of the pulmonary circulation. According to the SRR analysis, the ZIP Code 90602 had statistically significantly lower mortality rates: SRR=0.58 and 95% CI 0.41-0.80 for other disease of the respiratory system; and SRR=0.45 and 95% CI 0.27-0.75 for diseases of the pulmonary circulation. However, according to the SMR analysis, there was no evidence that the two populations had statistically different mortality rates: SMR=0.56 and 95% CI 0.24-1.11 for other disease of the respiratory system; and SMR=0.41 and 95% CI 0.11-1.05 for diseases of the pulmonary circulation.

In terms of the reference outcome analyses, compared to the U.S. population, the ZIP Code 90602 population had statistically significantly lower mortality rates from all cancers: SMR=0.67 and 95% CI 0.59-0.75; and SRR=0.71 and 95% CI 0.67-0.75. The SRR analysis produced evidence that the mortality rate for female breast cancer was statistically significantly lower in the ZIP Code 90602 population (SRR=0.81 and 95% CI 0.67-0.99), but the SMR analysis did not (SMR=0.78 and 95% CI 0.51-1.14). Neither analysis indicated that the rates of death from prostate cancer in the ZIP Code 90602 and U.S. populations were different: SMR=0.96 and 95% CI 0.61-1.43; and SRR=1.02 and 95% CI 0.83-1.26.

A possible reason for the deficits in cancer overall and female breast cancer is that the Hispanic population comprise greater percentages of the ZIP Code 90602 population than the U.S. population (Table 1). As a group, Hispanics have substantially lower rates of cancer and breast cancer than non-Hispanic whites (28, 29). Other factors which may contribute to these deficits

are unknown, but may be due to other aspects of the risk factors beyond the scope of this analysis, such as population differences in factors associated with health such as smoking status, race/ethnicity, diet, and obesity, or other aspects of the data reporting/recording, either for numerators or denominators.

Limitations of the Health Statistics Review

Five limitations of this analysis are worth discussion and exploration because they might 1) affect the accuracy of the results, 2) limit the ability of the analyses to observe an excess of asbestos-related disease attributable to vermiculite processing at Pryor Giggey, if one exists, or 3) limit the degree to which this analysis can serve as an indicator of community exposure to Libby asbestos.

1. *The SIR, SMR, and SRR results might be biased if the analyses do not account for the ways that the Whittier and U.S. population differ with respect to other risk factors for asbestos-related diseases (e.g., race/ethnicity, socioeconomic status, or smoking).*

As discussed previously, this analysis does not account for all the ways that the Whittier population differs from the U.S. population with respect to risk factors for diseases that can be caused by exposure to asbestos (e.g., smoking, race/ethnicity, or socioeconomic status). As a result, this analysis might not accurately identify an excess or lack of excess of disease attributable to asbestos exposure.

To assess whether the Whittier and U.S. populations differ with respect to other risk factors for asbestos-related disease, CDHS gathered information from the U.S. Census. Table 1 shows that the population in census tract 5020.02 differs substantially from the U.S. population in terms of race/ethnicity and socioeconomic status (measured by education level and poverty status). Also, the ZIP Code 90602 population differ substantially from the U.S. population in terms of these characteristics. No information on smoking rates in the study populations is available. However, smoking has historically been less common in California (30), and, since the late 1980s, smoking rates in California have been declining more rapidly than the rest of the country (31). Smoking rates also tend to be higher among people of low socioeconomic status (32) and tend to differ by race and ethnicity (33-35). Using these statewide trends, it is likely that the smoking rates in the Whittier study populations are different from those in the U.S. population.

It is not possible to predict whether or how the combined racial, ethnic, and socioeconomic differences between the study and U.S. populations could bias the analysis (that is, whether they could be masking a true elevation in rates of asbestos-related disease.) However, any conclusions drawn from this health statistics review could be made more definitively, if these differences were accounted for in the SIR, SMR, and SRR analyses.

2. *The results of the analyses might be inaccurate if the study populations are larger or smaller than they are assumed to be.*

Information on the size of the study populations during the study periods (1986-1995 for the cancer statistics review and 1989-1998 for the mortality statistics review) is needed to calculate SIR, SMR, and SRR as well as 95% CIs. Information on the size of the populations in census

tracts and ZIP Codes is collected by the U.S. Census once every decade, but not during the intervening years. Therefore, to calculate the statistical measures of comparison, ATSDR made the customary assumption that the size of the study populations in 1990 (as determined by the U.S. Census) represents the average size of the populations during the study periods.

If this assumption does not hold true, then the results of the SIR, SMR, and SRR analyses will be biased (inaccurate). Specifically, if the size of the study populations in 1990 is smaller than the average size of the study populations during the study periods, then SIR, SMR, and SRR will be inaccurately high numbers, and the statistical tests might falsely indicate a statistically significant excess of disease. And, if the size of the study populations in 1990 is larger than the average size of the study populations during the study periods, then SIR, SMR, and SRR will be inaccurately low numbers, and the statistical tests might falsely indicate a lack of disease excess.

Without knowing the true size of the study populations during the study periods, it is not possible to predict whether, or in what way, these statistical measures might be biased. However, it is possible to obtain some sense of whether any bias is occurring by referring to information on the size of these populations during U.S. Census years.

According to U.S. Census data, the census tract 5020.02 population grew by 30% between 1980 and 1990 and by 8% between 1990 and 2000 (36). If these trends represent the growth of the census tract population between 1986 and 1995, then the assumed size of the cancer statistics review study population is smaller than the true size. This difference will bias the values of SIR, SRR, and 95% CIs in a way that makes them higher than they actually are.

The ZIP Code 90602 population grew 10% between the years 1990 and 2000 (36). If this trend represents the growth of this population during the years 1989 and 1998, then the assumed size of the mortality statistics review study population is smaller than the true size. This difference will bias the values of SMR, SRR, and 95% CIs in a way that makes them higher than they actually are.

In summary, if more accurate information on population size was used in the analysis, then the values of SIRs, SMRs, and SRRs would be lower than they were in these results: the incidence and mortality rates in the Whittier study populations might be even lower, in comparison to the rates in the U.S. population, than this analysis indicates.

3. *The analysis might fail to observe a true excess of asbestos-related cancers and disease if the study populations include people who could not have been exposed to asbestos from the processing of vermiculite at Pryor Giggey.*

This health statistics review would ideally evaluate the health status of only those people who were exposed to asbestos from the processing of Libby vermiculite at Pryor Giggey, assuming that off-site contamination and exposure did occur. The effect of including people who were not exposed to asbestos in the study population is to lessen the ability to see an excess of asbestos-related disease in the population. This occurs because the people who were never exposed to asbestos can make the population appear healthier than it would otherwise appear if they were not included in the analysis.

Due to several reasons (e.g., lack of information on whether asbestos pollution from Pryor Giggey occurred, lack of information on how far the asbestos pollution would have traveled in the air, and restrictions on the geographic area for which cancer and mortality statistics are available), it is likely that this health statistics review evaluated the occurrence of asbestos-related cancers and death in a population that included people who were never exposed to asbestos. Therefore, SIRs, SMRs, SRRs, and 95% CIs are likely to be smaller numbers than they would otherwise be if unexposed people were not included in the study population. The incidence and mortality rates in the Whittier population might be higher, in comparison to the rates in the U.S. population, if the study populations only included people who were exposed to Libby asbestos from the processing of Libby vermiculite at Pryor Giggey.

4. *The analysis might fail to observe a true excess of asbestos-related cancers and disease, attributable to vermiculite processing at Pryor Giggey if the study periods do not correspond to the years that this excess of disease would be expected to occur.*

The diseases caused by exposure to asbestos take many years to develop. Current knowledge is that lung cancer will develop 20 to 30 years after exposure to asbestos, mesothelioma will develop 30 to 40 years after exposure, and asbestosis will develop 10 to 20 years after exposure. Pryor Giggey received shipments of Libby vermiculite between the years 1985 and 1988. Therefore, we would expect that any lung cancer caused by exposure to Libby asbestos would occur between 2005-2018, any mesothelioma caused by exposure to Libby asbestos would occur between 2015-2028, and any asbestosis caused by exposure to Libby asbestos would occur between 1995-2008.

This health statistics review evaluated the incidence rates and mortality rates from asbestos-related diseases between the years 1985-1996 and 1989-1998, respectively. These study periods precede the years that most disease caused by exposure to Libby asbestos is most likely to occur (see Table 4). Therefore, it is possible that this analysis did not find an excess of asbestos-related disease in the Whittier community because this excess of disease has not yet occurred.

Table 4. Years that Disease Due to Exposure to Libby Asbestos from Vermiculite Processing at Pryor Giggey Would Be Expected to Occur (Assuming that Hazardous Exposure Occurred), and Number of Period Years During Which Exposure-Related Disease Is Expected to Occur, Pryor Giggey Company, Whittier, California.

Disease	Years During which Asbestos-Related Disease Is Most Likely to Occur (Based on Latency Period)	Number of Years of Overlap between the Period Evaluated and the Years that Asbestos-Related Disease Is Most Likely to Occur	
		Cancer Statistics Review (1986–1995)	*Mortality Statistics Review (1989–1998)*
Cancer of the lung and bronchus	2005-2018	0	0
Mesothelioma	2015-2028	0	0
Asbestosis	1995-2008	—	4

5. *The results of the health statistics review can serve as an indicator of community exposure to Libby asbestos only if the study populations include the people who were living near Pryor Giggey at the time that Libby vermiculite was processed.*

According to the protocol for this health statistics review, finding a statistically significant elevation in asbestos-related disease in a community would alert CDHS and ATSDR to the possibility that community members might have been exposed to asbestos as a result of the facility's handling or processing of vermiculite from Libby. This interpretation is based on an assumption that the study population consists of people who were exposed to Libby asbestos. Therefore, this interpretation is appropriate only if the study populations include the people who were living near Pryor Giggey during the time that Libby vermiculite was processed.

Cancer registry and vital statistics records do not collect information on residential history. Therefore, it is not possible to determine whether the people in the study populations lived near Pryor Giggey during the years that Libby vermiculite was processed. However, information on population mobility from the U.S. Census can provide some insight into the likelihood that the study populations included the people who were living near Pryor Giggey during the years that Libby vermiculite was processed (1985-1988).

According to the 1990 U.S. Census, 79% of the people residing in census tract 5020.02 in 1990 moved into their home prior to 1988. According to the 1990 and 2000 Census, approximately 20% to 70% of the people residing in ZIP Code 90602 moved into their home prior to 1988 (37). Therefore, about 20% of the people in the cancer statistics review study population and about 30% to 80% of the people in the mortality statistics review study population did not have the potential to be exposed to Libby asbestos, since they moved into their homes after Pryor Giggey stopped using Libby vermiculite.

Child Health Considerations

ATSDR and CDHS recognize that infants and children may be more vulnerable to exposures than adults in communities faced with environmental contamination. Children could be especially vulnerable to asbestos exposure because they are more likely to disturb fiber-laden soils or indoor dust while playing. Children also breathe air that is closer to the ground and may thus be more likely to inhale airborne fibers from contaminated soils or dust.

Furthermore, children who are exposed could be more at risk of actually developing asbestos-related disease than people exposed later in life because of the long latency period between exposure and onset of asbestos-related respiratory disease. Children might also be more biologically susceptible to the toxic effects of asbestos. Whether the latency period for asbestos-related disease is different for people exposed during childhood is unknown.

This review of health statistics screened people of all ages, including the people who were infants or children during the years that Libby vermiculite was shipped to the Pryor Giggey facility. This group of people who were 18 years old or younger during the years of potential exposure to Libby asbestos (1985-1988) would be between the ages of 0 and 28 during the years that the cancer statistics review evaluates (1986-1995), and between 1 and 31 during the years that the mortality statistics review evaluates (1989-1998).

Conclusions

Pryor Giggey received 198 tons of asbestos containing vermiculite from Libby, Montana, between 1985 and 1988. Due to lack of information from Pryor Giggey, CDHS was unable to identify possible steps in the refractory manufacturing process in which workers could be exposed to dust from handling vermiculite contaminated with asbestos. In addition, Pryor Giggey has not provided CDHS with contact information of former workers. At this time, CDHS is unable to inform former Pryor Giggey workers about the health hazards of exposure to Libby vermiculite.

CDHS was not able to evaluate if or how much exposure occurred to people who lived near Pryor Giggey between 1985 and 1988. Neither the cancer statistics review nor the mortality statistics review produced any evidence that the census tract 5020.02 or the ZIP Code 90602 populations experienced higher incidence or mortality rates for asbestos-related diseases during the years 1986-1995 and 1989-1998, respectively, than the U.S. population. In fact, compared to the U.S. population, the study populations had either the same or lower incidence and mortality rates of lung cancer, mesothelioma and asbestosis.

This analysis did not produce any evidence that study and U.S. populations had different incidence and mortality rates of digestive organ cancers (which have been inconclusively linked to asbestos exposure). The mortality statistics review indicated that the ZIP Code 90602 population had either the same or statistically significantly lower rates of death from diseases that could theoretically be worsened by exposure to asbestos, including other diseases of the respiratory system, and diseases of the pulmonary circulation.

The results for the remaining diseases evaluated in the health statistics review indicate that an excess of asbestos-related disease in this Whittier population is not being obscured by physician misdiagnosis.

Cancers overall and selected outcomes assumed to have no causal relationship with asbestos were reviewed for comparison. Results of these analyses showed a slight deficit for cancers overall. This deficit may be due to differences in the racial composition of the study populations as compared to the U.S. population as a reference. Other unknown factors may also have contributed, such as differences in other health risk factors between populations beyond the scope of this analysis.

A very similar protocol to the one used in this health statistics review identified a statistically significant excess of asbestos-related disease in the Libby, Montana, community. If the Whittier study populations were similar to the Libby community in terms of level of exposure to Libby asbestos, population mobility, and other characteristics, then this type of analysis would be expected to also be able to detect a statistically significant excess of asbestos-related disease in the Whittier community.

The Whittier study populations differ from the Libby community in ways that increase the limitations of this type of analysis. Therefore, although the results of this health statistics review could be correctly reflecting that the health of the Whittier community was not impacted by exposure to Libby asbestos, the lack of consistent evidence of disease excess could be due to any or all of the following reasons:

1. this analysis did not account for the ways in which the Whittier and U.S. populations differ with respect to other risk factors for asbestos-related disease;

2. the assumptions about the size of the Whittier study populations made the incidence and mortality rates in the Whittier study populations appear more similar to the rates in the U.S. population than they truly are;

3. the study populations included people who were never exposed to Libby asbestos from Pryor Giggey, which also made the incidence and mortality rates in the Whittier study populations appear more similar to the rates in the U.S. population than they truly are; and

4. given the years that exposure to Libby asbestos would have occurred, combined with the amount of time that asbestos-related disease takes to develop, this analysis might be failing to observe an excess of disease or death because the time period it evaluates precedes the time period that almost all of the disease attributable to Libby asbestos is likely to occur.

More important than these limitations, is the likelihood that the study populations do not include the people who were living near Pryor Giggey during the years that Libby vermiculite was processed. Because the study populations do not appear to include a substantial proportion of people who were potentially exposed to Libby asbestos, the results of this analysis do not serve as a reliable indicator of past community exposure. Therefore, the lack of evidence of high rates of asbestos-related disease or death during the years 1986-1995 and 1989-1998, respectively, in the Whittier study populations, does not establish that the community neighboring the Pryor Giggey was not exposed to Libby asbestos.

Recommendations

CDHS recommends efforts to:

1. expand public awareness of the potential for and ways to avoid or reduce exposure to asbestos in consumer products made with WR Grace-Libby vermiculite; and

2. make information available to former workers at Pryor Giggey of their potential exposure to asbestos and of ways to reduce risk of asbestos-related disease (e.g., smoking cessation) via the CDHS website.

Public Health Action Plan

The Public Health Action Plan is a collection of activities intended to ensure that this health statistics review also provides a plan of action to mitigate and to prevent adverse effects on human health resulting from exposure to asbestos from Libby vermiculite. Some activities have already been taken by CDHS or ATSDR. Others activities are either ongoing or planned for the future.

Actions Completed

1. CDHS conducted a needs assessment with the Los Angeles County Health Officer and Environmental Health Departments, the goals of which were to educate the departments about the vermiculite health statistics review project, to obtain information about the extent and level of stakeholder concerns, to develop an information dissemination plan, and to identify ways CDHS can support local efforts or activities pertaining to Pryor Giggey.

2. CDHS disseminated information materials on consumer products made with Libby vermiculite to increase public awareness of the potential for and ways to reduce or avoid current or future exposure to asbestos from this source via the CDHS website.

3. CDHS briefed the Occupational Health Branch (of CDHS) about asbestos contamination of Libby vermiculite, the facilities in California that processed this vermiculite, and the potential for workers at these facilities to have been exposed to asbestos.

4. Information on the potential for and ways to reduce exposure to asbestos in vermiculite consumer products was included in this health consultation and provided to the Los Angeles County Health Officer and Environmental Health Director.

Ongoing Action

CDHS will continue to provide technical assistance to the Los Angeles County Health Officer and Environmental Health Director on the vermiculite health statistics review.

Planned Actions

1. ATSDR has funded health statistics reviews in 25 states with facilities that received Libby vermiculite. Once all of the results from participating states have been received, ATSDR will compare SRRs for all the sites examined in order to identify trends that might not be apparent when each facility is evaluated individually. The results of the health statistics reviews will also be evaluated in combination with all information on environmental exposures to asbestos produced by research by the National Asbestos Exposure Review project of ATSDR. ATSDR will distribute the results of these analyses to contributing state health departments and other interested parties.

2. Using the results of ATSDR's review of health statistics for all vermiculite facilities nationwide, CDHS will conduct follow-up activities with the Los Angeles County Health Officer and Environmental Health Departments. The specifics of these activities will depend on what is learned from the nationwide review.

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Certification

The health consultation Pryor Giggey Company, 12393 Slauson Avenue, Whittier, Los Angeles County, was prepared by the California Department of Health Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It was completed in accordance with approved methodology and procedures existing at the time the health consultation was initiated. Editorial review was completed by the Cooperative Agreement partner.

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Appendix A—Glossary

ATSDR
The Agency for Toxic Substances and Disease Registry. ATSDR is a federal health agency based in Atlanta, Georgia, that deals with hazardous substance and waste site issues. ATSDR provides information to the public on harmful chemicals in the environment and on how to be safe from contact with chemicals.

Cancer Risk
The potential for exposure to a contaminant to cause cancer in an individual or population is evaluated by estimating the probability of an individual developing cancer over a lifetime as the result of the exposure. This approach is based on the assumption that there are no absolutely "safe" toxicity values for carcinogens. The U.S. Environmental Protection Agency has developed cancer slope factors for many carcinogens. A slope factor is an estimate of a chemical's carcinogenic potency, or potential, for causing cancer.

If adequate information about the level of exposure, frequency of exposure, and length of exposure to a particular carcinogen is available, an estimate of excess cancer risk associated with the exposure can be calculated using the slope factor for that carcinogen. Specifically, to obtain risk estimates, the estimated chronic exposure dose (which is averaged over a lifetime or 70 years) is multiplied by the slope factor for that carcinogen.

Cancer risk is the likelihood, or chance, of getting cancer. We say "excess cancer risk" because we have a "background risk" of about one in four chances of getting cancer. In other words, in a million people, it is expected that 250,000 individuals would get cancer from a variety of causes. If we say that there is a "one in a million" excess cancer risk from a given exposure to a contaminant, we mean that if one million people are exposed to a carcinogen at a certain concentration over their lifetime, then one cancer above the background chance, or the 250,000th cancer, may appear in those million persons from that particular exposure. In order to take into account the uncertainties in the science, the risk numbers used are plausible upper limits of the actual risk based on conservative assumptions. In actuality, the risk is probably somewhat lower than calculated, and in fact may be zero.

Concern
A belief or worry that chemicals in the environment might cause harm to people.

Exposure
Coming into contact with a chemical substance. (For the three ways people can come in contact with substances, see Route of Exposure.)

Hazardous Waste
Substances that have been released or thrown away into the environment and, under certain conditions, could be harmful to people who come into contact with them.

Health Statistics Review
The analysis of existing health information (i.e., from death certificates, birth defects registries, and cancer registries) to determine if there is excess disease in a specific population, geographic area, and time period. A health statistics review is a descriptive epidemiologic study.

Incidence
The number of new cases of disease in a defined population over a specific time period.

Mortality
Death. Usually the cause (a specific disease, a condition, or an injury) is stated.

Population
A group of people living in a certain area or the number of people in a certain area.

Registry
A systematic collection of information on persons exposed to a specific substance or having specific diseases.

Source (of Contamination)
The place from which a chemical comes, such as a landfill, pond, creek, incinerator, tank, or drum.

Toxic
Harmful. Any substance or chemical can be toxic at a certain dose (amount).

Toxicology
The study of the harmful effects of chemicals on humans or animals.

Appendix B—Standardized Incidence Ratio

The standardized incidence ratio (SIR) is a measure that compares the incidence rate of disease in two populations. In this health statistics review, SIR compares, for the time period 1986 through 1995, the number of people who were diagnosed with a type of cancer while residing in census tract 5020.02 and the number of people expected to be diagnosed with cancer if the incidence rate of cancer in the census tract 5020.02 population was the same as the incidence rate in the U.S. population. SIR was calculated to account for ways in which census tract 5020.02 and U.S. populations differ in terms of age and sex. SIR is calculated in two steps.

Step 1

The expected number is calculated by 1) multiplying the incidence rate in various age and sex groups in the U.S. population by the number of people in those age and sex groups in the census tract 5020.02 population; then 2) summing the products to obtain the total number of expected cases in the census tract 5020.02 population.

Step 2

SIR is calculated by dividing the actual number of people who were diagnosed with cancer by the expected number.

These steps are demonstrated at right for all types of cancer.

	U.S. Incidence Rate, All Cancers 1986-1995		Number of People in Census Tract 5020.02 1986-1995		Number Expected of Cases in Census Tract 5020.02
STEP 1					
Females					
0 to 4	0.000188	X	3,710	=	0.7
5 to 9	0.000097	X	3,220	=	0.3
10 to 14	0.000116	X	2,570	=	0.3
15 to 19	0.000205	X	2,770	=	0.6
20 to 24	0.000351	X	2,890	=	1
25 to 29	0.000605	X	3,320	=	2
30 to 34	0.000948	X	2,860	=	2.7
35 to 39	0.001601	X	2,320	=	3.7
40 to 44	0.002631	X	1,710	=	4.5
45 to 49	0.004182	X	1,200	=	5
50 to 54	0.005868	X	890	=	5.2
55 to 59	0.008014	X	830	=	6.7
60 to 64	0.010734	X	920	=	9.9
65 to 69	0.013577	X	950	=	12.9
70 to 74	0.016334	X	670	=	10.9
75 to 79	0.018378	X	490	=	9.0
80 to 84	0.019683	X	270	=	5.3
85 and up	0.019640	X	250	=	4.9
Males					
0 to 4	0.000216	X	3,670	=	0.8
5 to 9	0.000123	X	3,010	=	0.4
10 to 14	0.000124	X	2,510	=	0.3
15 to 19	0.000210	X	2,820	=	0.6
20 to 24	0.000333	X	3,580	=	1.2
25 to 29	0.000573	X	3,510	=	2.0
30 to 34	0.000871	X	3,400	=	3.0
35 to 39	0.001191	X	2,400	=	2.9
40 to 44	0.001630	X	1,510	=	2.5
45 to 49	0.002697	X	1,240	=	3.3
50 to 54	0.004991	X	900	=	4.5
55 to 59	0.008856	X	790	=	7.0
60 to 64	0.014763	X	740	=	10.9
65 to 69	0.022620	X	660	=	14.9
70 to 74	0.030244	X	480	=	14.5
75 to 79	0.035267	X	420	=	14.8
80 to 84	0.038441	X	250	=	9.6
85 and up	0.037822	X	140	=	5.3
Total number of expected cases in census tract = 184.1					
STEP 2					
SIR = $\frac{118}{184.1}$ = 0.64					

Appendix C—Standardized Rate Ratio

The standardized rate ratio (SRR) is a measure that compares the incidence rate or the mortality rate for a disease in two populations. For the cancer statistics review, SRR compares the number of people in the United States who were diagnosed with a type of cancer, and the number of people expected to be diagnosed if the incidence rate in the U.S. population was the same as the incidence rate in the census tract 5020.02 population. For the mortality statistics review, SRR compares the number of people in the United States who died from a disease and the number of people expected to die if the mortality rate in the U.S. population was the same as the mortality rate in the ZIP Code 90602 population.

SRR is calculated in a manner that accounts for ways in which the study populations and the U.S. population differ in terms of age and sex. SRR is calculated in two steps.

Step 1

The expected number of cases or deaths in the U.S. population is calculated by 1) multiplying the incidence or mortality rate in various age and sex groups in the study population by the number of people in those age and sex groups in the U.S. population, then 2) summing the products to obtain the total number of expected cases or deaths in the U.S. population.

Step 2

SRR is calculated by dividing the expected number of cases or deaths (calculated in step 1) by the actual number of cases or deaths that occurred.

These steps are demonstrated at right for the mortality rate of all types of cancer.

	ZIP Code 90602 Mortality Rate, All Cancers 1989-1998		Number of People in the United States 1989-1998		Number of Expected Deaths in the United States 1989-1998
STEP 1					
Females					
0 to 4	0.000000	X	93,966,244	=	0.0
5 to 9	0.000000	X	91,867,322	=	0.0
10 to 14	0.000000	X	89,304,231	=	0.0
15 to 19	0.000215	X	87,811,833	=	18,864.0
20 to 24	0.000000	X	90,427,466	=	0.0
25 to 29	0.000000	X	98,755,306	=	0.0
30 to 34	0.000076	X	108,681,120	=	8,214.7
35 to 39	0.000455	X	107,902,167	=	49,046.4
40 to 44	0.000783	X	98,780,341	=	77,373.6
45 to 49	0.001061	X	82,737,629	=	87,785.3
50 to 54	0.000563	X	67,120,643	=	37,814.4
55 to 59	0.002694	X	57,368,622	=	154,528.3
60 to 64	0.003371	X	54,716,238	=	184,436.8
65 to 69	0.004279	X	54,396,949	=	232,779.7
70 to 74	0.004186	X	48,337,651	=	202,343.7
75 to 79	0.006780	X	39,220,867	=	265,904.2
80 to 84	0.008750	X	27,563,804	=	241,183.3
85 and up	0.007554	X	24,880,271	=	187,944.5
Males					
0 to 4	0.000000	X	98,444,382	=	0.0
5 to 9	0.000000	X	96,375,416	=	0.0
10 to 14	0.000000	X	93,779,769	=	0.0
15 to 19	0.000000	X	92,727,275	=	0.0
20 to 24	0.000000	X	93,916,511	=	0.0
25 to 29	0.000078	X	99,300,884	=	7,745.8
30 to 34	0.000085	X	107,836,073	=	9,123.2
35 to 39	0.000221	X	106,638,555	=	23,540.5
40 to 44	0.000898	X	96,528,396	=	86,702.2
45 to 49	0.000857	X	79,706,353	=	68,319.7
50 to 54	0.001775	X	63,474,519	=	112,676.7
55 to 59	0.002888	X	52,786,640	=	152,452.4
60 to 64	0.002821	X	48,333,937	=	136,365.3
65 to 69	0.003916	X	44,815,676	=	175,518.3
70 to 74	0.007818	X	36,773,021	=	287,476.4
75 to 79	0.008235	X	26,482,551	=	218,091.6
80 to 84	0.015652	X	15,345,068	=	240,183.7
85 and up	0.045833	X	9,774,311	=	447,989.3
Total number of expected deaths in U.S. = 3,714,403.9					
STEP 2					
SRR = $\frac{3,714,403.9}{5,259,810}$ = 0.71					

Appendix D—Standardized Mortality Ratio

The standardized mortality ratio (SMR) is a measure that compares the mortality rate for a disease in two populations. In this health statistics review, SMR compares, for the time period 1989 through 1998, the number of people who died from a disease while residing in ZIP Code 90602 to the number of people expected to die, if the mortality rate for the disease in the ZIP Code 90602 population was the same as the mortality rate for the disease in the U.S. population.

SMR was calculated in a manner that accounts for ways in which the ZIP Code 90602 and U.S. populations differ in terms of age and sex. SMR is calculated in two steps.

Step 1

The expected number of deaths is calculated by 1) multiplying the mortality rate in various age and sex groups in the U.S. population by the number of people in those age and sex groups in the ZIP Code 90602 population; then 2) summing the products to obtain the total number of expected deaths in the ZIP Code 90602 population.

Step 2

SMR is calculated by dividing the actual number of deaths that occurred by the expected number (calculated in step 1).

These steps are demonstrated at right for death from all types of cancer.

	U.S. Mortality Rate, All Cancers 1989-1998		Number of People in ZIP Code 90602 1989-1998		Number of Expected Deaths in ZIP Code 90602
STEP 1					
Females					
0 to 4	0.000027	X	12,460	=	0.3
5 to 9	0.000026	X	10,030	=	0.3
10 to 14	0.000024	X	7,170	=	0.2
15 to 19	0.000033	X	9,310	=	0.3
20 to 24	0.000045	X	12,180	=	0.6
25 to 29	0.000082	X	12,060	=	1.0
30 to 34	0.000162	X	13,230	=	2.1
35 to 39	0.000319	X	8,800	=	2.8
40 to 44	0.000591	X	7,660	=	4.5
45 to 49	0.001075	X	3,770	=	4.1
50 to 54	0.001851	X	3,550	=	6.6
55 to 59	0.002916	X	2,970	=	8.7
60 to 64	0.004336	X	3,560	=	15.4
65 to 69	0.005933	X	4,440	=	26.3
70 to 74	0.007832	X	4,300	=	33.7
75 to 79	0.009567	X	2,950	=	28.2
80 to 84	0.011546	X	2,400	=	27.7
85 and up	0.014049	X	2,780	=	39.1
Males					
0 to 4	0.000031	X	12,020	=	0.4
5 to 9	0.000032	X	9,980	=	0.3
10 to 14	0.000032	X	5,560	=	0.2
15 to 19	0.000047	X	8,180	=	0.4
20 to 24	0.000064	X	14,390	=	0.9
25 to 29	0.000090	X	12,820	=	1.2
30 to 34	0.000145	X	11,820	=	1.7
35 to 39	0.000252	X	9,060	=	2.3
40 to 44	0.000498	X	6,680	=	3.3
45 to 49	0.001033	X	3,500	=	3.6
50 to 54	0.002057	X	3,380	=	7.0
55 to 59	0.003744	X	2,770	=	10.4
60 to 64	0.006262	X	3,190	=	20.0
65 to 69	0.009319	X	3,830	=	35.7
70 to 74	0.012953	X	3,070	=	39.8
75 to 79	0.016628	X	2,550	=	42.4
80 to 84	0.021582	X	1,150	=	24.8
85 and up	0.027371	X	480	=	13.1
Total number of expected deaths = 409.2					
STEP 2					
SMR = $\frac{274}{409.2}$ = 0.67					