Health Consultation

PUCHACK WELL FIELD

PENNSAUKEN TOWNSHIP, CAMDEN COUNTY, NEW JERSEY

EPA FACILITY ID: NJD981084767

FEBRUARY 9, 2005

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

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HEALTH CONSULTATION

PUCHACK WELL FIELD

PENNSAUKEN TOWNSHIP, CAMDEN COUNTY, NEW JERSEY

CANCER INCIDENCE IN A SECTION OF CAMDEN CITY HISTORICALLY SERVED BY THE PUCHACK WELL FIELD

EPA FACILITY ID: NJD981084767

Prepared by:

New Jersey Department of Health and Senior Services
Public Health Protection and Emergency Preparedness
Consumer and Environmental Health Services
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

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Purpose

In 2002, the New Jersey Department of Health and Senior Services (NJDHSS) and the federal Agency for Toxic Substances and Disease Registry (ATSDR) finalized a Public Health Assessment of the Puchack Well Field Site (ATSDR, 2002). Based on the weight-of-evidence analysis of the health and environmental information compiled in that report, NJDHSS and ATSDR conclude that the Puchack Well Field represented a public health hazard due to past human exposures. The following report describes a NJDHSS cancer incidence investigation conducted specifically in response to recommendations contained in the 2002 Public Health Assessment for a health statistics review of the population which has been historically served community water from the Puchack Well Field Site.

Background and Statement of Issues

The Puchack Well Field, located in Pennsauken Township, consisted of six community water supply wells owned and operated by the City of Camden, Camden County, New Jersey. Water from the Puchack wells was blended with water from other wells located in Pennsauken Township and pumped to Camden City, south of the Cooper River. Contamination of the Puchack Well Field was first detected in the early 1970s in one well. Contaminants include trichloroethylene, 1,2-dichloroethane, tetrachloroethylene, mercury, and chromium compounds, including hexavalent chromium (ATSDR 2002). The well was removed from service in 1975 due to the high levels of contaminants. Contamination continued to spread through the groundwater to the remaining supply wells, resulting in closure of all but one well by 1984. Although the source of the contamination is unknown, activities at nearby commercial and industrial facilities are generally thought to be the source.

The Camden City Water Department continued to use water from the one remaining contaminated Puchack well until May 1998, in an effort to prevent the migration of the hazardous substances to other nearby public supply wells. In 1998, the Puchack Well Field was added to the U. S. Environmental Protection Agency (EPA) National Priorities List of hazardous sites (Superfund). Another well field (Parkside) of the Camden City Water Department, serving the southeast corner of Camden, also was historically contaminated in the 1970s and 1980s with trichloroethylene, 1,2-dichloroethane, and tetrachloroethylene, according to New Jersey Department of Environmental Protection (NJDEP) water supply monitoring records.

The Camden population north of the Cooper River was served by the New Jersey American-Camden water supply, which had historic water contamination problems also dating from the late 1970s through 1990, according to NJDEP records. Contaminants detected in the New Jersey American-Camden water supply were primarily volatile organic compounds (VOCs) (trichloroethylene, 1,2-dichloroethane, tetrachloroethylene, 1,1,1-trichloroethane, and carbon tetrachloride).

Methods

Study Area and Population

The study area for the cancer incidence analysis includes the entire city of Camden. In addition, Camden was divided, by census tracts, into two separate areas for evaluation purposes. Census tracts are geographic areas defined by the U.S. Census Bureau for the purpose of compiling demographic information for the U.S. Census of the Population. The first area comprises all census tracts in which a majority of households were likely to receive contaminated water from the Puchack Well Field. These census tracts were grouped together and designated as the Puchack study area. The census tracts in the Puchack study area are 1 through 8 and 14 through 20 (see Figure 1). The remaining census tracts (9 through 13), not served by the Puchack Well Field, were grouped together and designated as the non-Puchack study area.

The study population consists of all residents living in the city of Camden. For the purpose of calculating statistics for this investigation, annual age, race, and sex-specific population estimates were derived by interpolation from the 1980, 1990, and 2000 Census data for each Camden census tract (Census 1980, 1990, 2000).

Cancer Case Ascertainment and Study Period

The New Jersey State Cancer Registry (NJSCR) was used for the ascertainment of incident cancer cases. The NJSCR, operated by the NJDHSS, is a population based cancer incidence registry covering the entire state of New Jersey. New Jersey regulations require reporting of all primary malignant and in-situ neoplasms, except certain carcinomas of the skin. Reports are filed by hospitals, diagnosing physicians, dentists, and independent clinical laboratories. In addition, the NJSCR has reporting agreements with the states of New York, Pennsylvania, Delaware, and Florida, through which information on New Jersey residents diagnosed in those states is provided to the NJSCR. The NJSCR began operation in October 1, 1978.

The study period for the cancer incidence investigation was January 1, 1979, through December 31, 1998, 20 full years of observation. A "case" was defined as an individual who was diagnosed with a new primary malignant cancer during the study period while residing in the city of Camden.

The information collected by the NJSCR includes basic patient identification, demographic characteristics of the patient (date of birth, race, sex, age at diagnosis, address at diagnosis), medical information on each cancer diagnosis (including anatomical site, histologic type and summary stage of disease), and annual follow-up status (living/deceased). Information is collected and defined in accordance with the National Cancer Institute Surveillance, Epidemiology, and End Results (SEER) program. These data, along with underlying cause of death (when applicable), are incorporated into the NJSCR basic database.

Persons diagnosed with cancer while living in the city of Camden were assigned to the appropriate Camden census tract.

Data Analysis

Analyses were completed for all malignant cancer types combined and for select cancer types for the entire study area. Cancer types separately analyzed include the following: bladder, brain and central nervous system (CNS), colorectal, esophageal, leukemia, non-Hodgkin lymphoma, liver, kidney, and stomach. The cancer types were selected to represent groupings that may be more sensitive to the effects of exposure to volatile organic compounds and hexavalent chromium. Males and females were evaluated separately. Separate analyses were conducted for blacks and whites. Cancer in children (diagnosed under the age of 20 years) also was evaluated separately for all cancers combined, brain/CNS, leukemia, and non-Hodgkin lymphoma.

Standardized incidence ratios (SIRs) were used for the quantitative analysis of cancer incidence in each of the study areas (Kelsey, et al. 1996; Breslow and Day 1987). The SIR was calculated by dividing the observed number of cases (from the NJSCR) by an expected number for the surveyed population during the time period reviewed. The expected number was calculated using average annual statewide age-sex-race specific incidence rates for the cancer type groupings based on NJSCR data for the 1979 through 1998 period.

In general, race-specific analyses tend to provide a less biased estimate than analyses with all races combined. This is particularly true for certain cancer types (e.g., esophageal cancer), which have substantially higher age-specific rates for blacks compared to whites. Because New Jersey has a predominantly white population (about 72% in 2000), statewide rates for all races combined are generally more similar to the white statewide rates than the black statewide rates when white and black rates significantly diverge. In addition, application of statewide rates of all races combined for populations that have a substantially different racial distribution may also bias the SIR. Consequently, the race-specific analyses may provide a better estimate of effect.

Evaluation of the observed and expected numbers is accomplished by interpreting the ratio (SIR) of these numbers. If the observed number of cases equals the expected number of cases, the SIR will equal one (1.0). An SIR less than one indicates that fewer cases are observed than expected. An SIR greater than one indicates that more cases than expected are observed.

The statistical test used to evaluate the difference between the observed and expected numbers was the 95% confidence interval (CI) (Breslow and Day 1987). The 95% CI is used to evaluate the probability that the SIR may be greater or less than 1.0 due to chance alone. The upper and lower limits of the CI were calculated using computational formulas which closely approximate the exact test for the Poisson distribution (Breslow and Day 1987; Checkoway, Pearce et al. 1989). If the 95% CI includes 1.0, then the estimated SIR is not considered to be statistically significantly different than 1.0.

Results

Study Population

Table 1 presents the Camden City population by study area, race, and sex for the years 1980, 1990, and 2000. The citywide population, all races combined, rose slightly from 1980 (84,910) to 1990 (87,492) and then fell in 2000 (79,904). The black population followed a similar pattern and represented 53% to 56% of the total Camden population. The white population dropped steadily throughout the period from about 30% of the total population in 1980 to about 17% in 2000. Other races (non-black and non-white) in Camden grew inversely to the white population decline from approximately 17% in 1980 to nearly 30% in 2000.

Nearly two-thirds of the Camden City population resided in the Puchack area in each of the three census years. The black population was relatively stable over the time period, comprising between 60% to 63% of the Puchack area population, and the white population decreased from 24% of the Puchack area population in 1980 to 16% in 2000. The number of Puchack area residents of other races increased from about 16% in 1980 to nearly 22% in 2000.

Just over one-third of the Camden City population resided in the non-Puchack area in each of the three census years. The percentage of black residents varied somewhat over the time period, comprising 41%, 46%, and 37% of the non-Puchack area population in the three census years. The white population decreased from 41% to 19% of the non-Puchack area population from 1980 to 2000. The number of non-Puchack area residents of other races increased from about 19% in 1980 to nearly 44% in 2000. The ratio of non-Puchack area males to females was similar for each racial group throughout the time period, with fewer male residents than female residents.

Cancer Case Ascertainment

For the 20-year study period, the NJSCR identified 6,446 newly diagnosed cases of malignant cancer among Camden City residents. Table 2 presents select demographic characteristics of the cases. A total of 4,472 cases (69%) were from the Puchack study area, 1,871 cases (29%) were from the non-Puchack study area, and 103 cases (2%) could not be accurately located within the city. A slightly higher percentage of cases were males (53% in the Puchack area and 51% in the non-Puchack area). The Puchack area cases had a substantially different racial makeup (56.5% black and 41.9% white) compared to the non-Puchack area (35% black and 63% white). The percentage of childhood (under 20 years of age) cases in the Puchack area was slightly lower (1.3%, 60 cases) than in the non-Puchack area (2.2%, 41 cases).

A description of the cancer cases for all ages combined and for children separately, by study area, race, and cancer type is presented in Tables 3 through 8. Lung cancer, colorectal cancer, breast cancer, and prostate cancer were the most frequently diagnosed cancers in each of

the total population subgroups, and leukemia was the most frequent childhood cancer. These relative frequencies are similar to statewide cancer incidence figures.

SIR Analysis

SIRs were calculated for all cancers and nine specific cancer types. Tables 9 through 11 present the Puchack area results of the SIR analysis for all ages combined, by sex for all races combined and separately for blacks and whites. Statistically significantly high SIRs for all races combined in the Puchack area (Table 9) include the following: all cancers combined in males (SIR = 1.16; 95% CI= 1.11, 1.20), esophageal cancer in males (SIR = 2.29; 95% CI = 1.79, 2.88) and in females (SIR = 1.69; 95% CI = 1.04, 2.58), and stomach cancer in males (SIR = 1.52; 95% CI = 1.21, 1.89) and in females (SIR = 1.40; 95% CI = 1.05, 1.83). Low but statistically significant SIRs for all races combined in the Puchack area include the following: bladder cancer in males (SIR = 0.60; 95% CI = 0.49, 0.74), brain and CNS cancer in males (SIR = 0.66; 95% CI = 0.42, 0.99), kidney cancer in males (SIR = 0.68; 95% CI = 0.48, 0.93), and leukemia in males (SIR = 0.70; 95% CI = 0.51, 0.95).

Only one SIR was statistically significantly high for blacks in the Puchack area (Table 10), all cancers combined in females (SIR = 1.09; 95% CI = 1.03, 1.15), and no SIR was statistically significantly low.

Statistically significantly high SIRs for whites in the Puchack area (Table 11) include the following: all cancers combined in males (SIR = 1.36; 95% CI = 1.28, 1.45) and in females (SIR = 1.17; 95% CI = 1.10, 1.25), colorectal cancer in males (SIR = 1.32; 95% CI = 1.12, 1.55), esophageal cancer in males (SIR = 2.36; 95% CI = 1.49, 3.53), and stomach cancer in males (SIR = 1.72; 95% CI= 1.19, 2.40). No SIRs were statistically significantly low for whites in the Puchack area.

Table 12 presents the childhood SIR analyses by race and sex for the Puchack area. Three elevated SIRs were found to be statistically significant and include the following: all cancers combined in white males (SIR = 2.61; 95% CI = 1.39, 4.46), leukemia in white females (SIR = 3.78 95% CI = 1.02, 9.68), and non-Hodgkin lymphoma in white females (SIR = 11.0; 95% CI = 1.24, 39.8). While not statistically significantly elevated, leukemia in white males was more than twofold higher than expected, and non-Hodgkin lymphoma was more than fourfold higher than expected. No SIRs were statistically significantly low for any childhood race-sex group in the Puchack area.

Tables 13 through 15 present the non-Puchack area results of the SIR analyses by sex for all races combined and black and whites separately. In the non-Puchack area (Table 13), only esophageal cancer in males for all races combined was statistically significantly high (SIR = 1.94; 95% CI = 1.29, 2.80). Two SIRs were statistically significantly low, all cancers combined in females (SIR = 0.92; 95% CI = 0.86, 0.98) and bladder cancer in males (SIR = 0.70; 95% CI = 0.51, 0.93).

One SIR was statistically significantly high for blacks in the non-Puchack area (Table 14), bladder cancer in males (SIR = 1.83; 95% CI = 1.02, 3.02). No SIR was statistically significantly low.

Three SIRs were statistically significantly high for whites in the non-Puchack area (Table 15), including all cancers combined in males (SIR = 1.16; 95% CI = 1.07, 1.26) and in females (SIR = 1.20; 95% CI = 1.11, 1.30), and esophageal cancer in females (SIR = 2.54; 95% CI = 1.02, 5.24). No SIRs were statistically significantly low for whites in the non-Puchack area.

Table 16 presents the childhood SIR analyses by race and sex for the non-Puchack area. Four statistically significantly elevated SIRs were found and include: all cancers combined in white males (SIR = 2.69; 95% CI = 1.43, 4.61) and in females (SIR = 2.19; 95% CI = 1.00, 4.17), brain/CNS cancer in white males (SIR = 4.68 95% CI = 1.26, 12.0), and leukemia in white females (SIR = 3.96; 95% CI = 1.07, 10.1). Although not at statistically significant elevations, brain/CNS cancer in females was more than fourfold higher than expected, and leukemia in white males was more than threefold higher than expected. No SIRs were statistically significantly low for any childhood race-sex group in the non-Puchack area.

Discussion

Of the 60 SIRs calculated for all age groups combined in the Puchack study area, 11 (18%) were statistically significantly high and four (7%) were statistically significantly low. For all races combined, esophageal and stomach cancer were statistically significantly elevated for both males and females. All cancers combined in males also was statistically significantly elevated while bladder cancer, brain/CNS cancer, kidney cancer, and leukemia were statistically significantly low for males. For blacks, with the exception of all cancers combined, which was statistically significantly elevated in females, the observed and expected number of cases were similar for all analyses completed for the Puchack study area. For whites in the Puchack study area, all cancers combined were statistically significantly elevated for both males and females. In addition, colorectal cancer, esophageal cancer, and stomach cancer were statistically significantly elevated for white males.

Of the 24 SIRs calculated for children in the Puchack study area, three (13%) were statistically significantly high and none were statistically significantly low. Three SIRs for Puchack study area children (13%) were zero because no cases were observed. For children living in the Puchack study area, all cancers combined in white males and leukemia and non-Hodgkin lymphoma in white females were statistically significantly elevated. Although not statistically significant, SIRs for all cancers combined in white females, and leukemia and non-Hodgkin lymphoma in white males were elevated more than twofold.

Of the 60 SIRs calculated for all age groups combined in the non-Puchack study area, five (8%) were statistically significantly high and two (3%) were statistically significantly low. For all races combined, esophageal cancer in males was statistically significantly elevated, while all cancers combined in females and bladder cancer in males were statistically significantly low. Bladder cancer in black males was statistically significantly elevated. For non-Puchack study

area whites, all cancers combined were statistically significantly elevated for both males and females, while esophageal cancer in females was also statistically significantly elevated.

Of the 24 SIRs calculated for children in the non-Puchack study area, four (17%) were statistically significantly high and none were statistically significantly low. Six SIRs for non-Puchack study area children (25%) were zero because no cases were observed. For children living in the non-Puchack study area, all cancers combined for white males and females, leukemia in white females, and brain/CNS cancers in white males were statistically significantly elevated. Although not statistically significant, SIRs for leukemia in white males and brain/CNS cancer in white females were elevated more than threefold.

A disproportionate number of SIR analyses were statistically significantly high for the Puchack study area; only 5% would be expected to be high or low by chance alone, based on the 95% confidence interval. Esophageal and stomach cancers were consistently elevated for both males and females. Both male and female whites in the Puchack study area had statistically significantly elevated SIRs for all cancers combined. In addition, white male had statistically significantly elevated SIRs for colorectal, esophageal, and stomach cancers. The non-Puchack study area displayed a similar pattern of elevated SIRs for esophageal and stomach cancer for males and females, all races combined and whites, and for all cancers combined for whites.

Furthermore, many SIRs for white children in both the Puchack and non-Puchack study areas were statistically significantly high. Inspection of the years of diagnosis for the childhood cases did not reveal any unusual time trend. Case incidence appeared to be fairly evenly distributed over the study's 20-year time period. While the Puchack Well Field was contaminated with hexavalent chromium and VOCs, it is important to note that the non-Puchack study area was served by another community water system which had documented significant contamination from VOCs at higher levels than Puchack water during the same time period.

Very limited published evidence exists to confirm that exposure to environmental contamination is associated with esophageal or stomach cancer risk. Occupational exposure to tetrachloroethylene, the solvent used in dry cleaning, might lead to greater risk of esophageal cancer (American Cancer Society 2003a). Dry cleaning workers have a higher rate of esophageal cancer. Exposure to other chemical fumes also might lead to an increased risk of esophageal cancer.

However, the most important known risk factors for esophageal cancer are use of alcohol and tobacco products, which account for over 80% of the risk of squamous cell carcinoma of the esophagus (National Cancer Institute 1996). Tobacco and alcohol use increase the risk of stomach cancer (American Cancer Society 2003b). The rate of stomach cancer is approximately twice as high in smokers compared to nonsmokers. Independent of smoking or drinking, however, a number of studies have shown an association between esophageal cancer and low socioeconomic status, which may be associated with poor nutrition. The strongest predictive component of low socioeconomic status found to be associated with cancer incidence, including esophageal cancer, is the percentage of the population below the poverty level (McWhorter, et

al. 1989). Over 35% of Camden City's population lives below the poverty level (Census 2000).

In the 1930s, stomach cancer was the leading cause of death due to cancer in the United States. Since then, the death rates (and incidence rates) have dropped dramatically, by approximately 80-90% (National Cancer Institute 1996). The decrease in stomach cancer rates is thought to be due, in part, to widespread refrigeration, which began in the 1930s. Refrigeration reduced the need for other methods of food preservation and allowed year-round access to fresh fruits and vegetables, which is thought to be beneficial in reducing the risk of stomach cancer.

Infection with the bacterium Helicobacter pylori might increase the risk of stomach cancer (American Cancer Society 2003b). Nitrates and nitrites found in food and some drinking water can be converted by certain bacteria, including Helicobacter pylori, into compounds that have been found to cause stomach cancer in animals (American Cancer Society 2003b).

A limitation of cancer studies of this type is the inability to assess actual past exposure levels in the population. The critical piece of information required to assure a meaningful evaluation of these data is actual personal exposure to the contamination, as well as other relevant risk factors over time; that is, who was exposed and who was not exposed, and the magnitude of the exposure that did occur. Because personal exposure information does not exist, residential location was used as a surrogate measure for potential past exposure. This was accomplished by aggregating and analyzing separately the population living in the census tracts which received water from the Puchack Well Field.

Although aggregating the population into distinct community water service areas might have been the best way to grossly estimate past potential exposures at the time the study was designed, it is unlikely that all of the residents in these areas were exposed to the contaminated water supply. Moreover, the length of residence of each case is unknown, thereby potentially adding to exposure misclassification. The consequence of nondifferential exposure misclassification would be to bias study results in the direction of not finding an association (i.e., no exposure-health outcome relationship) (Kelsey et al. 1996).

Another interpretation problem is that cancer is a chronic disease that takes many years after both initial and cumulative exposures to manifest as clinical disease. The information supplied by the NJSCR provides only an address at time of diagnosis for each case. No information is available on the length of time an individual may have lived at the address before diagnosis. It is possible that some cases are new, short-term residents with little or no exposure to site contaminants. Furthermore, former residents who have moved out of the study area just prior to diagnosis are not available for analysis. Population mobility cannot be accounted for in this study. The current study assumes that in- and out-migration of cases will offset one another.

Additionally, when researchers independently examine statistical associations for a large number of comparisons, it is likely that some number of false positive results will be found because of the large number of comparisons conducted. Although it is possible to statistically correct for this concern, whether such corrections are needed is controversial. Confidence

intervals are presented without adjustment for multiple comparisons.

The approach utilized for this descriptive cancer investigation was "census" based; that is, where the entire population of Camden City and the state of New Jersey were reviewed in order to calculate age-standardized incidence rate ratios by race and by sex for the study area. This "census" approach (ecologic design) is a practical surveillance or screening method for cancer incidence (Morgenstern 1995). Although this approach is well suited for providing a picture of cancer incidence in specific localities, compared to statewide rates, the cause-effect relationships cannot be evaluated. Important information on potential personal or behavioral risk factors (such as, genetics, environmental factors, parental occupation, etc.) which might explain the results, are not available for analyses using this type of study design.

Conclusion

For the Puchack area, overall cancer incidence tended to be higher than expected, particularly for whites. In the non-Puchack area, overall cancer incidence tended to be either similar to the state expectation or lower than expected, with the exception of whites, which displayed a higher number of observed than expected cases. In the Puchack area, esophageal and stomach cancers were consistently elevated. These cancer types were statistically significantly higher in males and females, all races combined, and most notably for white males. The non-Puchack area also displayed statistically significantly elevated SIRs for esophageal cancer in all males and in white females.

Overall childhood cancer in the Puchack area was not elevated; however, the cancer incidence for children was elevated in whites. Leukemia and non-Hodgkin lymphoma also were elevated in white children in the Puchack area. In the non-Puchack area, overall childhood cancer incidence was not elevated. However, as with the Puchack area, all childhood cancer incidence in whites was higher than expected. Leukemia and brain/CNS cancer also were higher than expected in the non-Puchack area.

This review of cancer incidence in Camden provides descriptive analyses for the population historically served by community water from the Puchack Well Field and, in separate analyses, the population served by another community water system. Although certain cancer types were elevated in the Puchack area, the same cancer types were elevated in the non-Puchack area. It is unclear whether the elevations found for the Puchack and non-Puchack areas were due to historic drinking water contamination documented in each of the service areas, some other shared exposure within the community, or by chance.

Recommendation

The NJDHSS and ATSDR should continue to work with community representatives to determine what additional cancer follow-up should be considered. Additionally, NJDHSS and ATSDR should continue to meet with community representatives to determine the most appropriate health education materials and outreach strategies to inform the general population about drinking water and other environmental issues in the community.

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Certification

This health consultation was prepared by the New Jersey Department of Health and Senior Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry. This health consultation is in accordance with approved methodology and procedures existing at the time it was initiated.

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The Division of Health Assessment and Consultation, ATSDR, has reviewed this health consultation and concurs with its findings.

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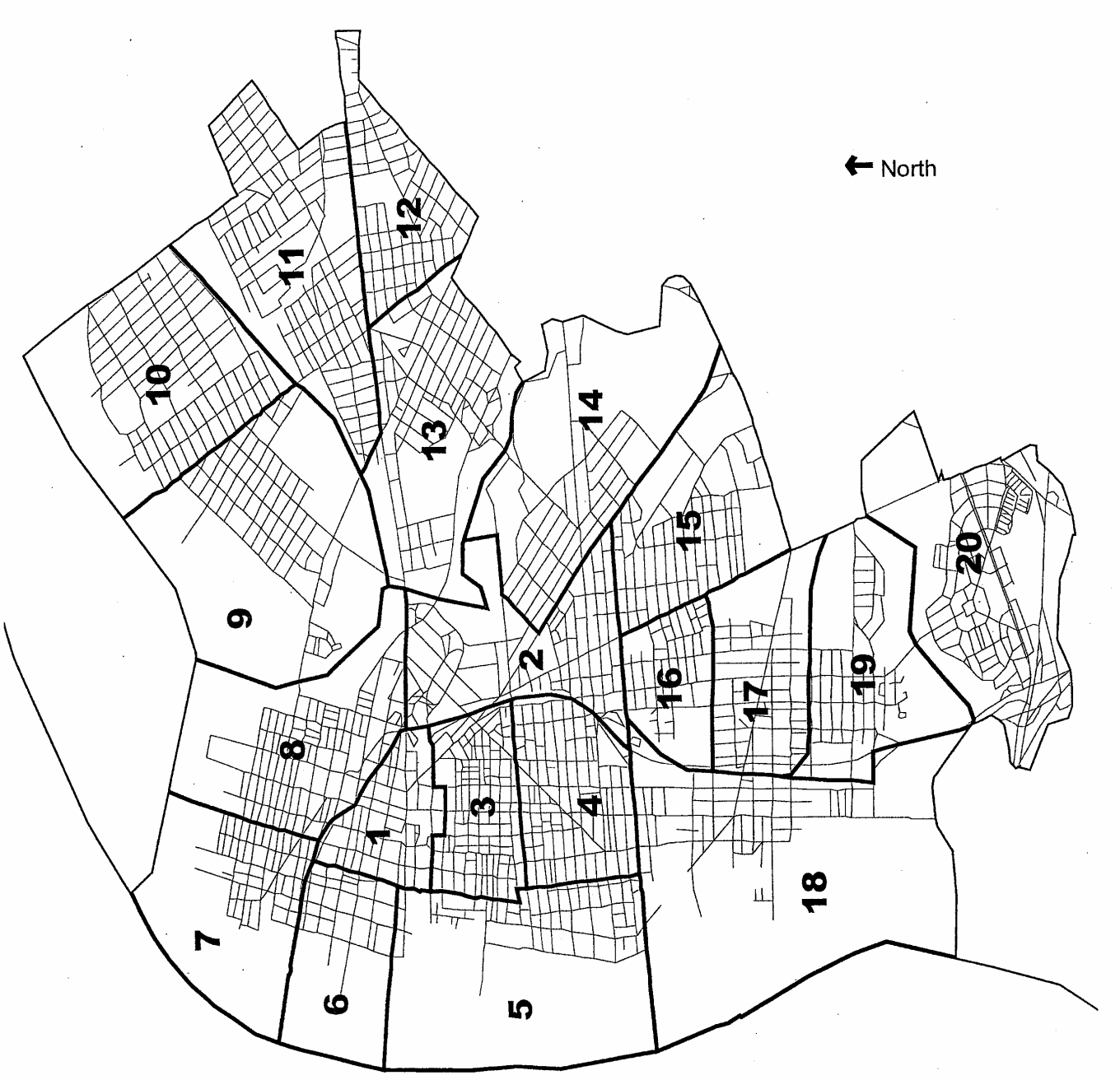
Figures and Tables

Figure I. Camden City Census Tracts



Note: Puchack study area census tracts are numbered 1 through 8 and 14 through 20.
Non-Puchack study area census tracts are numbered 9 through 13.

Table 1. Camden Population by Study Area, Race, and Sex, U.S. Census Data (1980, 1990, and 2000).

Study Area	Census Year		
	1980	1990	2000
Camden City:			
All Races Combined			
Males	39,218	41,605	38,784
Females	45,692	45,887	41,120
Black			
Males	20,594	23,031	19,912
Females	24,414	26,331	22,716
White			
Males	11,980	8,130	6,894
Females	13,759	8,490	6,560
Puchack:			
All Races Combined			
Males	25,108	25,986	24,464
Females	29,002	28,177	25,570
Black			
Males	14,878	16,007	14,915
Females	17,557	18,013	16,568
White			
Males	6,189	5,282	4,104
Females	7,021	5,260	3,676
Non-Puchack:			
All Races Combined			
Males	14,110	15,619	14,320
Females	16,690	17,710	15,550
Black			
Males	5,716	7,024	4,997
Females	6,857	8,318	6,148
White			
Males	5,791	2,848	2,790
Females	6,738	3,230	2,884

Table 2. Number of Cancer Cases by Study Area (1979-1998), Select Demographic Characteristics.

Demographic Characteristic	Study Area		
	Puchack	**Non-Puchack**	**Unknown**
Sex:			
Male	2,354	946	66
Female	2,118	925	37
Race:			
Black	2,528	647	49
White	1,873	1,171	52
Asian/Pacific Islander	8	13	0
Other	49	34	0
Unknown	14	6	2
Total	4,472	1,871	103
Age at Diagnosis:			
0-4	17	18	0
5-9	8	6	0
10-14	17	<5	<5
15-19	18	13	<5
20-24	19	17	0
25-29	50	21	<5
30-34	71	49	<5
35-39	111	63	<5
40-44	155	80	<5
45-49	211	99	<5
50-54	287	150	12
55-59	430	183	13
60-64	615	232	17
65-69	713	276	12
70-74	647	240	11
75-79	562	200	9
80-84	316	129	7
85+	225	91	5

Note: Number of cases between 0 and 5 are suppressed for confidentiality. Data from the New Jersey Department of Health and Senior Services' State Cancer Registry with analysis by the Department's Consumer and Environmental Health Services (October 2003).

Table 3. Number of Cancer Cases (1979-1998), by Cancer Type and Study Area, All Races Combined.

Cancer Type	Study Area		
	Puchack	Non-Puchack	Unknown
Oralpharynx	159	68	<5
Esophagus	93	38	<5
Stomach	136	56	<5
Small Intestine	11	9	0
Colon	408	168	6
Rectal	168	65	<5
Liver	30	17	0
Pancreas	132	32	<5
Other Digestive	51	25	<5
Lung	853	346	25
Other Respiratory	108	35	<5
Bones and Joints	12	<5	0
Soft Tissue	29	16	0
Melanoma	26	8	<5
Other Skin	26	12	0
Breast	523	238	9
Cervix	123	74	<5
Uterus	110	37	<5
Ovary	90	34	<5
Other Female Genital	23	<5	0
Prostate	533	200	9
Other Male Genital	10	11	0
Bladder	132	66	0
Kidney	78	43	<5
Other Urinary	6	<5	0
Eye	5	<5	0
Brain and Central Nervous System	45	23	<5
Thyroid	21	15	<5
Other Endocrine	6	<5	<5
Hodgkin Lymphoma	27	12	0
Non-Hodgkin Lymphoma	130	58	<5
Myeloma	78	31	<5
Leukemia	83	49	<5
Miscellaneous	188	62	13
Other	19	11	0
Total	4,472	1,871	103

Note: Number of cases between 0 and 5 are suppressed for confidentiality. Data from the New Jersey Department of Health and Senior Services' State Cancer Registry with analysis by the Department's Consumer and Environmental Health Services (October 2003).

Table 4. Number of Childhood Cancer Cases (1979-1998), by Cancer Type and Study Area, All Races Combined.

Cancer Type	Study Area		
	Puchack	Non-Puchack	Unknown
Oralpharynx	<5	0	0
Liver	<5	0	0
Other Digestive	<5	0	0
Lung	0	<5	0
Other Respiratory	<5	<5	0
Bones and Joints	<5	<5	0
Soft Tissue	<5	<5	0
Melanoma	<5	0	0
Other Skin	0	<5	0
Cervix	<5	<5	0
Ovary	<5	0	0
Other Male Genital	<5	<5	0
Kidney	0	<5	0
Eye	<5	<5	0
Brain and Central Nervous System	<5	9	<5
Thyroid	<5	<5	0
Other Endocrine	0	<5	0
Hodgkin Lymphoma	7	<5	0
Non-Hodgkin Lymphoma	7	<5	0
Leukemia	16	13	<5
Miscellaneous	<5	0	0
Total	60	41	<5

Note: Number of cases between 0 and 5 are suppressed for confidentiality. Data from the New Jersey Department of Health and Senior Services' State Cancer Registry with analysis by the Department's Consumer and Environmental Health Services (October 2003).

Table 5. Number of Cancer Cases (1979-1998), by Cancer Type and Study Area, Blacks.

Cancer Type	Study Area		
	Puchack	Non-Puchack	Unknown
Oralpharynx	100	17	<5
Esophagus	64	17	<5
Stomach	78	22	<5
Small Intestine	9	5	0
Colon	206	55	<5
Rectal	79	20	<5
Liver	15	<5	0
Pancreas	73	11	0
Other Digestive	24	6	0
Lung	521	112	11
Other Respiratory	55	9	<5
Bones and Joints	7	<5	0
Soft Tissue	21	9	0
Melanoma	6	<5	0
Other Skin	15	<5	0
Breast	305	92	5
Cervix	72	24	0
Uterus	61	8	0
Ovary	41	12	0
Other Female Genital	16	0	0
Prostate	338	99	6
Other Male Genital	<5	<5	0
Bladder	56	21	0
Kidney	44	14	<5
Other Urinary	<5	0	0
Eye	<5	<5	0
Brain and Central Nervous System	24	6	<5
Thyroid	11	8	0
Other Endocrine	5	<5	0
Hodgkin Lymphoma	13	<5	0
Non-Hodgkin Lymphoma	57	19	<5
Myeloma	55	10	<5
Leukemia	43	14	<5
Miscellaneous	107	19	6
Other	<5	0	0
Total	2,528	647	49

Note: Number of cases between 0 and 5 are suppressed for confidentiality. Data from the New Jersey Department of Health and Senior Services' State Cancer Registry with analysis by the Department's Consumer and Environmental Health Services (October 2003).

Table 6. Number of Childhood Cancer Cases (1979-1998), by Cancer Type and Study Area, Blacks

Cancer Type	Study Area		
	Puchack	Non-Puchack	Unknown
Liver	<5	0	0
Other Digestive	<5	0	0
Lung	0	<5	0
Other Respiratory	<5	0	0
Bones and Joints	<5	<5	0
Soft Tissue	<5	<5	0
Melanoma	<5	0	0
Cervix	<5	0	0
Ovary	<5	0	0
Eye	<5	<5	0
Brain and Central Nervous System	<5	<5	<5
Thyroid	<5	<5	0
Other Endocrine	0	<5	0
Hodgkin Lymphoma	<5	<5	0
Non-Hodgkin Lymphoma	<5	<5	0
Leukemia	8	<5	<5
Total	34	16	<5

Note: Number of cases between 0 and 5 are suppressed for confidentiality. Data from the New Jersey Department of Health and Senior Services' State Cancer Registry with analysis by the Department's Consumer and Environmental Health Services (October 2003).

Table 7. Number of Cancer Cases (1979-1998), by Cancer Type and Study Area, Whites.

Cancer Type	Study Area		
	Puchack	Non-Puchack	Unknown
Oralpharynx	56	50	0
Esophagus	28	18	<5
Stomach	51	32	0
Small Intestine	<5	<5	0
Colon	197	110	<5
Rectal	87	43	0
Liver	15	12	0
Pancreas	57	21	<5
Other Digestive	25	18	<5
Lung	327	229	14
Other Respiratory	53	25	<5
Bones and Joints	<5	0	0
Soft Tissue	8	6	0
Melanoma	19	6	<5
Other Skin	11	7	0
Breast	214	143	<5
Cervix	48	43	<5
Uterus	48	28	<5
Ovary	46	20	<5
Other Female Genital	7	<5	0
Prostate	185	96	<5
Other Male Genital	8	9	0
Bladder	73	45	0
Kidney	33	28	<5
Other Urinary	5	<5	0
Eye	<5	<5	0
Brain and Central Nervous System	20	16	<5
Thyroid	8	6	<5
Other Endocrine	<5	<5	<5
Hodgkin Lymphoma	13	8	0
Non-Hodgkin Lymphoma	67	36	<5
Myeloma	23	20	<5
Leukemia	37	33	<5
Miscellaneous	80	41	7
Other	15	11	0
Total	1,873	1,171	52

Note: Number of cases between 0 and 5 are suppressed for confidentiality. Data from the New Jersey Department of Health and Senior Services' State Cancer Registry with analysis by the Department's Consumer and Environmental Health Services (October 2003).

Table 8. Number of Childhood Cancer Cases (1979-1998), by Cancer Type and Study Area, Whites.

Cancer Type	Study Area		
	Puchack	**Non-Puchack**	**Unknown**
Oralpharynx	<5	0	0
Other Respiratory	0	<5	0
Soft Tissue	<5	<5	0
Other Skin	0	<5	0
Other Male Genital	<5	<5	0
Kidney	0	<5	0
Eye	<5	0	0
Brain and Central Nervous System	0	7	0
Hodgkin Lymphoma	<5	<5	0
Non-Hodgkin Lymphoma	<5	0	0
Leukemia	7	8	0
Miscellaneous	<5	0	0
Total	22	22	0

Note: Number of cases between 0 and 5 are suppressed for confidentiality. Data from the New Jersey Department of Health and Senior Services' State Cancer Registry with analysis by the Department's Consumer and Environmental Health Services (October 2003).

Table 9. Malignant Cancer Incidence (1979-1998), Puchack Study Area, SIR Analysis by Cancer Type and Sex, All Races Combined.

Cancer Type	Sex	Observed	Expected	SIR		95% CI
All Cancers Combined	Male	2,354	2,037.1	1.16	*	1.11 – 1.20
	Female	2,118	2,119.9	1.00		0.96 - 1.04
Bladder	Male	89	147.3	0.60	**	0.49 - 0.74
	Female	43	57.0	0.75		0.55 - 1.02
Brain/Central Nervous System	Male	23	35.0	0.66	**	0.42 - 0.99
	Female	22	31.3	0.70		0.44 - 1.06
Colorectal	Male	285	287.2	0.99		0.88 - 1.11
	Female	291	295.8	0.98		0.87 - 1.10
Esophagus	Male	72	31.5	2.29	*	1.79 - 2.88
	Female	21	12.5	1.69	*	1.04 - 2.58
Kidney	Male	37	54.6	0.68	**	0.48 - 0.93
	Female	41	36.6	1.12		0.80 - 1.52
Leukemia	Male	43	61.0	0.70	**	0.51 - 0.95
	Female	40	50.8	0.79		0.56 - 1.07
Liver	Male	19	16.5	1.15		0.69 - 1.80
	Female	11	8.3	1.32		0.66 - 2.37
Non-Hodgkin Lymphoma	Male	71	75.8	0.94		0.73 - 1.18
	Female	59	71.7	0.82		0.63 - 1.06
Stomach	Male	83	54.5	1.52	*	1.21 - 1.89
	Female	53	37.9	1.40	*	1.05 - 1.83

Note: *=statistically high, **= statistically low. Data from the New Jersey Department of Health and Senior Services' State Cancer Registry with analysis by the Department's Consumer and Environmental Health Services (October 2003).

Table 10. Malignant Cancer Incidence (1979-1998), Puchack Study Area, SIR Analysis by Cancer Type and Sex, Blacks.

Cancer Type	Sex	Observed	Expected	SIR		95% CI
All Cancers Combined	Male	1,303	1,293.3	1.01		0.95 - 1.06
	Female	1,225	1,122.8	1.09	*	1.03 - 1.15
Bladder	Male	31	35.0	0.89		0.60 - 1.26
	Female	25	21.8	1.15		0.74 - 1.70
Brain/Central Nervous	Male	14	12.8	1.10		0.60 - 1.84
System	Female	10	12.0	0.83		0.40 - 1.53
Colorectal	Male	134	139.9	0.96		0.80 - 1.13
	Female	151	157.4	0.96		0.81 - 1.13
Esophagus	Male	48	45.5	1.05		0.78 - 1.40
	Female	16	16.2	0.99		0.56 - 1.60
Kidney	Male	19	29.1	0.65		0.39 - 1.02
	Female	25	19.0	1.32		0.85 - 1.95
Leukemia	Male	16	25.7	0.62		0.36 - 1.01
	Female	27	23.8	1.14		0.75 - 1.65
Liver	Male	10	12.8	0.78		0.37 - 1.44
	Female	5	5.7	0.89		0.29 - 2.07
Non-Hodgkin	Male	31	34.1	0.91		0.62 - 1.29
Lymphoma	Female	26	29.1	0.89		0.58 - 1.31
Stomach	Male	45	42.4	1.06		0.77 - 1.42
	Female	33	31.2	1.06		0.73 - 1.49

Note: *=statistically high. Data from the New Jersey Department of Health and Senior Services' State Cancer Registry with analysis by the Department's Consumer and Environmental Health Services (October 2003).

Table 11. Malignant Cancer Incidence (1979-1998), Puchack Study Area, SIR Analysis by Cancer Type and Sex, Whites.

Cancer Type	Sex	Observed	Expected	SIR		95% CI
All Cancers Combined	Male	1,008	741.4	1.36	*	1.28 - 1.45
	Female	865	736.8	1.17	*	1.10 - 1.25
Bladder	Male	56	60.0	0.93		0.70 - 1.21
	Female	17	22.7	0.75		0.44 - 1.20
Brain/Central Nervous System	Male	9	10.4	0.86		0.39 - 1.64
	Female	11	9.3	1.19		0.59 - 2.12
Colorectal	Male	148	112.1	1.32	*	1.12 - 1.55
	Female	136	117.5	1.16		0.97 - 1.37
Esophagus	Male	23	9.8	2.36	*	1.49 - 3.53
	Female	5	4.2	1.20		0.39 - 2.79
Kidney	Male	17	19.3	0.88		0.51 - 1.41
	Female	16	13.1	1.22		0.70 - 1.98
Leukemia	Male	24	20.3	1.18		0.76 - 1.76
	Female	13	17.1	0.76		0.40 - 1.30
Liver	Male	9	5.3	1.69		0.77 - 3.21
	Female	6	2.9	2.08		0.76 - 4.52
Non-Hodgkin Lymphoma	Male	36	25.6	1.40		0.98 - 1.94
	Female	31	25.8	1.20		0.82 - 1.70
Stomach	Male	34	19.8	1.72	*	1.19 - 2.40
	Female	17	14.3	1.19		0.69 - 1.91

Note: *=statistically high. Data from the New Jersey Department of Health and Senior Services' State Cancer Registry with analysis by the Department's Consumer and Environmental Health Services (October 2003).

Table 12. Childhood Cancer Incidence (1979-1998), Puchack Study Area, SIR Analysis by Cancer Type, Race, and Sex.

Cancer Type	Sex	Observed	Expected	SIR		95% CI
All Races Combined:						
All Cancers Combined	Male	37	37.8	0.98		0.69 - 1.35
	Female	23	31.8	0.72		0.46 - 1.08
Brain/Central Nervous System	Male	<5	NR	0.44		0.09 - 1.28
	Female	<5	NR	0.18		0.00 - 1.01
Leukemia	Male	9	10.0	0.90		0.41 - 1.71
	Female	7	7.9	0.89		0.36 - 1.84
Non-Hodgkin Lymphoma	Male	5	3.6	1.41		0.45 - 3.29
	Female	<5	NR	1.38		0.15 - 4.97
Black:						
All Cancers Combined	Male	21	18.1	1.16		0.72 - 1.77
	Female	13	16.2	0.80		0.43 - 1.37
Brain/Central Nervous System	Male	<5	NR	0.95		0.19 - 2.79
	Female	<5	NR	0.34		0.00 - 1.88
Leukemia	Male	5	3.4	1.45		0.47 - 3.39
	Female	<5	NR	0.84		0.17 - 2.45
Non-Hodgkin Lymphoma	Male	<5	NR	1.58		0.32 - 4.29
	Female	0	0.9	0		-
White:						
All Cancers Combined	Male	13	5.0	2.61	*	1.39 - 4.46
	Female	9	4.2	2.16		0.99 - 4.11
Brain/Central Nervous System	Male	0	0.9	0		-
	Female	0	0.7	0		-
Leukemia	Male	<5	NR	2.17		0.44 - 6.33
	Female	<5	NR	3.78	*	1.02 - 9.68
Non-Hodgkin Lymphoma	Male	<5	NR	4.38		0.49 - 15.8
	Female	<5	NR	11.0	*	1.24 - 39.8

Note: *=statistically high. Data from the New Jersey Department of Health and Senior Services' State Cancer Registry with analysis by the Department's Consumer and Environmental Health Services (October 2003).

Table 13. Malignant Cancer Incidence (1979-1998), Non-Puchack Study Area, SIR Analysis by Cancer Type and Sex, All Races Combined.

Cancer Type	Sex	Observed	Expected	SIR		95% CI
All Cancers Combined	Male	946	934.3	1.01		0.95 - 1.08
	Female	925	1,003.5	0.92	**	0.86 - 0.98
Bladder	Male	46	66.1	0.70	**	0.51 - 0.93
	Female	20	25.5	0.78		0.48 - 1.21
Brain/Central Nervous System	Male	12	18.4	0.65		0.34 - 1.14
	Female	11	16.5	0.67		0.33 - 1.19
Colorectal	Male	113	128.7	0.88		0.72 - 1.06
	Female	120	131.0	0.92		0.76 - 1.10
Esophagus	Male	28	14.5	1.94	*	1.29 - 2.80
	Female	10	5.6	1.80		0.86 - 3.31
Kidney	Male	24	25.6	0.94		0.60 - 1.40
	Female	19	17.2	1.11		0.67 - 1.73
Leukemia	Male	27	30.5	0.89		0.58 - 1.29
	Female	22	25.3	0.87		0.54 - 1.32
Liver	Male	12	7.7	1.56		0.80 - 2.72
	Female	5	3.9	1.29		0.42 - 3.02
Non-Hodgkin Lymphoma	Male	30	36.8	0.81		0.55 - 1.16
	Female	28	34.0	0.82		0.55 - 1.19
Stomach	Male	32	24.7	1.29		0.88 - 1.83
	Female	24	16.8	1.43		0.91 - 2.12

Note: *=statistically high, **= statistically low. Data from the New Jersey Department of Health and Senior Services' State Cancer Registry with analysis by the Department's Consumer and Environmental Health Services (October 2003).

Table 14. Malignant Cancer Incidence (1979-1998), Non-Puchack Study Area, SIR Analysis by Cancer Type and Sex, Blacks.

Cancer Type	Sex	Observed	Expected	SIR		95% CI
All Cancers Combined	Male	348	325.3	1.07		0.96 - 1.19
	Female	299	310.1	0.96		0.86 - 1.08
Bladder	Male	15	8.2	1.83	*	1.02 - 3.02
	Female	6	5.1	1.17		0.43 - 2.55
Brain/Central Nervous System	Male	<5	NR	0.69		0.14 - 2.01
	Female	<5	NR	0.70		0.14 - 2.06
Colorectal	Male	36	34.1	1.06		0.74 - 1.46
	Female	39	38.0	1.03		0.73 - 1.40
Esophagus	Male	14	11.9	1.18		0.64 - 1.98
	Female	<5	NR	0.72		0.14 - 2.10
Kidney	Male	10	7.9	1.27		0.61 - 2.33
	Female	<5	NR	0.75		0.20 - 1.91
Leukemia	Male	8	7.6	1.05		0.45 - 2.07
	Female	6	7.2	0.84		0.31 - 1.83
Liver	Male	<5	NR	0.86		0.17 - 2.51
	Female	0	1.5	-		-
Non-Hodgkin Lymphoma	Male	14	10.8	1.30		0.71 - 2.17
	Female	5	8.7	0.57		0.18 - 1.34
Stomach	Male	11	10.4	1.06		0.53 - 1.90
	Female	11	7.3	1.50		0.75 - 2.69

Note: *=statistically high. Data from the New Jersey Department of Health and Senior Services' State Cancer Registry with analysis by the Department's Consumer and Environmental Health Services (October 2003).

Table 15. Malignant Cancer Incidence (1979-1998), Non-Puchack Study Area, SIR Analysis by Cancer Type and Sex, Whites.

Cancer Type	Sex	Observed	Expected	SIR		95% CI
All Cancers Combined	Male	570	490.3	1.16	*	1.07 - 1.26
	Female	601	498.9	1.20	*	1.11 - 1.30
Bladder	Male	31	39.5	0.78		0.53 - 1.11
	Female	14	15.0	0.93		0.51 - 1.56
Brain/Central Nervous	Male	9	7.1	1.27		0.58 - 2.41
System	Female	7	6.6	1.07		0.43 - 2.20
Colorectal	Male	76	73.9	1.03		0.81 - 1.29
	Female	77	76.9	1.00		0.79 - 1.25
Esophagus	Male	11	6.5	1.69		0.84 - 3.03
	Female	7	2.8	2.54	*	1.02 - 5.24
Kidney	Male	14	12.9	1.08		0.59 - 1.82
	Female	14	8.8	1.59		0.87 - 2.66
Leukemia	Male	17	13.7	1.24		0.72 - 1.99
	Female	16	11.7	1.37		0.78 - 2.22
Liver	Male	7	3.6	1.97		0.79 - 4.05
	Female	5	1.9	2.62		0.84 - 6.10
Non-Hodgkin	Male	14	17.0	0.82		0.45 - 1.38
Lymphoma	Female	22	17.3	1.27		0.80 - 1.92
Stomach	Male	19	13.0	1.46		0.88 - 2.28
	Female	13	9.3	1.39		0.74 - 2.39

Note: *=statistically high. Data from the New Jersey Department of Health and Senior Services' State Cancer Registry with analysis by the Department's Consumer and Environmental Health Services (October 2003).

Table 16. Childhood Cancer Incidence (1979-1998), Non-Puchack Study Area, SIR Analysis by Cancer Type, Race, and Sex.

Cancer Type	Sex	Observed	Expected	SIR		95% CI
All Races Combined:						
All Cancers Combined	Male	21	25.1	0.84		0.52 - 1.28
	Female	20	21.3	0.94		0.57 - 1.45
Brain/Central Nervous System	Male	<5	NR	0.87		0.23 - 2.22
	Female	5	3.7	1.35		0.43 - 3.15
Leukemia	Male	9	6.7	1.34		0.61 - 2.54
	Female	<5	NR	0.75		0.20 - 1.91
Non-Hodgkin Lymphoma	Male	<5	2.4	0.85		0.10 - 3.08
	Female	0	NR	0		-
Black:						
All Cancers Combined	Male	7	8.6	0.82		0.33 - 1.68
	Female	9	7.7	1.16		0.53 - 2.21
Brain/Central Nervous System	Male	0	1.5	0		-
	Female	<5	NR	0.69		0.01 - 3.86
Leukemia	Male	<5	NR	2.42		0.65 - 6.19
	Female	0	1.7	0		-
Non-Hodgkin Lymphoma	Male	<5	NR	2.25		0.25 - 8.12
	Female	0	0.9	0		-
White:						
All Cancers Combined	Male	13	4.8	2.69	*	1.43 - 4.61
	Female	9	4.1	2.19	*	1.00 - 4.17
Brain/Central Nervous System	Male	<5	NR	4.68	*	1.26 - 12.0
	Female	<5	NR	4.43		0.89 - 13.0
Leukemia	Male	<5	NR	3.06		0.82 - 7.83
	Female	<5	NR	3.96	*	1.07 - 10.1
Non-Hodgkin Lymphoma	Male	0	0.5	0		-
	Female	0	0.2	0		-

Note: *=statistically high. Data from the New Jersey Department of Health and Senior Services' State Cancer Registry with analysis by the Department's Consumer and Environmental Health Services (October 2003).